VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"Jnana Sangama" Belagavi – 590 018

PROJECT REPORT ON

"AUTO DELIVERY BOT"

Submitted in partial fulfillment of the requirements for the award of degree

BACHELOR OF ENGINEERING
IN
ELECTRONICS & COMMUNICATION ENGINEERING

Submitted By

Name	USN
Akshay	4AL20EC004
Chaithrashree M G	4AL20EC008
Pavan K H	4AL20EC030
Pratham M P	4AL20EC035

Under the Guidance of
Mrs. Vijetha T S
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

ALVA'S INSTITUTE OF ENGINEERING & TECHNOLOGY

A+, Accredited by NAAC & NBA

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(Affiliated to VTU, **BELAGAVI**)

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

CERTIFICATE

Certified that the project work entitled "**AUTO DELIVERY BOT**" *is a bona fide work carried out by*

Akshay	**4AL20EC004**
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Pavan K H	**4AL20EC030**
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in partial fulfillment for the award of **BACHELOR OF ENGINEERING** in **ELECTRONICS & COMMUNICATION ENGINEERING** of the **VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI** during the year 2023–2024. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of Project work prescribed for the Bachelor of Engineering Degree.

Signature of the Guide	**Signature of the H.O.D**	**Signature of the Principal**
Mrs. Vijetha T S	**Dr. Siddesh G K**	**Dr. Peter Fernandes**

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ABSTRACT

This paper presents a delivery bot system aimed at providing precise, efficient, and affordable last-mile delivery services accessible to all, leveraging the versatility and affordability of Raspberry Pi technology. The system integrates a range of hardware components and software functionalities to achieve its objectives. Hardware features include ultrasonic and infrared sensors for obstacle detection, ensuring safe navigation in diverse environments. Actuators and motor drivers enable precise movement and control, enhancing the bot's agility and responsiveness. The Raspberry Pi acts as the central processing unit, orchestrating data processing, communication with peripherals, and execution of navigation algorithms. Software functionalities encompass route optimization algorithms and user-friendly graphical user interfaces (GUIs) for intuitive control. By combining these elements, the delivery bot offers a cost-effective and reliable solution for last-mile delivery, empowering businesses and individuals alike to access efficient and affordable delivery services. This project demonstrates the practical application of Raspberry Pi technology in addressing real-world logistical challenges and highlights the potential for future advancements in autonomous delivery systems.

ACKNOWLEDGEMENT

The project of any research work depends so much on: the quality of education received the quality of teachers, research resources and enabling and encouraging environment. Studying in **Alva’s Institute of Engineering and Technology**, Mijar provides all these above-mentioned facilities which have made possible the successful outcome of this project work.

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Our gratitude goes to our guide, **Mrs. Vijetha T S.**, Assistant Professor, Department of Electronics and Communication, AIET, who is our source of encouragement and motivation throughout this project. Without her valuable guidance, this work would never have been a successful one.

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LIST OF ABBREVIATIONS

AGV	Automated Guided Vehicles
AI	Artificial Intelligence
API	Application User Interface
AS	Automated Storage
AVS	Automated Vehicle Storage
CPU	Central Processing Unit
CSI	Camera Serial Interface
DC	Direct Current
GND	Ground
GPIO	General-Purpose Input /Output
GPS	Global Positioning System
GPU	Graphic Processing Unit
GSM	Global System Monitoring
GUI	Graphical User Interface
HRI	Human-robot interaction
IC	Integrated Circuit
IDE	Integrated Development Environment
IR	Infrared Ray
LAN	Local Area Network
LED	Light Emitting Diode
LIDAR	Light Detection and Ranging
MMH	Manual Materials Handling
NM	Newton Meter

OS	Operating System
PWM	Pulse Width Modulation
QR	Quick Response
RPM	Revolutions Per Minute
SDA	Serial Data
SNR	Signal to Noise Ratio
SPI	Serial Peripheral Interface
USB	Universal Serial Bus
UI	User Interface
VS	Visual Studio
WSN	Wireless Sensor Networks

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 Prelude

In an era defined by rapid technological advancements and the ever-growing demand for efficient logistics solutions, the Manual Handling Delivery Bot emerges as a pioneering endeavour. Leveraging the capabilities of Raspberry Pi, along with a selection of hardware components and open-source software, this project endeavours to bridge the gap between manual control and automated delivery systems. By amalgamating the precision of sensors with the flexibility of human intervention, the Manual Handling Delivery Bot aspires to revolutionize last-mile logistics.

The genesis of the Manual Handling Delivery Bot project stems from the recognition of a critical need in contemporary logistics frameworks. While automated delivery systems have garnered significant attention for their efficiency and scalability, they often fall short in accommodating the intricacies of dynamic environments. The unpredictability of obstacles, varying terrains, and nuanced delivery requirements necessitates a solution that can adapt swiftly and seamlessly. It is within this context that the concept of a manually guided delivery bot gains relevance. The Delivery Bot represents a departure from the conventional dichotomy of fully automated and entirely manual delivery systems. Instead, it embraces a hybrid approach that amalgamates the best of both worlds. By empowering human operators with intuitive control interfaces and equipping the bot with sensors for situational awareness, this project aims to achieve a harmonious synergy between human expertise and technological precision.

It will delve into the intricacies of hardware integration, software development, and user interface design. Through meticulous experimentation and iterative refinement, it will strive to unlock the full potential of the Manual Handling Delivery Bot. Moreover, explore the broader implications of such a solution in enhancing efficiency, reducing costs, and improving user experience in the realm of last-mile logistics.

1.2 Importance of Delivery Bot in Modern Logistics

In the ever-evolving landscape of logistics and commerce, delivery bots emerge as a transformative force, reshaping traditional paradigms and offering innovative solutions to age-old challenges. At the heart of their significance lies a myriad of benefits that span efficiency, cost savings, scalability, accessibility, safety, environmental sustainability, customer experience, and innovation.

Efficiency stands as a cornerstone of the delivery bot revolution. These autonomous entities navigate the intricacies of urban landscapes and suburban sprawls with unparalleled precision, optimizing routes and circumventing traffic snarls to deliver goods swiftly and seamlessly. By automating routine tasks and minimizing human intervention, delivery bots unlock new levels of operational efficiency, ensuring timely deliveries and reducing overhead costs for businesses.

In tandem with efficiency comes cost savings, a paramount consideration for any logistics operation. Delivery bots offer a compelling proposition, promising to slash labor expenses, fuel costs, and vehicle maintenance expenditures. With their ability to operate round-the-clock without succumbing to fatigue or scheduling constraints, these bots represent a cost-effective alternative to traditional delivery methods, particularly in high-volume and time-sensitive scenarios.

Scalability emerges as another key advantage of delivery bots, empowering businesses to adapt and expand their delivery operations in response to fluctuating demand. Unlike traditional delivery models that hinge on the availability of human resources, scaling up with bots is a matter of deploying additional units, a process that can be executed swiftly and seamlessly. This scalability not only enhances operational flexibility but also positions businesses to capitalize on growth opportunities in dynamic market environments.

Accessibility, particularly in underserved or remote areas, is a compelling driver of the adoption of delivery bots. These autonomous entities traverse rugged terrains and navigate narrow alleyways with ease, extending the reach of delivery services to previously inaccessible regions. For communities grappling with limited access to goods and services, delivery bots represent a lifeline, offering a reliable and efficient means of obtaining essential provisions.

Safety and security considerations further underscore the importance of delivery bots in modern logistics frameworks. Equipped with advanced sensors and surveillance systems, these bots possess the acumen to detect and evade obstacles, mitigating the risk of accidents and collisions. Furthermore, secure locking mechanisms safeguard goods in transit, assuaging concerns related to theft and tampering, thereby instilling confidence in both businesses and consumers.

Environmental sustainability emerges as a compelling rationale for the adoption of delivery bots, aligning with broader efforts to mitigate the ecological footprint of logistics operations. With their reliance on electric or alternative fuel sources, delivery bots represent a greener alternative to traditional delivery vehicles, curtailing carbon emissions and promoting environmental stewardship. Additionally, optimization algorithms minimize fuel consumption by devising the most efficient delivery routes, further reducing the ecological impact of transportation activities.

1.3 Block Diagram

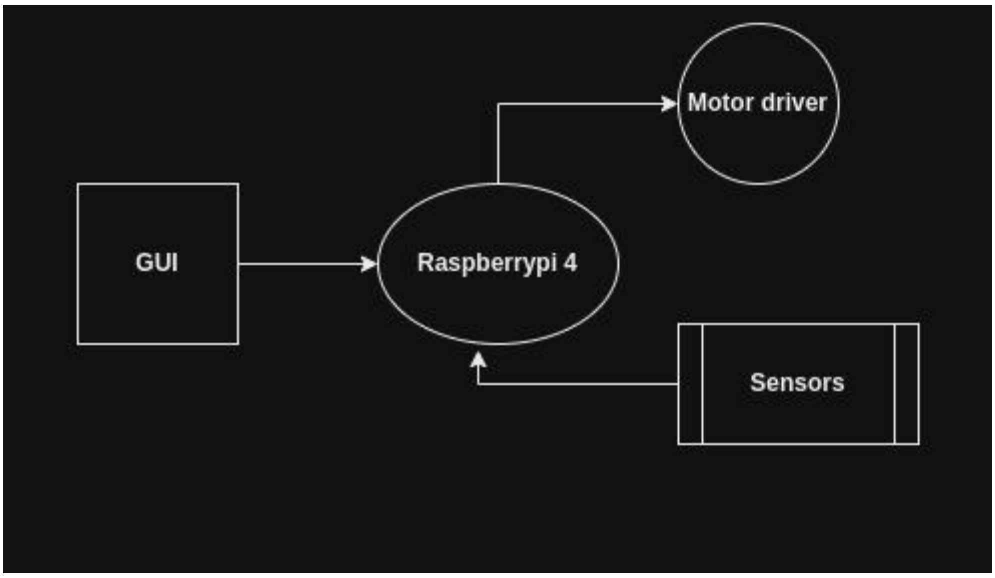

Figure 1.1: Basic Block Diagram Delivery Bot

The Delivery Bot consists of central component raspberry pi, a powerful credit-card sized single board computer which controls operation of the system as shown in Figure 1.1. It receives data from various sensors, like magnetometers for navigation and unspecified sensors for environment details. This data is then processed by the microcontroller, which makes decisions based on it. These decisions are then sent to motor drivers, which control the movement of servo motors for precise positioning or other actuators. An LCD display can be interfaced to show operational data or user instructions. This cycle of sensing, processing, and acting allows the robot to interact with its environment.

1.4 Motivation

The motivation behind the development of the Manual Handling Delivery Bot project stems from the recognition of pressing challenges and untapped opportunities within the realm of last-mile logistics. Traditional delivery methods face constraints such as inefficiencies in manual handling, limited scalability, and environmental concerns. By leveraging advancements in robotics, sensor technologies, and automation, this project seeks to revolutionize delivery operations. Motivated by the prospect of enhancing efficiency, reducing costs, and improving customer experience, the project aims to bridge the gap between manual control and automated delivery systems. Moreover, the project is driven by a commitment to sustainability, aiming to minimize environmental impact while maximizing operational effectiveness. Ultimately, the Manual Handling Delivery Bot project aspires to redefine the future of delivery logistics, offering innovative solutions to meet the evolving demands of modern commerce while contributing to a more connected, efficient, and sustainable world.

1.5 Issues of the project

The implementation of the Manual Handling Delivery Bot project entails addressing several potential issues and challenges that could impact its successful deployment. Ensuring the reliability of hardware components, such as the Raspberry Pi and sensors, is crucial to prevent malfunctions during operation. Accuracy and stability in obstacle detection and navigation algorithms are paramount for safe and efficient bot movement. Additionally, designing an intuitive and user-friendly GUI interface is essential to facilitate manual control by users. Software stability and power management must be carefully monitored to prevent system crashes and optimize battery life. Attention to security measures is necessary to safeguard sensitive data and comply with regulatory requirements. By addressing these challenges through rigorous testing, continuous monitoring, and collaboration with experts, the project can overcome obstacles and achieve its objectives effectively.

1.6 Objectives

The objective of the Manual Handling Delivery Bot project is to design, develop, and implement an autonomous delivery system capable of efficiently transporting goods in last-mile logistics scenarios. This includes integrating hardware components such as sensors, actuators, and control systems, as well as developing sophisticated software algorithms for navigation, obstacle avoidance, and user interaction. The project aims to address challenges in traditional delivery methods by improving efficiency, reducing costs, and enhancing scalability. Additionally, ensuring safety, regulatory compliance, and environmental sustainability are key objectives. Ultimately, the project seeks to demonstrate the viability of autonomous delivery systems in real-world applications, paving the way for advancements in logistics automation and contributing to the evolution of future delivery technologies.

1.7 Tools used

In the development of delivery bots, a combination of hardware, software, and specialized equipment is essential. Hardware components like motors, wheels, sensors, and actuators form the physical foundation, enabling movement, perception, and interaction with the environment. Software platforms provide autonomy, navigation, and decision-making capabilities, leveraging algorithms and machine learning techniques. Specialized equipment includes payload compartments, temperature-controlled chambers, and secure locking mechanisms for efficient and secure delivery operations. Additionally, communication protocols facilitate seamless interaction between the bot, its control system, and external interfaces. Overall, these tools work in tandem to ensure the effectiveness, efficiency, and safety of delivery bots in real-world logistics scenarios.

➢ Hardware tools

- ❖ Raspberry pi 4
- ❖ Ultrasonic sensor
- ❖ IR sensor
- ❖ Buzzer
- ❖ Motor driver L2958N
- ❖ 12v power supply
- ❖ Chasis and wheels
- ❖ LED
- ❖ Jumper wires

➢ Software tools

- ❖ Raspbean OS
- ❖ Python 3
- ❖ Turtle module
- ❖ Tkinter module

1.8 Applications

1. Medical Fields

Transporting Medical Supplies: The delivery bot can be used to transport medical supplies, equipment, and medications within hospitals, clinics, and pharmacies, ensuring timely delivery and efficient inventory management.

Lab Sample Collection: It can also be employed for collecting and transporting lab samples from patient rooms to laboratory facilities, reducing the risk of contamination and improving turnaround times for test results.

2. E-Commerce Deliveries

Last-Mile Delivery: E-commerce companies can utilize the delivery bot for last-mile delivery of online orders to customers' homes.

Offering faster and more cost-effective delivery options compared to traditional courier services.

Parcel Pickup/Drop-off Points: The delivery bot can be integrated with parcel lockers or pickup points, allowing customers to conveniently retrieve or return packages at designated locations without relying on human couriers.

3. Food Deliveries

Restaurant Deliveries: Restaurants, cafes, and food delivery services can deploy the delivery bot to transport food orders from kitchens to customers' doorsteps, ensuring timely delivery and minimizing delivery costs.

Commercial Kitchens: It can also be used within commercial kitchens for transporting prepared meals, ingredients, and supplies between different sections or locations, improving operational efficiency.

4. Waste Collection

Trash Collection: The delivery bot can assist in waste collection by autonomously transporting trash bins or containers from households or commercial establishments to collection points or waste disposal facilities.

Recycling Collection: It can also be utilized for collecting recyclable materials, such as paper, plastic, and glass, from designated recycling bins or centers, promoting sustainability and efficient waste management practices.

5. Medical Supplies Delivery

Hospitals and Clinics: Manual delivery bots can transport essential medical supplies, medications, and equipment within hospital premises, ensuring timely delivery to different departments, patient rooms, and operating theaters.

Home Healthcare: Healthcare providers can utilize delivery bots to deliver medical supplies, prescriptions, and equipment to patients' homes, especially for individuals with chronic conditions or limited mobility.

6. Library and Bookstore Services

Library Book Delivery: Libraries can employ manual delivery bots to transport books and other library materials between branches, storage facilities, and patrons' homes, offering a convenient and efficient way to access library resources.

Bookstore Deliveries: Bookstores can use delivery bots for same-day or next-day delivery of purchased books, magazines, and other reading materials to customers' residences or designated pickup locations, enhancing customer satisfaction and loyalty.

LITERATURE SURVEY

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

The motive of this chapter is to provide a background information on the factors that has to be considered for the proposed system and also it emphasizes to check if the there is any similarities in the work carried out by other authors.

The literature survey for the Manual Handling Delivery Bot project constitutes a meticulous exploration of scholarly articles, technical reports, and advancements in the domains of manual handling delivery systems, autonomous robotics, and last-mile logistics. This comprehensive analysis serves as a cornerstone for delineating prominent trends, discerning prevailing challenges, and identifying nascent opportunities within the realm of automated delivery solutions. By scrutinizing pertinent literature, our endeavor is to glean profound insights into cutting-edge technologies, exemplary methodologies, and prospective avenues for innovation. This foundational exploration not only underpins the conceptualization and execution of our project but also endeavors to foster the enrichment and evolution of manual handling delivery systems. Our aspiration through this survey is to contribute substantively to the advancement of delivery logistics, elevating standards of efficiency, dependability, and sustainability in contemporary supply chain operations.

2.2 Literature Survey

Kartikeya [1] “Medicine Delivery Bot Using Time Series and Object Detection”: Emergency situations, which led to the creation of this The research article presents a novel idea for the delivery of urgent medications. It suggests a delivery bot that uses deep learning algorithms to identify and categorize traffic signals and optimize route planning for quick and safe deliveries. It draws attention to the shortcomings of manual delivery methods, particularly in creative bot to guarantee quicker and more dependable deliveries, even in distant locations.

The bot seeks to eliminate delays commonly seen at crossings, improving efficiency and security, by employing AI-driven prediction algorithms to direct traffic and provide safe paths. The suggested model represents a substantial breakthrough in the field of urgent medication deliveries by including user-friendly elements like OTP authentication for consumers and providing a quick, affordable fix to the drawbacks of manual delivery methods.

Shin [2] “An Automated Truck Platoon for Energy Saving Sadayuki Tsugawa”, This study examines the creation and assessment of an automated truck platoon in relation tothe 2008- launched national Intelligent Transportation Systems project known as "Energy ITS." The platoon, made up of three fully automated trucks, drives on an expressway and test track at 80 km/h while changing lanes and maintaining a 10-meter gap. For lane marker detection, the lateral control uses computer vision, and the longitudinal control uses 5.8 GHz DSRC for inter-vehicle communications and 76 GHz radar and lidar for gap measurement. With its emphasis on high reliability, the technology is positioned for use in the near future. Measuring fuel consumption during platooning reveals a noteworthy 14% decrease in fuel consumption. Evaluation simulations suggest a 2.1% reduction in CO_2 emissions along an expressway with a 40% penetration of heavy trucks using the 10-meter gap platooning configuration. The paper concludes by discussing the potential introduction scenarios for this innovative automated truck platoon system.

Mamatha al. [3] “Smart Ai Based Delivery Robot” : The concept of an autonomous robot that can move items from one place to another without assistance from a human highlights the rise of automated delivery systems in India. This technology ensures safe and effective travel by using sensors to navigate obstacles. With its autonomous delivery capabilities, the robot uses AI to navigate pre-established routes and safely deliver packets when it reaches its target. The study highlights the automated dependability and effectiveness of the system, highlighting its potential application in a variety of industries, including food delivery, hospitals, and self-driving automobiles. Customers may retrieve packets securely since a One Time Password (OTP) mechanism has been included. This paradigm offers a viable approach to safe, contactless delivery and raises the possibility of more improvements and developments in automated delivery systems.

Mokter Hossain. [4] “Autonomous Delivery Robot”: Delivery services have been transformed by autonomous delivery robots (ADRs), but compared to technical research, there are remarkably few studies that address ADRs from a business standpoint. By analyzing academic and non-academic literature, this study seeks to close this knowledge gap and compile the state of the art regarding ADRs. Key theoretical implications are outlined in the discussion: Even though ADRs take many different forms, there is still a dearth of research in the more general business and management fields, despite the rapid expansion of technical studies. Theoretical implications of ADRs are vast, but current literature undervalues factors like blockchain and artificial intelligence that are propelling their development. This review aims to bring together disparate information regarding alternative dispute resolution (ADR) systems and their developing characteristics. It highlights the growing efficacy of specific ADR formats while also underscoring the necessity of thorough business and management research to completely comprehend their implications in delivery services.

D Lee, et al. [5] “Assistive delivery robot application for real world postal services”. This paper introduces a robot system that is designed to assist postal workers by carrying heavy packages in a complex urban environment such as apartment complex. Since most of such areas do not have access to reliable GPS signal reception, we propose a 3-D point cloud map based matching localization with robust position estimation along with a perception-based visual serving algorithm. The delivery robot is also designed to communicate with the control center so that the operator can monitor the current and past situation using onboard videos, obstacle information, and emergency stop logs.

Mohd Ariffanan Mohd Basri, et al. [6] “Design of Sub-Systems for GPS-Guided Autonomous Delivery Robot System”: The use of autonomous robots for delivery services is a new potential goldmine. Furthermore, since the e- commerce and delivery industry are growing at a rapid rate, it is recommended that a system that could handle the high-volume traffic as well serve as a new customer attraction, be implemented. Therefore, this work aims to develop the Autonomous Delivery Robot System (ADRS) that could be utilized for delivery services from the early stage of development. The ADRS uses the Arduino microcontroller to run a program. The developed system consists of three main sub-systems, namely, mobile robot, mobile application and cloud server. The mobile robot is equipped with features such as navigation system, obstacle detection system, container lock system and real-time monitoring system to manoeuvre it autonomously. The ultrasonic sensors are used for obstacle detection, coupled with a Global Positioning System (GPS) for the navigation purpose. The ADRS ensures a human contact less and secure delivery while carry the delivery packages. Only the customer can unlock the container using the one-step authentication via mobile application.

Buchegger,et al . [7] “An autonomous vehicle for parcel delivery in urban areas”: The flexible and individualized transportation of goods is a central task of today's economy. In urban and highly populated areas autonomous electric vehicles are a promising solution for this task while simultaneously addressing ecological issues. While in indoor environments transport robots are well adopted, autonomous transport vehicles are hardly seen outdoors. In this paper, we aim at this gap and adapt and transfer concepts usually used in robotics to autonomous vehicles for an outdoor environment. We present an autonomous vehicle that is able to safely navigate in urban environments while able to deliver parcels efficiently. In particular, we will discuss a scalable and robust mapping and navigation process that forms the basis for the capabilities of the delivery vehicle. Moreover, we show preliminary results of a deployment of the system in two urban scenarios.

Sankari, et al. [8] “Automatic Delivering System in Hospital Using GPS Technology and Efficient Fault Management”: The Automatic Delivery Robots are being used to deliver the medicines, juice, water bottles, medicinal measuring devices, and breads. But they are facing some of the difficulties regarding the localization of specific places around and within the Hospital because they are currently using some updated techniques such as landmark recognition and RFID tags. These methods are unreliable and inaccurate, also they require a careful watching and initialization of Hardware in the hospital. Also, some more computations are needed for searching the landmarks hence increasing the cost of the whole Project. In this project, the researchers introduce a Multiliterate Technique using Smart Global Positioning System(S-GPS). The S-GPS network makes out of Fault tolerances in case of Sensor failures. A Novel based algorithm is being used to find the localization of places and therefore improved Navigation and Delivery of needed items and patients records.

Hossain, M. et al. [9] “Self-Driving Robots”: A Revolution in the Local Delivery,” California Management Review, 2022: Self-driving robots are revolutionizing foods, groceries, and package deliveries. They are a reality and becoming a part of urban life in many cities. Initially, people are curious about robots but after robots have been in an area for some time, they get used to it. They provide convenient services to improve our everyday life. In the USA alone, robots are used on more than a dozen college campuses for food delivery. The typical size of delivery robots is like luggage. Some robots are similarly small sized and others are significantly larger and heavier. Small-sized robots run through side walks and the larger ones on public roads. Estonian-origin Starship robots have delivered two million autonomous deliveries in different cities across the world since they started three years ago

Murad Mehrab Abrar, et al. [10] “An Autonomous Delivery Robot to Prevent the Spread of Coronavirus in Product Delivery System”: In light of the COVID- 19 epidemic, this study presents an autonomous delivery robot that is intended to provide safe, contactless distribution. The prototype enables safe product movement to GPS-defined locations by utilizing a password protected container system. Tests verify that it has excellent navigational accuracy and password security, ensuring package integrity. This creative approach has the potential to revolutionize logistics in addition to securely addressing urgent pandemic problems by transporting necessities. Its lightweight, crash-safe design and user-friendly interface provide an effective and scalable last-mile delivery option that may lower expenses and relieve urban traffic congestion. This study provides a window into the revolutionary developments that autonomous delivery robots may bring about in the future by demonstrating how they might improve contactless delivery services and resolve significant logistical issues.

Akshet “Med Buddy, [11] “The Medicine Delivery Robot”: In order to safeguard medical personnel from the possibility of contracting the coronavirus while caring for patients in general wards, the "Med Buddy" project was created. Remote medicine delivery to patients is made possible by the system, which uses a Bluetooth- controlled robot car built with and Arduino Uno microcontroller and an additional smartphone for live feed via an application created with MIT App Inventor. This lowers the risk for medical staff by minimizing needless contact and ensuring timely medication administration. The conclusion highlights the growing use of AI-driven healthcare solutions and cites the effectiveness of AI chat bots and self assessment bots used by healthcare institutions. The potential of robots like Med Buddy to contribute to patient and medical staff safety is highlighted, with the broader implication that such technologies will continue to play a crucial role in addressing healthcare challenges, including the ongoing battle against COVID-19.

Neil Mathew, et al. [12] “Planning Paths for Package Delivery in Heterogeneous”: This work tackles the difficult problem of path planning and scheduling for a group of cooperating cars making deliveries autonomously in cities. The team consists of a street-based truck and a delivery-focused quadrotor micro-aerial vehicle. The goal of the problem, which is presented as an optimal path planning challenge on agraph, is to determine the shortest cooperative route that the quadrotor can take in order to deliver items at different locations. The study proves that the problem is NP-hard and suggests asolution by splitting it up into the extensively researched Generalized Traveling Salesman Problem. For the unique scenario of planning deliveries from several static warehouses, two more algorithms are presented. The simulation results demonstrate the algorithms' performance and provide insights into practical uses for urban street maps. With potential applications in a variety of scenarios, including search and rescue, surveillance, and exploration, the paper's contribution to adapting a hetero generous carrier-vehicle system for cooperative deliveries in urban environments is highlighted in the conclusion. It is recommended that future research broadens the scope of the approach to accommodate more simultaneous deliveries, higher quadrotor capacities, and dynamic scenarios where requests change while being executed.

Anton Vorina ,et al . [13] “Autonomous delivery robots and their contribution during the pandemic”: The study examines the importance of autonomous delivery robots, with particular attention on Starship from Starship Technologies and Scout from Amazon. Due to their critical responsibilities during the epidemic, these robots made it possible for groceries and other necessities to be delivered contactless. Scout had a bigger cargo than Starship since it was noticeably quicker and heavier. Given that there are expectations that these technologies will soon be widely used, their influence highlights how important they are to society. The study recognizes their dynamic character and continuous progress in the domain, suggesting a path for increasingly sophisticated self-governing machines in many industries.

Kichun Jo, et al . [14] “Development of Autonomous Car: Distributed System Architecture “: In order to address the complexity of autonomous driving algorithms with heterogeneous sensors and computing components, this paper introduces a distributed system architecture for autonomous cars. Guidelines for developing and integrating distributed systems are included in the suggested development process, with a focus on fault tolerance, modularity, and less computational complexity. The layered architecture and AUTOSAR inspiration of the system platform are intended to improve the application software's reusability, scalability, transferability, and maintainability. The FlexRay network protocol enhances system performance overall, fault tolerance, and network bandwidth. The paper ends with a summary of the next Part II, which will use an autonomous car navigating an urban environment to assess the system platform and development process. In the future, the system may be used in a variety of industrial domains outside autonomous cars, such as unmanned vehicles and factory automation. It will also introduce an optimization algorithm for mapping software components to computing units

Francesco Bullo, et al . [15] “Dynamic Vehicle Routing for Robotic Systems “: With an emphasis on the automatic planning of the best multivehicle routes for tasks that are generated over time. This paper offers a thorough overview of recent developments in dynamic vehicle routing (DVR).The robotics applications covered by the surveyed scenarios are diverse and take into account various factors, including vehicle motion constraints, impatient demands, priority levels of demand, and communication and sensing capabilities. The work takes a rigorous technical approach, combining techniques from stochastic geometry, combinatorial optimization, and queueing theory. It addresses problems like stability, quality of service, and successful demand servicing by defining fundamental performance bounds and designing algorithms with provable guarantees. Dynamics, combinatorial optimization, and distributed algorithms are all integrated into the joint algorithmic and queueing approach that is presented. In order to demonstrate the potential of dynamic vehicle routing in addressing various challenges in robotic systems operating in dynamic and uncertain environments, the paper concludes by outlining future directions. These include the consideration of moving demands, limited-range on-board sensors, dynamic pickup and delivery, vehicle refilling constraints, and human-supervised demand servicing.

Dae-Nyeon Kim, et al . [16] “Object Recognition of Outdoor Environment by Segmented Regions for Robot Navigation”: When an autonomous robot navigates, it is likely for him to set specific a target. This paper focuses on object recognition. He also needs avoid objects when he encounters obstacle, and Know where he is and know further path take, he.

To recognize an object, we classify object into artificial and natural. Then we define their characteristics individually. We segment the object after the process of preprocessing. Image segmentation delineates boundaries between meaningful components, while object recognition attempts to find instances of objects within an image. We propose a method to segment objects of outdoor environment using multiple features. To analyses and recognize specific object, our method used property of segmented objects. This paper proposed the method object recognition of outdoor environment using segmented region by multiple features. The PCs are used to recognize the building. The meshes of parallelograms can help us to detect more. In addition, the relation of geometrical properties as the height and the number of windows can be exploited to analyze more information of building. For example, how many rooms the building has. This process is preprocessing objects from an image taken by moving robot in an outdoor environment.

Vikas Kumar, et al . [17] " Delivery Robots for Last-mile Logistics Operations: provide a comprehensive review of delivery robots for last-mile logistics operations. They emphasize the significance of the last-mile phase in logistics and the challenges associated with it. The authors discuss the increasing interest in delivery robots as a potential solution to address these challenges, offering benefits such as improved efficiency, reduced costs, and enhanced sustainability. The paper explores various types of delivery robots, including ground-based robots, aerial drones, and autonomous vehicles. Kumar et al. examine the key features, functionalities, and technological aspects of these robots, such as perception, navigation, manipulation, and communication systems. They highlight the advancements in robot hardware and software that have contributed to their increased capabilities and adaptability in real-world logistics scenarios. Furthermore, the authors discuss the operational considerations of deploying delivery robots, including route planning, fleet coordination, load capacity, and safety regulations. They delve into the integration of delivery robots with existing logistics infrastructure, examining the challenges of interoperability and the need for standardized. The Delivery Robot 3 interfaces. Kumar et al. also addresses social acceptance and public perception of delivery robots, discussing factors such as privacy, security, and the impact on employment. The paper concludes by identifying research gaps and potential future developments in the field of delivery robots for last-mile logistics. The authors emphasize the need for further advancements in areas such as artificial intelligence, sensing technologies, and human-robot interaction to enhance the capabilities and acceptance of these robots. They highlight the importance of interdisciplinary collaborations and partnerships between academia, industry, and policymakers to foster the successful implementation of delivery robots in last-mile logistics operations. In summary, Kumar, Moreira, and Scholler’s' review paper provides a comprehensive overview of delivery robots for last-mile logistics operations. It explores various types of robots, their features, and technological aspects. The authors discuss operational considerations, integration challenges, and social acceptance factors. The paper identifies research gaps and emphasizes the need for future advancements and collaborations in the field.

Alexander Buchegger ,et al . [18] “An Autonomous Vehicle for Parcel Delivery in Urban Areas”, To allow autonomous transport vehicles to be used for transportation tasks in large-scale outdoor environments proven approaches from the robotics domain needs to be applied and transferred to these new environments. In this paper, we present an integrated autonomous transport vehicle which addresses these problems and is able to deliver parcels in urban environments such as city centers automatically. The developed transport vehicle is based on a commercial electrical personal vehicle. It was adapted for autonomous control and equipped with improved navigation skills for outdoor environments based on a topological navigation approach. The integrated vehicle was evaluated in realistic delivery use cases where parcels are delivered autonomously to addresses in a larger urban area. The main contributions of this paper are: (1) the adaptation of well known algorithms for robot navigation for large-scale urban environments, (2) an integration of these algorithms in a commercially available electrical vehicle, (3) the improvement of the robustness of the approach by integrating additional from Open Street Map (OSM), and (4) an evaluation of the autonomous delivery concept in real urban environments such as an university campus or a city center.

Nalinaksh, [19] "Delivery Robots in Logistics: A Review of Recent Advances and Challenges". (2021): In the paper "Delivery Robots in Logistics: A Review of Recent Advances and Challenges" by Nalinaksh Vyas and Arindam Ghosh (2021), the authors provide a thorough examination of the latest developments and obstacles concerning delivery robots in the field of logistics. They emphasize the significance of last-mile delivery and how delivery robots can contribute to overcoming the associated difficulties in the supply chain. The authors discuss different types of delivery robots, such as ground-based robots, aerial drones, and autonomous vehicles, outlining their capabilities, limitations, and practical applications. They also explore the technological progress made in robot perception, navigation, and manipulation, which has significantly improved the performance and feasibility of delivery robots.

Aniket, [20] “Design and Development of Autonomous Delivery Robot” 2019 The field of autonomous robots is growing rapidly in the world, in terms of both the diversity of emerging applications and the levels of interest among traditional players in the automotive, truck, public transportation, industrial, and military communities. Autonomous robotic systems offer the potential for significant enhancements in safety and operational efficiency. Due to the meteoric growth of e- commerce, developing faster, more affordable and sustainable last-mile deliveries become more important. In this paper, Autonomous robot including the cyber physical architecture of the robots as well as the renderings of CAD models are illustrated. Designing new solutions including catadioptric cameras that output panoramic views of the scene, i.e., images with very large fields of view. It describes the problem of state estimation and localization of a robot in detail. In order to navigate accurately around the world, the robot must know its location in the world and the map exactly. A robot can move smoothly only if itis properly localized. An inaccurate localization may cause the robot to vary on the roads or behave erroneously which are serious issues when the robot is completely autonomous.

Murad, et.al, [21] “An Autonomous Delivery Robot to Prevent the Spread of Coronavirus in Product Delivery System Robots and autonomous vehicles” can help to ease the stress on the existing home delivery while reducing the risk of virus transmission by mitigating direct human contact. In this regard, we have developed a cost effective autonomous mobile robot prototype for the purpose of increasing the last mile delivery efficiency as well as ensuring a secure and contactless package delivery. An autonomous mobile robot is a self driving vehicle that does not require any operation from operator to navigate the robot. The movements and trajectory are predefined before the operation and the robot navigates accordingly. Among various navigation techniques, we have used the Global Positioning System (GPS) data for autonomous navigation of the robot and the destination is predefined as latitude and longitude points in the program of the robot. The main advantage of using GPS for navigation is that the data received from the GPS are independent of the previous readings; therefore, it is easy to minimize errors. A digital compass measures the heading angle of the robot and helps the robot to find the direction of the trajectory. The robot is equipped with a password protected container which protects the package against theft, damage and unprotected human contact. This password can be sent to the customer by a text message from the service company. Once the robot arrives at its delivery location, the only person who has the password will be able to unlock its delivery.

Alfandari, et al. [22] "A tailored Benders decomposition approach for lastmile delivery with autonomous robots," European Journal of Operational Research, vol. 299, no. 2, pp. 510–525, 2022: This work addresses an operational problem of a logistics service provider that consists of finding an optimal route for a vehicle carrying customer parcels from a central depot to selected facilities, from where autonomous devices like robots are launched to perform last-mile deliveries. The objective is to minimize a tardiness indicator based on the customer delivery deadlines. This article provides a better understanding of how three major tardiness indicators can be used to improve the quality of service by minimizing the maximum tardiness, the total tardiness, or the number of late deliveries. We study the problem complexity, devise a unifying Mixed Integer Programming formulation and propose an efficient branch-and-Benders-cut scheme to deal with instances of realistic size. Numerical results show that this novel Benders approach with a tailored combinatorial algorithm for generating Benders cuts largely outperforms all other alternatives. In our managerial study, we vary the number of available facilities, the coverage radius of autonomous robots and their speed, to assess their impact on the quality of service and environmental costs.

Marc-Oliver, et al. [23] "Autonomous Unmanned Ground Vehicles for Urban Logistics: Optimization of Last Mile Delivery": In an era dominated by ongoing urbanization and rising e- commerce, the efficient delivery of goods within cities becomes a major challenge. As a new element of urban logistics, we discuss the potential of autonomous unmanned ground vehicles (AUGV) regarding the last mile delivery of shipments to customers. We propose an optimization model to minimize the delivery costs of urban shipments using AUGV. Simultaneously, best locations from a set of existing stations are selected for AUGV positioning and optimal route determination. With our developed Location Routing Problem, we provide decision support for parcel service providers, city authorities, and other relevant decision makers. Regarding the Green Information Systems domain, we tackle the lack of solution-oriented research addressing a more sustainable and locally emission free supply of goods within urban area.

Akiya Kamimura, et al. [24] “Automatic Locomotion Design and Experiments for a Modular Robotic System”: In order to overcome the difficulties caused by the various configurations and degrees of freedom found in modular robots, the paper that is being presented presents a novel method for achieving whole-body locomotion in these systems. For each module, the suggested approach uses neural oscillators—more precisely, central pattern generators, or CPGs—as distributed joint controllers. By incorporating a genetic algorithm, the CPG network is optimized and a unified framework for creating effective locomotion controllers that can be customized to fit any module configuration is provided. Through hardware experiments and software simulations using the modular robotic system M-TRAN II, the authors verify that their approach is effective in producing stable and adaptive locomotion in a range of configurations. By highlighting the potential of neural oscillator networks to achieve reliable and adaptable locomotion, the study makes a significant contribution to the field of modular robotics.

Yuan, et al. [25] “Path Planning for Unmanned Delivery”: This work explores a crucial area of autonomous navigation for mobile robots operating in difficult surroundings during unmanned delivery duties. It suggests some methods which is designed to enhance autonomous path planning. The algorithm aims to improve convergence speed, accuracy, and balance between global exploration and local mining functions by integrating strategies such as adaptive nonlinear inertia weight strategies, oppositionbased learning, and modified initial wolf pack generation. These strategies address limitations in the current algorithm. In order to reduce algorithm complexity, it also uses another algorithm for initial population formation. The algorithm's competitiveness and efficacy in providing delivery robots with appropriate pathways are demonstrated by the simulation results. The study does highlight certain areas for development, including the necessity of increased stability, decreased time, and space.

Lee H Y and Murray C [26] have proposed “Robotics in order picking”: Evaluating warehouse layouts for pick, place, and transport vehicle routing systems. With recent advancements in mobile robotics, this paper explores a novel approach to warehouse order picking using specialized picker and transporter robots. Termed the pick, place, and transport vehicle routing problem (PPT-VRP), this study seeks to minimize the time required to deliver items from storage locations to a packing station. A mixed integer linear programming formulation is developed to address key research questions regarding the optimal composition of robot fleets and the impact of warehouse layout designs on system performance.

Yahya, [27] have proposed Integration and Optimisation of an RFID-Enabled Inventory Management System of a Future Generation Warehousing System Thesis for the Degree of Doctor of Philosophy. This thesis investigates the design theories and optimization methodologies for future generation warehousing systems, focusing on real-time inventory visibility and accuracy. With the rise of online shopping and centralized distribution centers, there is a growing demand for efficient and cost-effective warehousing solutions. The research proposes an RFID-based inventory management system integrated with automated storage and retrieval mechanisms to achieve optimal material handling and operational efficiency.

Tejesh and Neeraja [28] have proposed Warehouse inventory management system using IoT and open-source framework. Warehouses play a crucial role in storing goods, but locating products within them manually can be time-consuming and labor-intensive. To address this challenge, warehouse inventory management systems are essential, and RFID technology offers significant advantages in this regard. This paper presents a novel warehouse inventory management system based on RFID and Internet of Things (IoT) architecture, utilizing Raspberry Pi as a central server and a web interface for user interaction.

Anusha [29] has proposed Automation in Wireless Control System: A Small Review Study of Automation of Water Motor using ZigBee. Embedded systems, combining software and hardware, are commonly employed for various technical tasks, including remote control of AC motors. This paper investigates the design and development of a wireless AC motor speed control system using Zigbee modules. Zigbee technology, operating on the IEEE 802.15.4 standard, enables low-cost, low-power wireless communication in M2M networks. The study aims to explore the integration of Zigbee technology for efficient AC motor control and considers potential extensions using Wi-Fi and GSM modems.

Ravivand [30] have proposed Optimal inventory management of a bike-sharing station. Bike-sharing systems (BSSs) have become popular in urban areas, offering convenient short-term bicycle rentals. Effective management of bike inventory and locker availability at stations is crucial for the success of such systems. This article introduces an inventory model tailored for BSSs and presents a numerical solution method along with a proof of the model's convexity. The study also discusses the broader applicability of the model to closed-loop inventory systems and presents an extensive numerical study based on real-life data to demonstrate its effectiveness.

Smith et al [31] have proposed a Automated Warehousing Systems. This paper provides a comprehensive review of recent advancements in automated warehousing systems. It discusses various technologies such as robotics, RFID, and wireless communication systems employed in modern warehouses. The review also highlights future trends and challenges in the field.

Michael and Jennifer [32] have proposed Integration of Robotics in Warehouse Operations. his study investigates the integration of robotics in warehouse operations through a series of case studies. It evaluates the impact of robotics on efficiency, accuracy, and safety in different warehouse environments. The findings offer insights into best practices for implementing robotic systems in warehouses.

Robert and Jessica [33] have proposed Wireless Communication Protocols for Warehouse Automation: A Comparative Analysis. This study compares different wireless communication protocols used in warehouse automation systems. It evaluates factors such as reliability, throughput, and power consumption to determine the suitability of each protocol for warehouse applications. The findings help guide the selection of appropriate communication technologies in warehouse automation projects.

Alexander and Maria [34] have proposed Safety Considerations in Implementing Robotic Systems in Warehouses. This paper discusses safety considerations associated with the deployment of robotic systems in warehouses. It examines potential hazards such as collisions, falls, and entrapment, and proposes strategies for mitigating these risks. The paper also highlights the importance of safety standards and training programs for warehouse personnel working alongside robots.

Kshitija [35] have proposed Robotic Navigation and Inventory Management in Warehouses. This paper highlights the limitations of traditional human-operated warehouses, including fatigue, errors, and inefficiency. It proposes a solution in the form of automated warehouse systems using robots. These robots would enhance speed, precision, and safety within the warehouse.

You and Ji [36] have proposed Design of a Multi-robot Bin Packing System in an Automatic Warehouse. The paper discusses multi-agent motion planning, a crucial area in robotics for efficiently controlling multiple robots. The growing demand for specialized robots, like those used in bin packing systems, highlights the need for improved warehouse automation. However, challenges like localization, safety, and limited space make deploying mobile robots for indoor tasks difficult. The paper also acknowledges the ongoing challenge of multi-agent motion planning, particularly resolving conflicts between robots. Centralized approaches suffer from limitations like the curse of dimensionality and high computational complexity. To address this, the authors built upon previous work with the extended collision map method. Their proposed (M,D) network model analyzes the mutual relationships between robots in collision zones. This model can not only handle collisions between two robots but also account for complex interactions involving more than three robots. The model facilitates collision-free operation and helps determine task completion times for multiple robots.

Nils Boysen, et al. [37] have proposed Parts-to-picker based order processing in a rack-moving mobile robots environment. This paper describes research on a specific type of warehouse system - Kiva warehouses - that utilizes mobile robots to deliver storage racks directly to pickers, eliminating picker travel time. The paper focuses on optimizing order processing within picking stations in such warehouses.

Amato [38] have proposed An approach to control automated warehouse systems. This paper contributes significantly to the field of automated warehouse control by proposing a comprehensive framework that integrates modeling, optimization, and real-world validation. By addressing the limitations of the simplifying assumptions and exploring the potential of advanced data analytics, future research can further refine and extend the applicability of this approach.

Azadeh K, et al. [39] have proposed Robotized and automated warehouse systems: Review and recent developments. A key finding of the paper is the lack of extensive academic research on these new robotized systems despite their growing prevalence in practice. This highlights the need for further investigation into these technologies. The paper emphasizes the unique features of these systems, such as autonomous control and dynamic operation, which necessitate novel models and methodologies for addressing design and operational challenges. The paper concludes by looking towards the future of warehousing, where integrated robotized systems are projected to become the norm. This will require a complete re-evaluation of traditional warehouse design, planning, and control practices. Aspects like layout design, storage selection, order picking strategies, and task allocation will all need to be revisited to optimize operations within these new, automated environments.

Jiang M, et al. [40] have proposed Picking-replenishment synchronization for robotic forward-reserve warehouses. Forward-reserve strategies are a common approach in warehouses that handle a large volume of small orders. These strategies involve keeping frequently picked items in a forward area readily accessible to pickers. However, this approach can suffer from inefficiencies in the forward area, particularly when robotic systems are used to retrieve pick locations and deliver them to workers. This paper addresses the challenge of optimizing efficiency in robotic forward-reserve warehouses. It proposes a novel Picking-Replenishment Synchronization Mechanism (PRSM) that aims to achieve an optimal balance between replenishing forward-reserve stock and maintaining picking efficiency.

2.3 Summary

From the above Literature survey, the major attributes used for the contributions of significant studies and survey of existing works, the following major points are considered for delivery bot.

- ❖ Technological Advancements: Highlighting significant technological advancements in manual handling delivery systems and autonomous robotics, such as advancements in sensor technology, navigation algorithms, and motion control systems.

- Challenges in Last-Mile Logistics: Identifying key challenges in last-mile logistics, including traffic congestion, urban infrastructure limitations, delivery density, and customer preferences, and how these challenges impact the design and implementation of delivery bots.
- Human-Robot Interaction: Exploring research on Human-Robot Interaction (HRI) and user interface design principles to inform the development of intuitive GUIs for manual control of the delivery bot and enhance user experience.
- Safety and Regulatory Compliance: Discussing safety standards, regulations, and guidelines relevant to autonomous robots and delivery systems to ensure compliance and mitigate risks associated with deployment in real-world environments.
- Environmental Sustainability: Examining literature on sustainable logistics practices and eco-friendly delivery solutions, such as electric vehicles and green logistics strategies, to promote environmental sustainability in delivery operations.
- Case Studies and Best Practices: Reviewing case studies and best practices from existing implementations of manual handling delivery systems and autonomous robots to draw lessons learned and practical insights for the project.
- Integration with Smart City Infrastructure: Investigating the integration of delivery bot systems with emerging smart city infrastructure, such as smart traffic management systems, IoT networks, and urban planning initiatives, to optimize route planning, reduce congestion, and enhance overall efficiency.
- Data Security and Privacy: Addressing concerns related to data security and privacy in delivery bot operations, including secure transmission of sensitive information, protection against cyber threats, and adherence to data protection regulations to safeguard customer information and maintain trust in the service.
- Scalability and Fleet Management: Exploring strategies for scalability and fleet management in the deployment of delivery bots, including fleet coordination algorithms, dynamic resource allocation techniques, and scalability challenges associated with expanding operations to meet varying demand levels and geographic regions.

PROPOSED SYSTEM

CHAPTER 3

PROPOSED SYSTEM

3.1 Introduction

The delivery bot primarily focuses on providing the user with precise, efficient, and affordable last-mile delivery services accessible to the common man. Leveraging the versatility and affordability of the Raspberry Pi 4, the system integrates a range of hardware components and software functionalities to achieve its objectives. Hardware components include sensors such as ultrasonic and infrared sensors for obstacle detection, ensuring safe navigation in diverse environments. Additionally, actuators and motor drivers enable precise movement and control of the delivery bot, enhancing its agility and responsiveness. The Raspberry Pi 4 serves as the central processing unit, orchestrating data processing, communication with peripherals, and execution of navigation algorithms. Software functionalities encompass route optimization algorithms, user-friendly Graphical User Interfaces (GUIs) for intuitive control. By combining these hardware components and software functionalities, the delivery bot offers a cost-effective and reliable solution for last-mile delivery, empowering businesses and individuals alike to access efficient and affordable delivery services.

3.2 Advantages

- ❖ Efficiency through autonomous navigation.
- ❖ Cost-effectiveness with affordable components like Raspberry Pi 4.
- ❖ Accessibility to delivery services, especially in remote areas.
- ❖ Precision in navigation and delivery.
- ❖ Scalability for expanding delivery operations.
- ❖ Safety features including obstacle detection.
- ❖ Environmental sustainability by optimizing routes and reducing fuel consumption.
- ❖ Innovation in last-mile logistics with autonomous technology.

3.3 Workflow of the system

The overall working of the system is controlled by Raspberry Pi, which takes care of all the data transfer activities. The power supply is given to Raspberry Pi which in turn gives power supply to all the sensors as shown in the Figure 3.1.

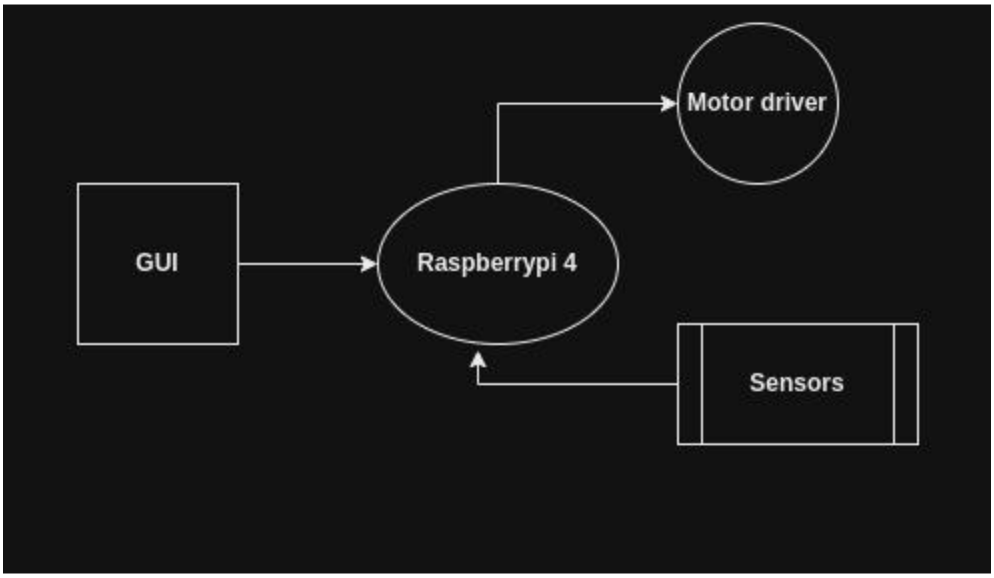

Figure 3.1 Workflow of the system

3.4 Methodology

The methodology for developing the manual delivery bot system entails several key steps. It begins with thorough project planning and requirements gathering to define objectives and gather stakeholder input. Following this, system design and architecture are established, outlining the overall structure and functionality of the system. Software development involves implementing the Graphical User Interface (GUI) using Python's tkinter library, as well as developing algorithms for obstacle avoidance, path planning, and package delivery. Hardware setup and integration involve calibrating sensors, configuring the Raspberry Pi 4, and setting up essential components like the buzzer and motor drive. Testing and validation ensure the system functions reliably under various conditions, while deployment and implementation involve deploying the system in a real-world environment and conducting training sessions for operators. Finally, ongoing maintenance and optimization involve regular upkeep, performance analysis, and incorporating updates based on user feedback, ensuring the system remains efficient and effective over time.

Step 1: Initial Setup

The initial setup of the delivery bot system involves the creation of a user-friendly Graphical User Interface (GUI) using Python's tkinter library, allowing users to input key parameters such as the starting and destination points, as well as the type of delivery. This GUI serves as the control panel for the entire system, facilitating smooth interaction between operators and the delivery bot. Additionally, modules like turtle and time might be utilized to visualize the bot's movement and schedule tasks within the interface, providing a comprehensive user experience.

Step 2: Sensor Interfacing

The hardware setup phase encompasses the calibration and integration of essential sensors such as UV and IR sensors into the delivery bot system. This calibration ensures accurate detection of obstacles and environmental conditions along the delivery route. Furthermore, configuring the Raspberry Pi 4 with Raspbian OS serves as the central processing unit for the bot, while setting up the buzzer provides auditory alerts or notifications. Additionally, configuring the motor drive and regulating proper power supply to all components are critical for seamless operation.

Step 3: Data Logging

Data logging is vital for tracking the bot's movement and operations throughout the delivery process. This step involves creating a grid system using tkinter and turtle to visually map the bot's trajectory from the starting point to the destination. Concurrently, mechanisms are established to log relevant data such as coordinates, timestamps, and sensor readings. This data logging facilitates analysis, troubleshooting, and optimization of the delivery process, ensuring efficiency and reliability.

Step 4: Obstacle Avoidance

To ensure safe navigation, a custom algorithm is developed using Python 3 to enable the bot to detect and avoid obstacles along its path. Leveraging sensor data, the algorithm dynamically adjusts the bot's trajectory to navigate around obstacles while adhering to the delivery route. This obstacle avoidance mechanism enhances the bot's autonomy and reliability, minimizing the risk of collisions and ensuring successful delivery completion.

Step 5: Package Delivery

The final step entails initiating the package delivery process and confirming successful delivery to the customer. Upon reaching the destination, the bot triggers the sending of a delivery confirmation email to the customer's email address using Python's SMTP module. This email includes pertinent delivery details and prompts the customer to confirm receipt. Once confirmation is received, the delivery process is initiated, marking the culmination of a seamless and transparent delivery experience.

3.5 Summary

The chapter discusses the methodology of the proposed system and it briefs about the hardware and software control flow. It also provides some information about the data acquisition process from multiple nodes. The workflow of the system is explained step by step in this section.

HARDWARE AND SOFTWARE REQUIREMENTS

CHAPTER 4

HARDWARE AND SOFTWARE REQUIREMENTS

4.1 Introduction

This chapter gives brief idea about various hardware and software tools/components used in Design and Implementation of delivery bot. The Raspberry Pi 4 is user as the micro-computer. The explanation to various parts of delivery bot is given below.

4.2 Block diagram

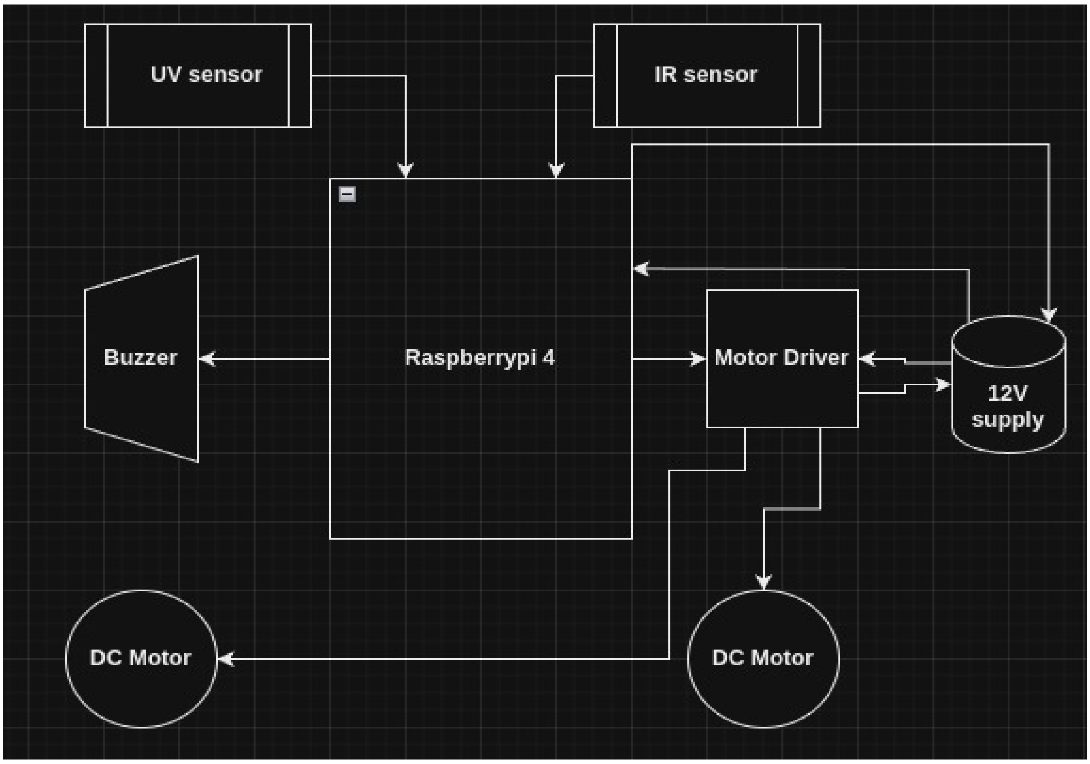

Figure 4.1 Block diagram of delivery bot

The Figure 4.1 shows the Block Diagram of a delivery bot using Raspberry Pi 4 with a buzzer, a motor driver, and a 12v supply. Here's a breakdown of the components:

➢ Hardware tools

- ❖ Raspberry pi 4
- ❖ Ultrasonic sensor
- ❖ IR sensor
- ❖ Buzzer
- ❖ Motor driver L2958N
- ❖ 12v power supply
- ❖ Chasis and wheels
- ❖ LED
- ❖ Servo motor
- ❖ Jumper wires

➢ Software tools

- ❖ Raspbean OS
- ❖ Python 3
- ❖ Turtle module
- ❖ Tkinter module

4.3 Raspberry Pi 4

Raspberry Pi 4 is a 64-bit quad-core processor with 1.4GHz clock frequency. It comes with dual band wireless LAN, Bluetooth 4.2/BLE (Bluetooth Low Energy), faster Ethernet and Power over Ethernet support shown in Figure 4.2.

Figure 4.2 Raspberry Pi 4

The Raspberry Pi 4 Model B is the latest product in the Raspberry Pi range, boasting a 64-bit quad core processor running at 1.5GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 5.0/BLE, true Gigabit Ethernet, and PoE capability via a separate PoE HAT.

- ❖ A high-performance 64-bit quad-core processor
- ❖ Dual display support with resolutions up to 4K via a pair of micro-HDMI ports
- ❖ Hardware video decoding up to 4Kp60
- ❖ 4 GB of RAM
- ❖ A connection to the dual-band wireless local area network 2.4/5.0 GHz
- ❖ Bluetooth 5.0 / Gigabit Ethernet / USB 3.0 / PoE features (via a separate HAT PoE add-on module).

4.4 Sensors

Sensors are indispensable components of modern technology, facilitating the measurement and detection of a wide range of physical phenomena and environmental conditions. These electronic devices serve as the eyes and ears of countless applications across diverse industries, including automotive, healthcare, and manufacturing. Sensors provide crucial data for decision-making and control systems. They operate by converting physical signals into electrical signals, which can then be processed and analyzed by associated circuitry. Whether based on changes in resistance, capacitance, voltage, or utilizing optical, acoustic, or magnetic principles, sensors come in various forms tailored to specific sensing tasks. Recent advancements have led to the development of miniaturized, highly sensitive sensors capable of real-time monitoring in compact devices. With the rise of the Internet of Things, sensors play a pivotal role in enabling connectivity and data exchange between interconnected devices, contributing to the emergence of smart systems and environments. From ensuring safety and efficiency in smart homes and wearable devices to optimizing processes in industrial automation, sensors continue to drive innovation and progress. However, maintaining their accuracy and reliability through regular calibration and maintenance remains crucial for their effective operation. Looking ahead, ongoing advancements in sensor technology promise to unlock new capabilities and applications, shaping the future of technology and society.

4.4.1 Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver.

In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation is D = ½ T x C (where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second). For example, if a scientist set up an ultrasonic sensor aimed at a box and it took 0.025 seconds for the sound to bounce back, the distance between the ultrasonic sensor and the box would be:

$$D = 0.5 \times 0.025 \times 343$$

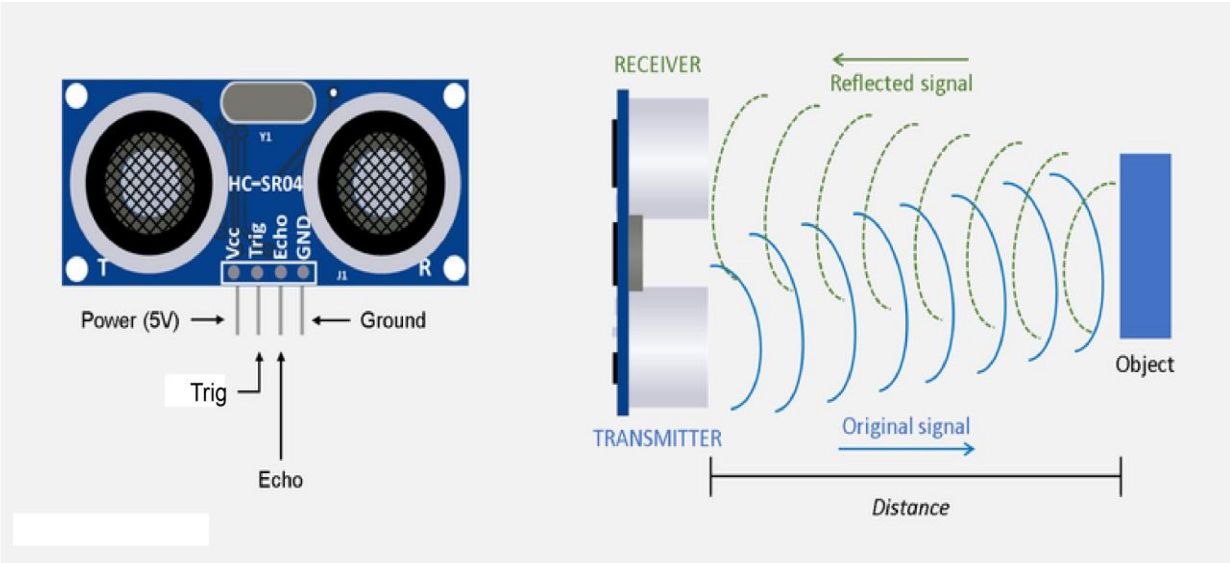

Figure 4.3 Ultrasonic Sensor

Ultrasonic Sensors serve as indispensable tools for navigation and obstacle avoidance as shown in Figure 4.3. These sensors emit high-frequency sound waves and measure the time it takes for the sound waves to bounce back after hitting an object. By analysing the reflected signals, ultrasonic sensors can accurately determine the distance between the delivery bot and obstacles in its path.

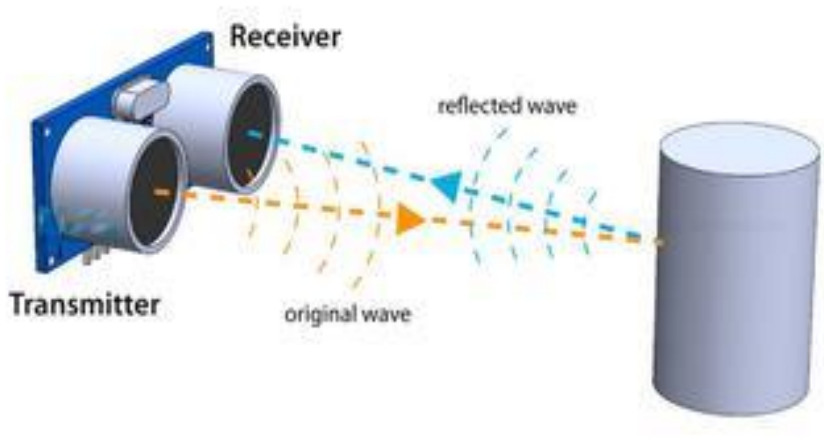

Figure 4.4 Working of Ultrasonic sensor

Working of ultrasonic sensor as shown in Figure 4.4 in the context of a delivery bot, ultrasonic sensors play a critical role in ensuring safe and efficient movement through its environment. As the bot traverses its route, ultrasonic sensors continuously scan the surroundings, detecting obstacles such as walls, furniture, or other objects. Upon detecting an obstacle within its proximity, the delivery bot can adjust its course or come to a halt to avoid collisions.

Ultrasonic sensors enable the delivery bot to navigate through narrow spaces and tight corners with precision. By providing real-time feedback on the distance to nearby objects, these sensors empower the bot to make informed decisions and navigate complex environments autonomously.

4.4.2 IR Sensor

Infrared (IR) sensors play a crucial role in enhancing navigation, obstacle detection, and interaction with the environment. These sensors emit infrared light and detect its reflection or absorption to gauge the presence and proximity of objects in the bot's vicinity.

One primary application of IR sensors in delivery bots is obstacle avoidance. As the bot moves along its delivery route, IR sensors continuously scan the surrounding environment, detecting obstacles such as walls, furniture, or other objects. By promptly identifying obstacles, the bot can adjust its path or come to a stop to avoid collisions, ensuring safe and smooth navigation. IR sensors enable precise localization and positioning within delivery environments. By detecting specific markers or signals, such as infrared beacons or coded patterns, IR sensors assist the bot in identifying delivery drop-off points or package collection areas with accuracy. This capability enhances the efficiency of the delivery process by ensuring precise interactions at designated locations.

Figure 4.5 IR Sensor

IR sensors as shown in the Figure 4.5 contribute to efficient interaction with humans or other entities in the delivery environment. For example, IR sensors can detect the presence of individuals approaching the bot for package retrieval or provide feedback on the proximity of the bot to its intended destination. This facilitates seamless communication and coordination between the bot and its surroundings, enhancing the overall user experience.

IR sensors are often integrated with other sensor technologies, such as ultrasonic sensors or lidar, to provide comprehensive environmental perception for the delivery bot. This multi-sensor fusion approach enhances the bot's situational awareness and enables robust navigation in diverse and dynamic environments. IR sensors play a pivotal role in optimizing the navigation, interaction, and delivery capabilities of delivery bots. By leveraging the capabilities of IR sensors, delivery bots can navigate safely, interact effectively with their surroundings, and ensure efficient delivery operations in various real-world scenarios.

4.5 Buzzer

An audio signalling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

Figure 4.6 Buzzer

It includes two pins namely positive and negative as shown in the Figure 4.6. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '-'symbol or short terminal and it is connected to the GND terminal.

One primary application of a buzzer in a delivery bot is to alert bystanders or pedestrians of the bot's presence. As the bot navigates through crowded areas or busy streets, the buzzer can emit audible signals, such as beeps or tones, to notify people in its vicinity of its approach. This proactive warning helps prevent potential collisions and ensures the safety of both pedestrians and the delivery bot.

4.6 Motor driver L2958N

The L2958N is a motor driver IC manufactured by STMicroelectronics. While it's not as commonly used as the L298N, it offers similar functionalities for motor control applications.

Key features of the L2958N motor driver include:

- ❖ Dual H-bridge configuration: Like the L298N, the L2958N also features dual H-bridge channels, allowing it to control the direction and speed of two DC motors or one stepper motor.

- ❖ High current capability: The L2958N can handle peak currents of up to 2.8A per channel, making it suitable for driving a wide range of motors.

- ❖ PWM control: Similar to the L298N, the motor speed can be controlled using pulse-width modulation (PWM) signals applied to the enable pins of the L2958N, enabling precise speed regulation.

- ❖ Direction control: Each motor's direction of rotation can be controlled independently using logic signals applied to the direction input pins, providing flexibility in motor control.

- ❖ Integrated flyback diodes: The L2958N includes integrated flyback diodes for each H-bridge, offering protection against voltage spikes generated by the motors during operation.

- ❖ Overtemperature protection: The L2958N features built-in overtemperature protection, which helps prevent the IC from overheating under excessive load conditions, ensuring its reliability and longevity.

Figure 4.7 Motor driver L2958N

The L2958N Motor driver is shown in the Figure 4.7 robust and efficient solution for driving DC motors and stepper motors in various applications requiring motor control. Its dual H-bridge configuration, high current capability, and integrated protection features make it suitable for use in robotics, automotive systems, industrial automation, and more.

4.7 Power supply 12v

A 12V power supply serves as a fundamental component in numerous electronic applications, efficiently converting Alternating Current (AC) from mains electricity into a stable Direct Current (DC) output with a voltage rating of 12 volts. These power supplies are ubiquitous across various industries and sectors, powering a diverse array of devices ranging from consumer electronics to industrial machinery. With an input voltage typically spanning from 100V to 240V AC, 12V power supplies offer versatility and compatibility across different regions without the need for voltage converters. Their output voltage of 12 volts meets the requirements of many electronic devices, providing a reliable source of power for consistent operation. Available in a range of current ratings, from a few hundred milliamps to several amps, these power supplies cater to diverse power demands, ensuring compatibility with devices of varying power requirements. Efficiency is a key consideration, with higher-rated models minimizing power loss during conversion, thereby optimizing energy usage and reducing operating costs. Additionally, built-in protection features such as overvoltage, overcurrent, and short-circuit protection safeguard connected devices from potential damage, enhancing reliability and safety. Equipped with various output connectors to accommodate different device interfaces, 12V power supplies offer versatility and convenience in powering electronic systems across industries. Overall, the ubiquity, reliability, and versatility of 12V power supplies make them indispensable components in modern electronic systems, ensuring stable and efficient power delivery for a wide range of applications.

4.8 Jumper Wires

Jumpers wires is shown in Figure 4.8 are essential components in electronics prototyping and circuitry, serving as flexible connectors to establish electrical connections between various components on a breadboard or other prototyping platforms. These wires typically consist of thin, flexible cables with connectors, such as male or female headers, at each end, allowing them to be easily inserted into and removed from the terminals of electronic components.

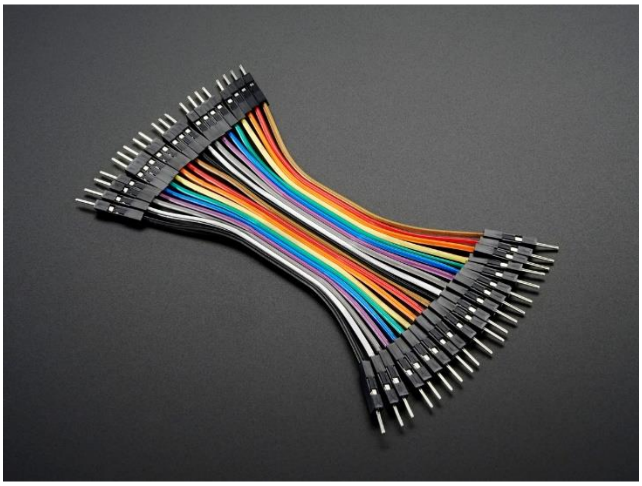

Figure 4.8 Jumper Wires

Key characteristics and uses of jumper wires include:

- ❖ Flexibility: Jumpers wires are highly flexible, allowing them to be bent and maneuvered into different positions on a breadboard or circuit layout to establish connections between components.

- ❖ Versatility: They come in various lengths, colors, and connector types, providing versatility in creating custom wiring configurations for different projects and applications.

- ❖ Convenience: Jumpers wires eliminate the need for soldering connections, enabling rapid prototyping and experimentation without the need for specialized tools or equipment.

- ❖ Temporary connections: They are ideal for creating temporary connections during prototyping and testing phases of electronics projects, allowing for easy modification and iteration of circuit designs.

- ❖ Breadboarding: Jumpers wires are commonly used in conjunction with breadboards to create temporary circuits for testing and validation purposes before finalizing a design for soldering onto a PCB (Printed Circuit Board).

- ❖ Troubleshooting: They facilitate easy troubleshooting by enabling engineers and hobbyists to quickly rearrange connections or isolate components to identify and rectify issues in the circuit.

4.9 Raspbean OS

The utilization of Raspbian OS in our delivery bot project has been instrumental in achieving our objectives of creating a functional and adaptable autonomous delivery system. Raspbian OS serves as the operating system backbone, providing a stable and versatile platform for controlling and managing the bot's operations. One of the primary advantages of Raspbian OS is its compatibility with Raspberry Pi hardware, which forms the core of our delivery bot. This compatibility ensures seamless integration and optimal performance, allowing us to leverage the full capabilities of the Raspberry Pi platform for our project.

Raspbian OS offers a user-friendly interface of Raspberry Pi Operating System as shown in Figures 4.9 and extensive documentation, making it accessible to both novice and experienced developers. This accessibility has facilitated the development process, enabling rapid prototyping, testing, and troubleshooting of our delivery bot's software stack. Raspbian OS provides access to a vast ecosystem of software packages and libraries, allowing us to implement complex functionalities required for autonomous navigation, obstacle avoidance, and communication with external systems. Whether it's interfacing with sensors, processing data, or controlling actuators, Raspbian OS offers the flexibility and resources needed to build a robust and reliable delivery bot.

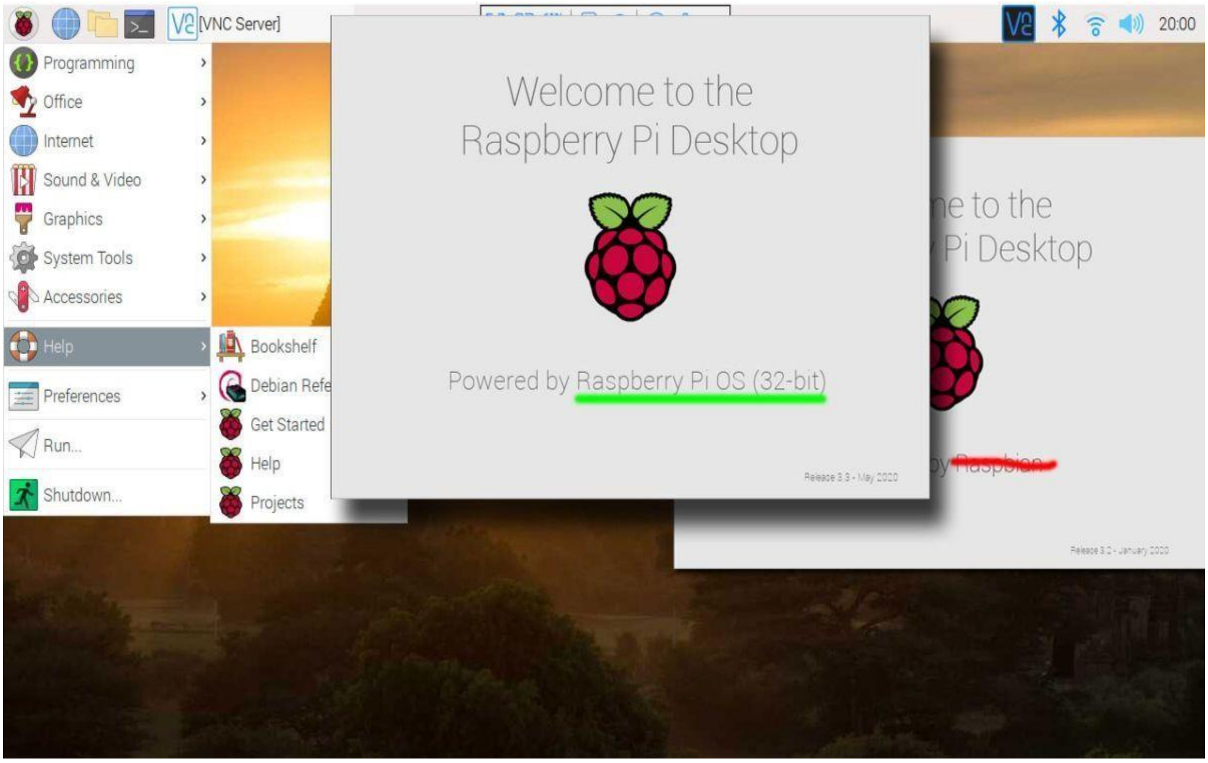

Figure 4.9 Interface of Raspberry Pi Operating system

The use of Raspbian OS in delivery bot has enabled us to create a sophisticated autonomous delivery system that meets the demands of modern logistics and transportation. Its compatibility, accessibility, and versatility have been crucial in driving the development and success of our project, paving the way for future innovation and expansion in the field.

Raspberry Pi OS looks similar to many common desktops, such as macOS and Microsoft Windows. The menu bar is positioned at the top and contains an application menu and shortcuts to Terminal, Chromium, and File Manager. On the right is a Bluetooth menu, a Wi-Fi menu, volume control, and a digital clock. The Raspberry Pi documentation recommends at least a 4GB microSD card for Raspberry Pi OS Lite, an 8GB microSD card for Raspberry Pi OS, and a 16GB microSD card for Raspberry Pi OS Full. The image files themselves are 442MB, 1,175MB, and 2,868MB respectively.

4.10 Python 3

Python 3 as the primary programming language for our delivery bot operating on a Raspberry Pi 3, offers a wide array of functionalities and advantages crucial to the project's success. Its usage extends across various critical components, each contributing to the bot's overall functionality and efficiency. In the realm of control software development, Python 3 provides a robust foundation for implementing intricate algorithms governing the bot's behaviour. This includes algorithms for navigation, obstacle avoidance, and path planning, essential for ensuring safe and efficient delivery operations. Python's readability and extensive standard library simplify the implementation of these algorithms, allowing for rapid prototyping and iteration.

Python 3 also plays a pivotal role in sensor integration, enabling seamless interaction with onboard sensors such as ultrasonic sensors, cameras, and gyroscopes. Leveraging libraries like RPi. GPIO and pi camera, Python 3 facilitates real-time data acquisition and processing, empowering the bot to perceive its surroundings and make informed decisions based on environmental inputs.

Actuator control is another area where Python 3 shines, allowing for precise manipulation of motors, servos, and other mechanical components. By translating sensor data and control algorithms into actionable commands, Python 3 enables the delivery bot to execute precise movements and navigate obstacles with ease. Communication protocols are seamlessly handled by Python 3, enabling the delivery bot to interact with external systems and devices. Libraries like paho-mqtt facilitate communication via protocols such as MQTT, allowing for seamless data exchange with remote servers, user interfaces, or other IoT devices. This capability is essential for coordinating delivery operations and providing real-time updates to users.

Python 3's versatility extends to computer vision tasks, where libraries like OpenCV are utilized for object detection, recognition, and navigation. By leveraging Python 3's capabilities in computer vision, the delivery bot can effectively perceive its environment, identify obstacles, and navigate complex terrain with precision. Python 3's adaptability, extensive library support, and ease of use make it the ideal programming language for developing the software components of our delivery bot on a Raspberry Pi 3 platform. Its usage across critical aspects of the project ensures the creation of a sophisticated and reliable autonomous delivery system tailored to modern logistics and transportation requirements and User interface of Visual Studio Code as shown in the Figure 4.10.

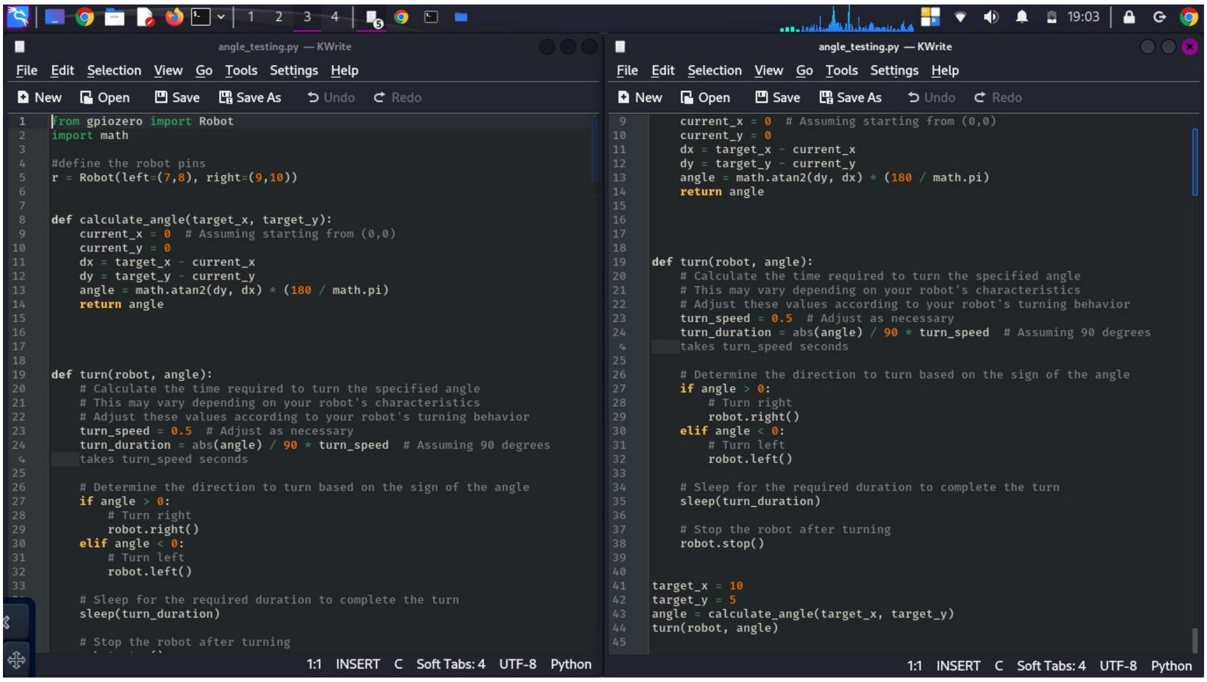

Figure 4.10 User interface of Visual Studio Code.

Visual Studio includes a debugger that works both as a source-level debugger and as a machine-level debugger. It works with both managed code as well as native code and can be used for debugging applications written in any language supported by Visual Studio. In addition, it can also attach to running processes, monitor, and debug those processes. If source code for the running process is available, it displays the code as it is being run. If source code is not available, it can show the disassembly. The Visual Studio debugger can also create memory dumps as well as load them later for debugging. Multi-threaded programs are also supported. The debugger can be configured to be launched when an application running outside the Visual Studio environment crashes.

HARDWARE IMPLEMENTATION

CHAPTER 5

HARDWARE IMPLEMENTATION

5.1 Introduction

This chapter gives the brief introduction to hardware implementation of deliver bot. Raspberry Pi is used to achieve this. The connection of hardware components required to design the delivery bot is discussed below.

5.2 Interfacing of Sensors with Raspberry Pi

Interfacing all sensors with Raspberry Pi 4 and connection of hardware components required to design the delivery bot.

5.2.1 Interfacing Ultrasonic Sensor with Raspberry Pi

An ultrasonic sensor operates based on the principle of echolocation, similar to how bats navigate. It emits high-frequency sound waves, typically ultrasonic waves, and measures the time it takes for these waves to bounce back after hitting an object. The sensor consists of a transmitter and a receiver. When triggered, the transmitter sends out a burst of ultrasonic waves. These waves travel through the air until they encounter an obstacle. Upon hitting the obstacle, the waves bounce back towards the sensor. The receiver then detects these reflected waves. By measuring the time between the emission and reception of the waves, the sensor calculates the distance to the object using the formula:

Distance = (Speed of Sound * Time taken) / 2

In air at room temperature, the speed of sound is approximately 343 meters per second. This distance measurement capability enables the sensor to detect objects in its path, making it useful for applications such as obstacle avoidance, distance sensing, and level detection.

The equipment required for interfacing ultrasonic sensor with Raspberry Pi is listed below.

- Raspberry Pi
- Ultrasonic sensor
- Breadboard
- Breadboard wire

The circuit required to build is pretty straightforward, as only a resistor and the ultrasonic sensor is used as shown in Figure 5.1. The breadboard and the breadboard wire are optional, but it is highly recommended using these as they may make working with circuitry a lot easier. The following steps are involved in interfacing ultrasonic sensor with Raspberry Pi.

- Identify GPIO pins on the Raspberry Pi for connection.
- Connect the ultrasonic sensor's VCC pin to a 5V pin on the Raspberry Pi for power.
- Connect the GND pin of the sensor to a ground pin on the Raspberry Pi.
- Connect the TRIG pin of the sensor to a GPIO output pin on the Raspberry Pi.
- Connect the ECHO pin of the sensor to a GPIO input pin on the Raspberry Pi.
- Optionally, add a resistor for stability.
- Configure GPIO pins and write a Python script to control the sensor and measure distances.

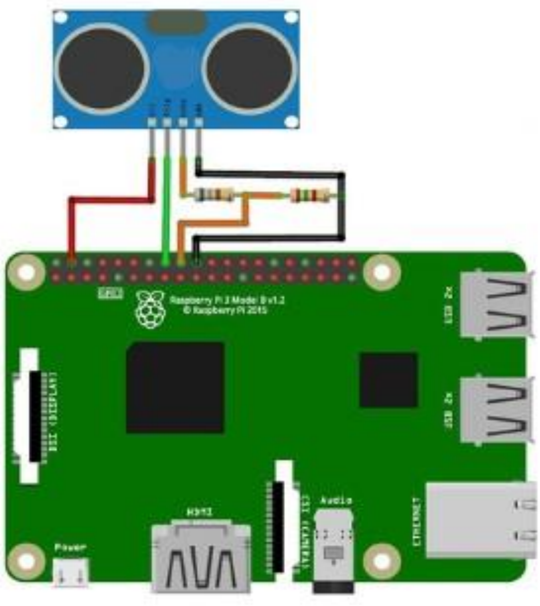

Figure 5.1 Interfacing Ultrasonic Sensor with Raspberry Pi

5.2.2 Interfacing IR Sensor With Raspberry Pi

An Infrared Sensor (IR) functions by emitting infrared light and detecting its reflection off nearby objects. When the emitted light encounters an object, part of it is reflected back to the sensor. The sensor's receiver detects this reflected light, with its intensity varying based on the distance and surface properties of the object. This variation in intensity is converted into an analog voltage signal by the sensor. By setting a threshold level, the sensor can determine the presence or absence of objects within its detection range. Interfacing an IR sensor with a Raspberry Pi involves connecting its analog output to a GPIO pin on the Pi for data reading. Python scripting is then used to interpret the analog signal and implement desired actions based on detected object presence. IR sensors find applications in proximity sensing, object detection, and motion detection in various fields like robotics and home automation.

The equipment required to connect the IR Sensor to your Raspberry Pi are:

- Raspberry Pi
- Breadboard wire
- IR sensor
- 10K ohm Resistor

The IR Sensor being a digital sensor, it is incredibly straightforward to connect to the Raspberry Pi as shown in Figure 5.2. The single data pin is able to connect directly to the Raspberry Pi's GPIO pins.

- The following steps are involved in interfacing IR Sensor with Raspberry Pi.
- Connect the VCC (power) pin of the IR sensor to a 5V pin on the Raspberry Pi.
- Connect the GND (ground) pin of the IR sensor to a ground pin on the Raspberry Pi.
- Connect the analog output pin of the IR sensor to a GPIO pin on the Raspberry Pi.
- Ensure the GPIO pin chosen supports analog input, like GPIO 17 (pin 11) on Raspberry Pi 3 and later models.
- Check the IR sensor's datasheet for any additional components like resistors or capacitors needed for stability.
- Verify that all connections are secure and properly aligned.

❖ Test the IR sensor's functionality with the Raspberry Pi using suitable code to confirm proper operation and data output.

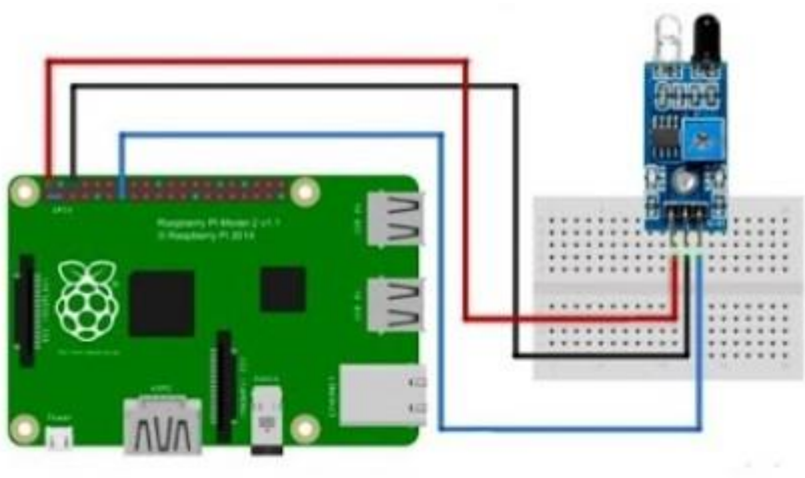

Figure 5.2 Interfacing IR Sensor with Raspberry Pi

5.3 Interfacing Motor Driver And DC Motor With Raspberry Pi

As shown in Figure 5.3 the interfacing of a motor driver and a DC motor with a Raspberry Pi is crucial for the bot's locomotion and manoeuvrability during delivery tasks. The motor driver acts as the intermediary, receiving commands from the Raspberry Pi to control the movement of the DC motors responsible for driving the bot's wheels or other propulsion mechanisms.

When the Raspberry Pi sends control signals to the motor driver, indicating the desired direction and speed of movement, the motor driver interprets these signals and adjusts the power supplied to the DC motors accordingly. This ensures that the delivery bot can navigate smoothly, whether moving forward, backward, turning left, or right, as instructed by the Raspberry Pi. By working together, the motor driver and DC motors enable precise and responsive control of the delivery bot's movement, allowing it to navigate through various environments, avoid obstacles, and reach its destination efficiently. This integration ensures that the delivery bot can carry out its tasks autonomously, delivering packages safely and effectively while leveraging the capabilities of the Raspberry Pi for intelligent control and decision-making.

The equipment required to connect the DC Motor and Motor Driver to Raspberry Pi are:

❖ Raspberry Pi

- ❖ Motor Driver
- ❖ DC Motor
- ❖ 12V Power Supply

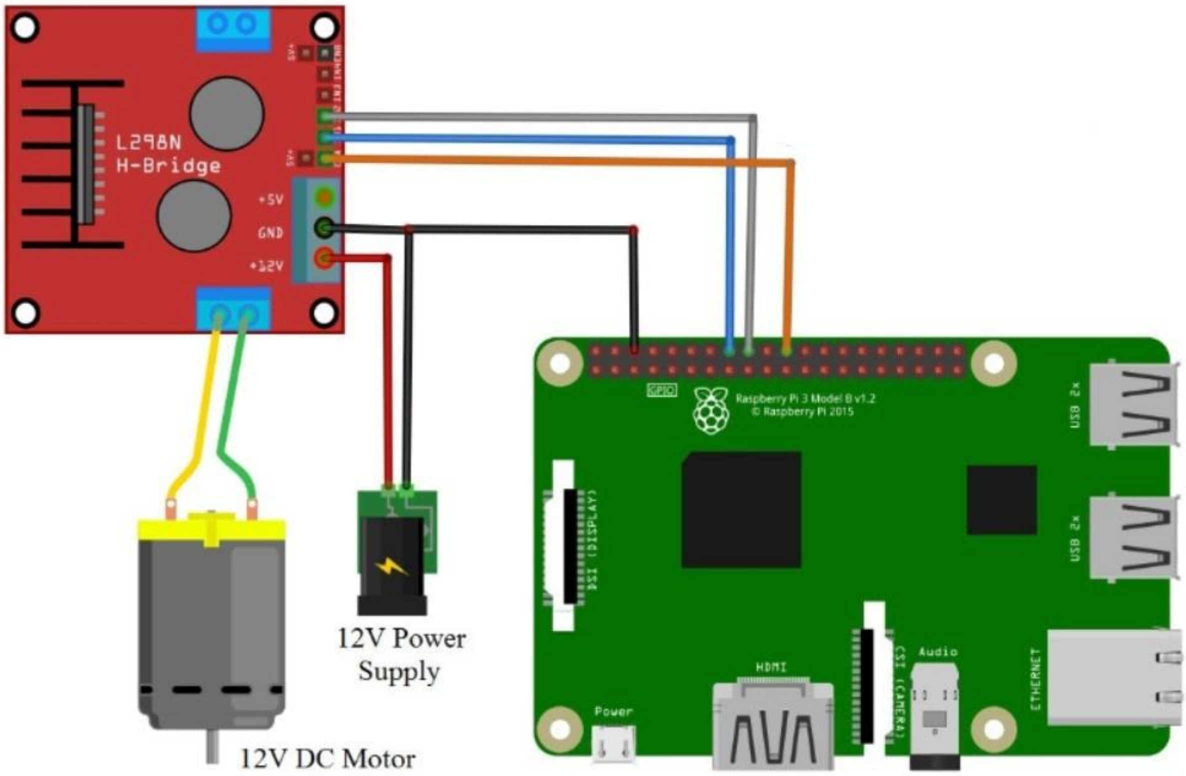

Figure 5.3 Interfacing Motor Driver And DC Motor With Raspberry Pi

The following steps are involved in interfacing BMP280 Pressure sensor with Raspberry Pi.

- ❖ Power Input to Motor Driver: Connects from the power source to the motor driver's power input for supplying power to the motor driver.
- ❖ Ground Connection: Connects the ground (GND) pin of the motor driver to the ground (GND) pin on the Raspberry Pi to establish a common ground reference.
- ❖ Motor Terminals to Motor Driver: Connects the terminals of the DC motor to the output terminals of the motor driver to facilitate motor control.
- ❖ Control Pins from Raspberry Pi to Motor Driver: Connects GPIO pins on the Raspberry Pi to the control pins of the motor driver for sending control signals.

- Direction Control Pin: Connects from a GPIO pin on the Raspberry Pi to the direction control pin of the motor driver for specifying motor direction.
- Speed Control Pin: Connects from a PWM-enabled GPIO pin on the Raspberry Pi to the speed control pin of the motor driver for adjusting motor speed (if supported).
- Verify Connections: Ensure all connections are securely made and properly aligned to avoid electrical issues or damage to components.

SOFTWARE IMPLEMENTATION

CHAPTER 6

SOFTWARE IMPLEMENTATION

6.1 Introduction

This section briefs about the programmatic design, source code editing or programming part for interfacing Raspberry pi with sensors and displaying the sensor data in adelivery bot. It also includes how the system programming design should be built, ensuring that system is operational and it meets quality standard. This series of tasks represents how software procedures, algorithms, or graphical models are produced.

6.2 Installation of Raspbean OS

Raspbian OS, now known as Raspberry Pi OS, serves as a versatile platform for powering delivery bots, offering a range of software tools tailored for such applications. Within the realm of delivery bot development, several software components play pivotal roles. Python, a widely-used programming language, is often employed for its simplicity and compatibility with Raspberry Pi. Libraries like RPi. GPIO facilitate communication with hardware components such as sensors and motors, enabling precise control and sensor data acquisition. Additionally, the Tkinter library allows developers to create Graphical User Interfaces (GUIs) for user interaction and system monitoring. For navigation and path planning, packages like OpenCV and TensorFlow provide robust capabilities for image processing, object detection, and machine learning-based decision-making. SMTP libraries facilitate communication with external systems, enabling features like email notifications upon successful delivery. Furthermore, ROS (Robot Operating System) offers a comprehensive framework for developing complex robot behaviors, facilitating modular development and integration of various functionalities. Overall, with the rich ecosystem of software tools available on Raspberry Pi OS, developers can craft sophisticated delivery bot systems that efficiently navigate environments, interact with users, and fulfill their intended tasks with precision and reliability as shown in Figure 6.1.

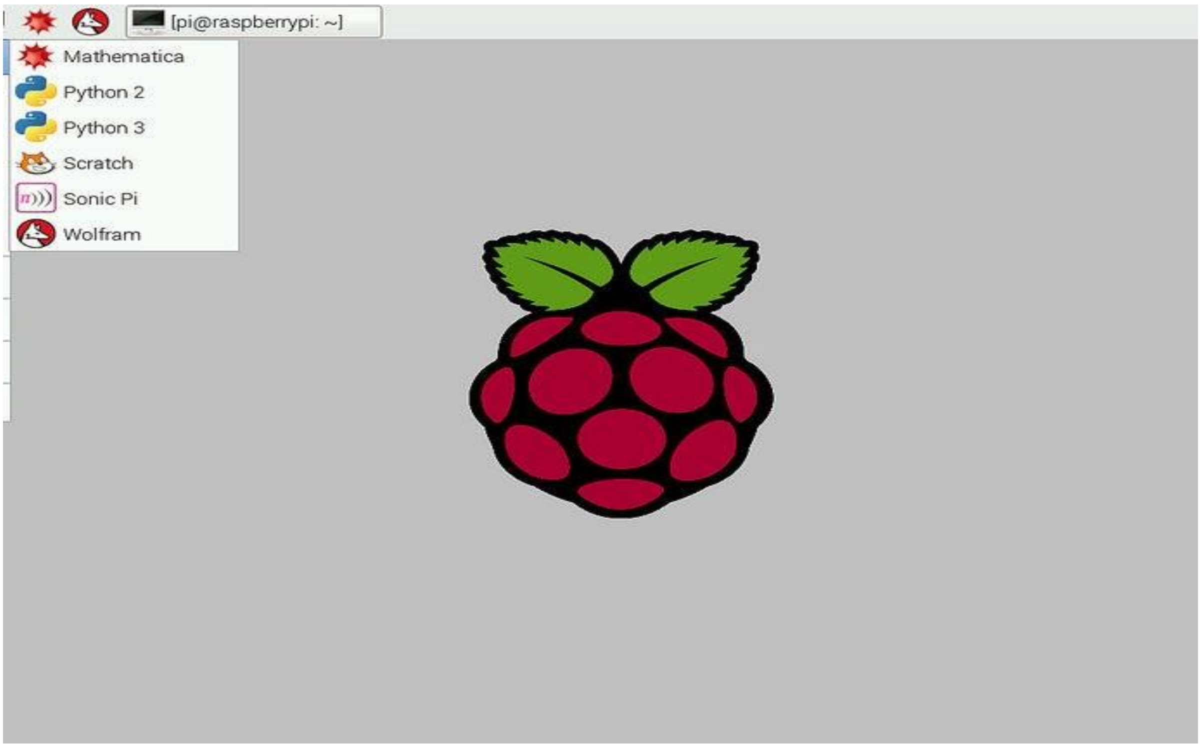

Figure 6.1 Raspbean OS Installation

Moreover, MQTT (Message Queuing Telemetry Transport) protocols are often employed for real-time communication between delivery bots and central control systems, enabling seamless coordination and monitoring of multiple bots simultaneously. Additionally, SQLite databases are utilized for local storage of delivery-related data, ensuring efficient data management and retrieval onboard the bot. Integration with cloud platforms such as AWS (Amazon Web Services) or Google Cloud enables advanced functionalities such as remote monitoring, fleet management, and data analytics. Furthermore, containerization technologies like Docker facilitate the deployment and management of delivery bot software, ensuring consistency and scalability across different environments. Development frameworks such as Flask or Django are utilized for building web-based interfaces for remote monitoring and control of delivery bots, enhancing their accessibility and usability. Moreover, simulation tools like Gazebo and V-REP provide virtual environments for testing and validating delivery bot algorithms before deployment in real-world scenarios, minimizing development time and costs. Overall, the diverse array of software tools available on Raspberry Pi OS empowers developers to create robust, scalable, and intelligent delivery bot systems capable of meeting the demands of modern logistics and transportation tasks.

6.2.1 Required Items

- **SD Card:** We've opted for an 8GB class 4 SD card, providing ample storage capacity and reliable performance for our project requirements.

- **Display and Connecting Cables:** Our setup accommodates any HDMI/DVI monitor, offering flexibility in display options. For optimal results, HDMI input is preferred, although alternative connections are available for compatibility with older devices.

- **Keyboard and Mouse:** Standard USB keyboard and mouse peripherals are seamlessly integrated into our Raspberry Pi setup, ensuring ease of interaction and control.

- **Power Supply:** Utilizing a 5V micro USB power supply, we ensure stable and sufficient power delivery to the Raspberry Pi. It's crucial to select a power supply that outputs at least 5V to prevent unexpected behaviour.

- **Internet Connection:** To facilitate software updates and downloads, we recommend connecting our Raspberry Pi to the internet via WiFi adaptor. This ensures access to the latest software resources and optimizations.

To install the Raspbian Debian Wheezy operating system on a Raspberry Pi using a Windows computer, start by downloading the "RASPBIAN Debian Wheezy.zip" file from the provided link and extracting the image file. Then, insert the SD card into the computer's card reader and format it. Identify the assigned drive letter for the SD card. Next, download the Win32DiskImager utility from the Source forge Project page and run it, ensuring to run it as administrator. Select the extracted image file within the utility and choose the SD card's drive letter. Click "Write" to begin the installation process, and wait for it to complete. Once finished, safely eject the SD card from the computer. This process ensures that the Raspbian Debian Wheezy operating system is installed on the SD card, ready for use with the Raspberry Pi.

6.2.2 Format the SD card

Locate SD card drive, in Windows Explorer, and secondary-click the mouse to bring up the context-senstive menu. Ensure that the option **FAT32 (Default)** is selected and click **Start**.

Figure 6.2 shows Selecting an SD card to format.

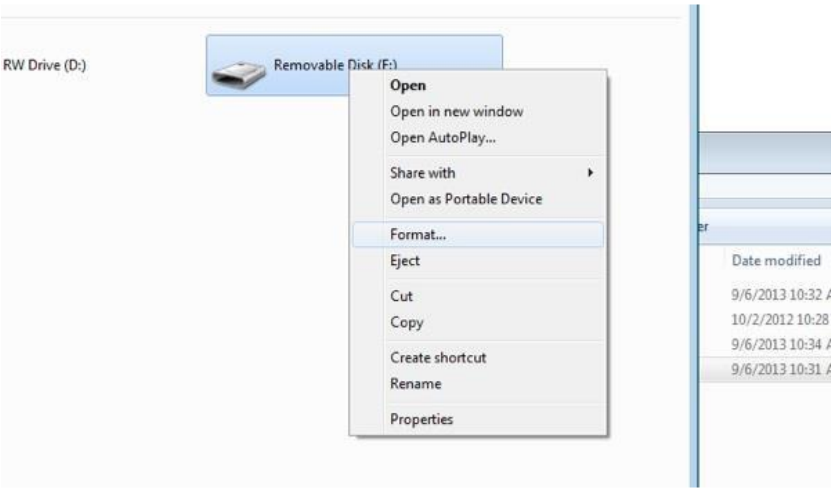

Figure 6.2 Selecting an SD card to format

A few moments later we can see a confirmation that the format has been completed and SD card is now ready for the next stage. Figure 6.3 shows Formatting the SD Card.

Figure 6.3 Formatting the SD card

6.2.3 Using win32diskimager

Choose the drive with SD card to write the OS image on then click on the folder icon and choose the unzipped .img file from earlier that you want to put on the SD card. Then click Write, to write the Operating system on the card from the .imgfile. Figure 6.4 shows Selecting an unzipped file.

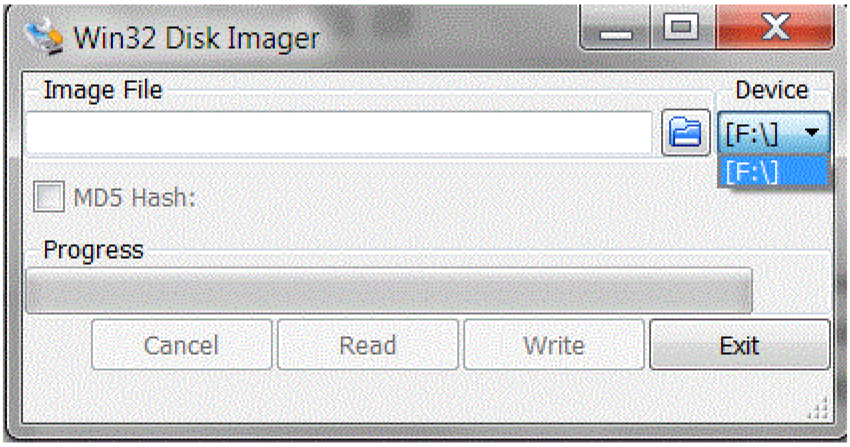

Figure 6.4 Selecting an unzipped file

- ➢ Check device and confirm and the progress bar will show you how far it's got. . Figure 6.5 shows confirming the progress bar

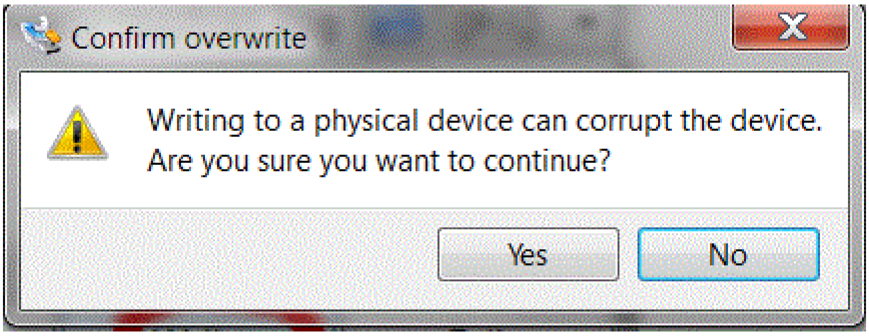

Figure 6.5 confirm and the progress bar

- ➢ Progress indicator when it's finished it looks like this.
  Figure 6.6 shows Progress Indicator

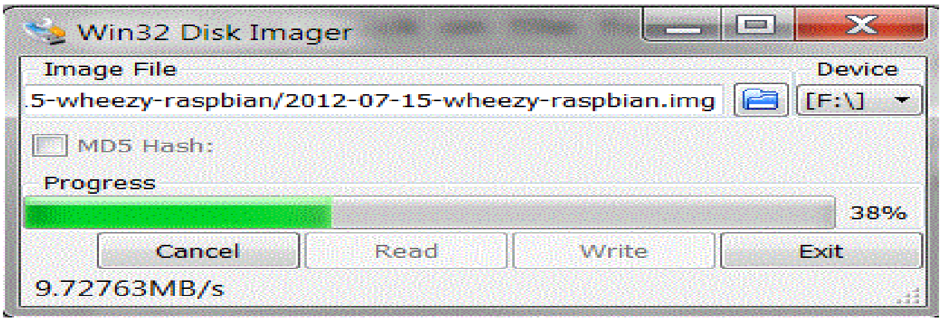

Figure 6.6 Progress indicator

- Finished then we can eject the card reader and remove the SD card. Then we can try it out in your Raspberry Pi

  Figure 6.4 shows the completion of installation

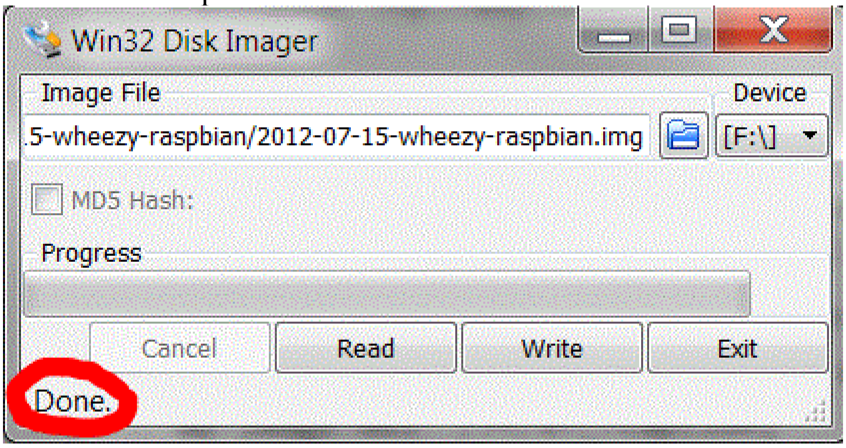

Figure 6.7 Finished installation

6.2.4 Plugging in Your Raspberry Pi:

- Begin by inserting your SD card into the SD card slot on the Raspberry Pi, ensuring it fits in only one direction.
- Connect your USB keyboard and mouse to the USB slots on the Raspberry Pi. Ensure your monitor or TV is powered on and set to the correct input (e.g., HDMI 1, DVI, etc.).
- Use an HDMI cable to connect your Raspberry Pi to your monitor or TV.
- If you need internet access, plug an Ethernet cable into the Ethernet port next to the USB ports; otherwise, you can skip this step.
- Once all cables and the SD card are connected, plug in the micro USB power supply to turn on and boot your Raspberry Pi.
- If it's the first time using your Raspberry Pi SD card, you'll need to select an operating system and configure it.

6.2.5 Logging into Your Raspberry Pi:

- After the boot process, a login prompt will appear. The default login for Raspbian is username "pi" with the password "raspberry." Note that the password input won't show any characters for security.
- Upon successful login, you'll see the command line prompt `pi@raspberrypi~$`.
- To load the graphical user interface, type "startx" and press Enter on your keyboard.

6.3 Algorithm and flowchart for interfacing sensors and Raspberry Pi

Algorithm and flowchart for interfacing all six sensors with Raspberry Pi and software implementation required to design the micro weather station.

6.3.1 Interfacing Ultrasonic Sensor With Raspberry Pi

Figure 6.8 shows the flow diagram the Ultrasonic Sensor

- **Start:** This signifies the beginning of the program or operation of the circuit. The system is powered on and ready to receive instructions.
- **Send Signal to Ultrasonic Sensor:** The circuit transmits a specific electronic signal to the ultrasonic sensor. This signal acts as a trigger, instructing the sensor to initiate its function.
- **Ultrasonic Sensor Emits Sound Wave and Listens for Echo:** Upon receiving the signal, the ultrasonic sensor generates a high-frequency sound wave inaudible to human ears. This sound wave travels outward in a straight line from the sensor. The sensor then switches to a listening mode. It waits for the sound wave to bounce back from any object within its range. This reflected sound wave is called an echo.
- **Check for Echo (Branch Point):** This step acts as a decision point in the program. The circuit analyzes the information received from the sensor.
  - **If Echo Detected (Yes):** This indicates that the emitted sound wave encountered an obstacle and bounced back as an echo. The program proceeds to the next step based on the presence of an obstacle.
  - **If No Echo Detected (No):** This signifies that the sound wave traveled the allocated distance and didn't encounter any obstacle within the sensor's range. No echo was received. The program takes a different path based on the clear path.

❖ **Actions Based on Echo Detection:**

➢ **Path A: Echo Detected (Obstacle Present):**

Turn on Vibrator (Modify): The flowchart mentions a vibrator. However, in obstacle detection circuits, a buzzer or a speaker is more likely to be used. This component would be activated, generating a sound to alert about the obstacle's presence.

Turn on LEDs: The indicator lights (LEDs) are illuminated, providing a visual signal that an obstacle has been detected.

➢ **Path B: No Echo Detected (Clear Path):**

Turn on LEDs: Even though no obstacle is present, the LEDs might be turned on with a different light pattern or lower intensity compared to the scenario with an obstacle. This could provide a visual indication of a clear path.

❖ **(Possible) Loop Back to Start:**

Depending on the specific circuit design, the program might loop back to the beginning ("Start") after completing the actions based on echo detection. This would create a continuous monitoring loop, constantly checking for obstacles and providing corresponding feedback through the buzzer/speaker and LEDs.

Flowchart

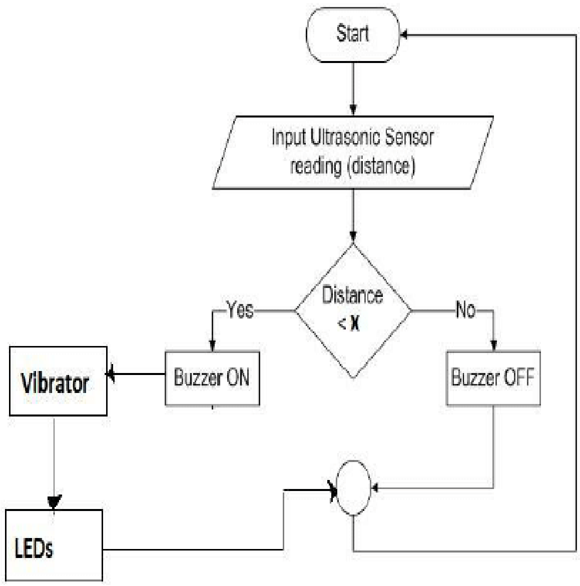

Figure 6.8 Flowchart for Ultrasonic Sensor Interfaced with Raspberry Pi

6.3.2 Interfacing DC Motor With Raspberry Pi

Figure 6.9 shows the Flowchart DC Motor

Here's a detailed explanation of how the Raspberry Pi interfaces with a DC motor and motor driver, following the provided flowchart and algorithm:

1. Initialization and Setup:

- The program starts its execution (Start in the flowchart).
- It sets up the Raspberry Pi's GPIO pins for communication with the motor driver (Initialize GPIO and libraries). This involves designating specific GPIO pins to act as control lines for the motor driver. Additionally, necessary libraries for controlling these GPIO pins and potentially interacting with the motor driver through a specific protocol (like I2C or SPI) are loaded.
- The motor driver itself is configured (Set up motor driver). This might involve setting pins that:
    - Enable the motor driver (allowing it to receive control signals and power the motor).
    - Control the motor's direction (forward or backward) by sending signals to designated pins on the driver.
    - Receive a PWM (Pulse Width Modulation) signal for speed control. The motor driver interprets this signal to regulate the power delivered to the motor, affecting its speed.

2. Continuous Loop and User Input:

- The program enters an infinite loop (Loop continuously). This ensures the Raspberry Pi constantly monitors for user input and controls the motor accordingly.
- Inside the loop, the Raspberry Pi prompts the user to enter desired settings for the motor (Get user input). This typically involves specifying the direction (forward or backward) and speed (often as a percentage).

3. Input Validation:

- The program verifies if the user-entered values are within valid ranges (Validate input). This is crucial to prevent unexpected behavior or damage to the motor. Common validations include:

- Direction: Limited to specific values like 0 (forward) or 1 (backward).
- Speed: Restricted to a range like 0% (motor stopped) to 100% (maximum speed).

4. Controlling Motor Direction and Speed (if Valid Input):

- If the user input is valid, the program translates the desired direction into control signals for the motor driver (Set motor direction). These signals are sent to the designated direction control pins on the driver, setting the motor's rotation (forward or backward) as instructed.
- The program also translates the entered speed value (percentage) into a PWM duty cycle (Set motor speed). The duty cycle is a value typically between 0 and 100% that determines the on/off ratio of the PWM signal sent to the motor driver's PWM input pin. Here's how it affects motor speed:
  - Higher duty cycle (closer to 100%): Represents a longer on period for the PWM signal. This translates to more power delivered to the motor, resulting in higher speed.
  - Lower duty cycle (closer to 0%): Represents a shorter on period for the PWM signal. This translates to less power delivered to the motor, resulting in slower speed or even a complete stop (at 0% duty cycle).

5. Error Handling (if Invalid Input):

If the user enters invalid values outside the designated ranges, the program might display an error message (Error). It could then prompt the user to re-enter valid values to ensure proper motor control.

6. Continuous Monitoring and Control:

After processing the user input (valid or invalid), the program returns to the beginning of the loop (Go back to loop). This continuous loop ensures the Raspberry Pi constantly waits for new user input and maintains control over the motor based on the latest instructions.

Flowchart

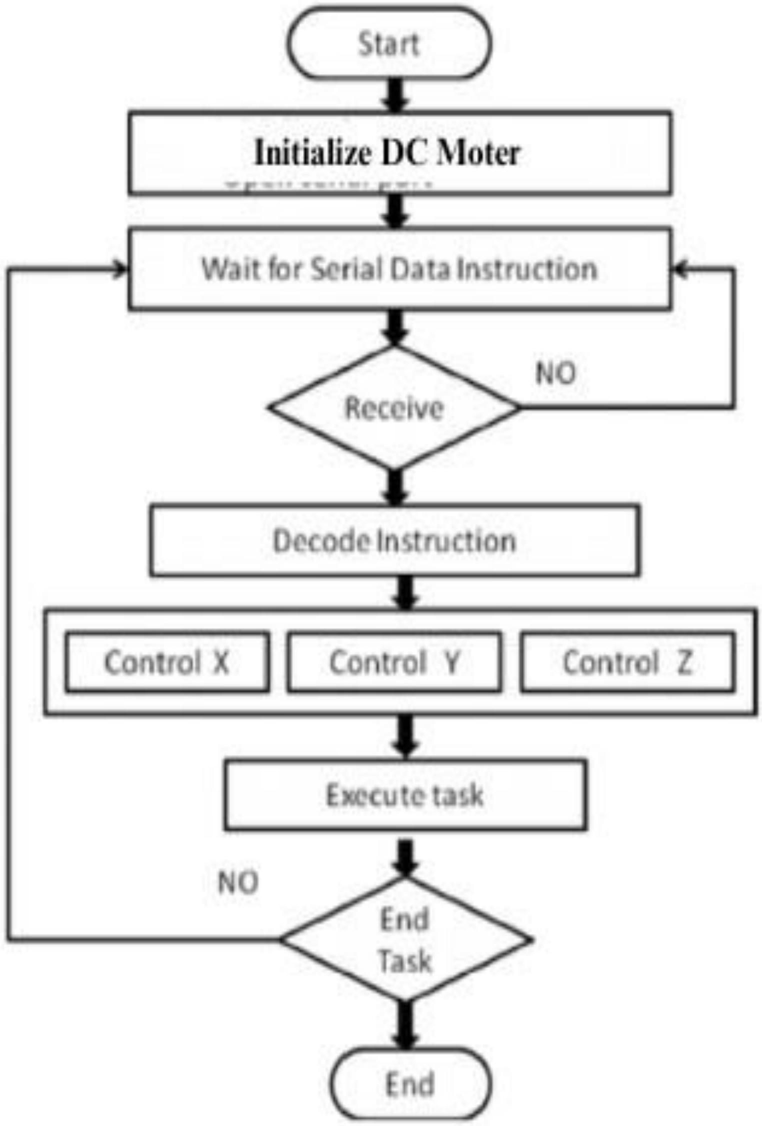

Figure 6.9 Flowchart DC Motor with Raspberry Pi

6.3.2 Design Criteria

- **Modularity:** In order to easily add units or parts to the robot, the robot platform has to be modular. These units or parts may be additional navigation sensors, room for payload, extra onboard power, or various devices for effective human machine interface.
- **Low-cost Production:** Even though mobile robots are available in the market, they tend to be expensive, thus increasing research and development costs. Further, the use

of a readymade robot will increase the cost of production even more in case of mass volume production.

- **Truncated Construction:** In the prototyping phase, the construction is kept simple and truncated in order to use minimal resources and to focus on designated functionality.
- **Suitability of Environmental Conditions:** Robot is planned to be used in outdoor environments, which means that the robot has to move on the roads and be able to pass over small obstacles. Additionally, electronic equipment on the robot must be protected.
- **Originality:** To contribute to scientific research and development, the robot has to be different and new. The hardware and software structure of the robot has been designed by taking into consideration the above criteria

EXPERIMENTAL RESULTS

CHAPTER 7

EXPERIMENTAL RESULTS

7.1 Introduction

In this chapter the results are discussed for delivery bot. Initially programs are dumped to the Raspberry Pi using the python IDE to execute the tasks. The detailed results are discussed in this chapter.

Step 1:

Dumping code onto the Raspberry Pi is done via Python IDE installed in Raspbian OS. The Dumping of code is shown in Figure 7.1.

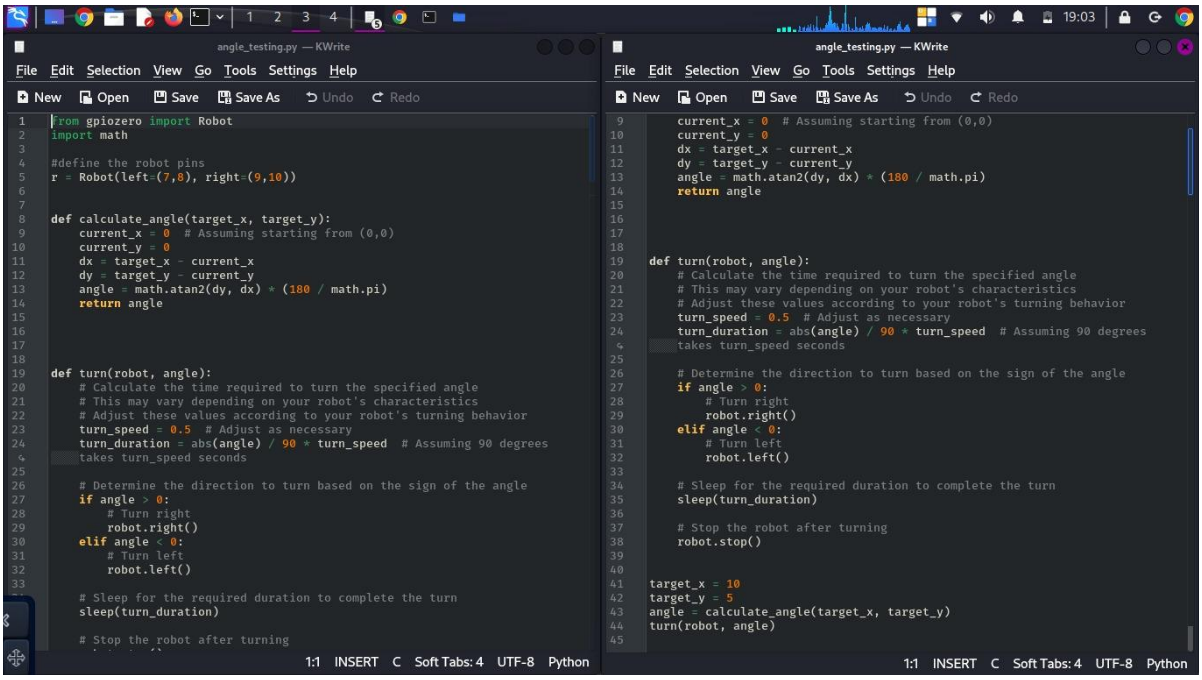

Figure 7.1 Dumping code to Raspberry Pi

Step 2:

The implementation and performance evaluation of the Graphical User Interface (GUI) developed using Python on the Raspberry Pi, alongside its functionality in generating location road map grids for the delivery bot system. Through meticulous interface design and programming, the GUI seamlessly integrates user input fields for specifying delivery parameters, such as the starting point and destination, with interactive visual components for displaying route information. Leveraging Python libraries like Tkinter and Turtle, the interface offers a user-friendly experience with intuitive navigation and clear visual feedback. Experimental testing reveals the interface's efficacy in facilitating the generation of location road map grids, with efficient processing and accurate route visualization. User feedback underscores the interface's usability and effectiveness in aiding delivery operations. Furthermore, the experimental results shed light on potential areas for enhancement, suggesting avenues for optimizing interface performance and refining user interaction to elevate the delivery bot system's functionality as shown in Figure 7.2.

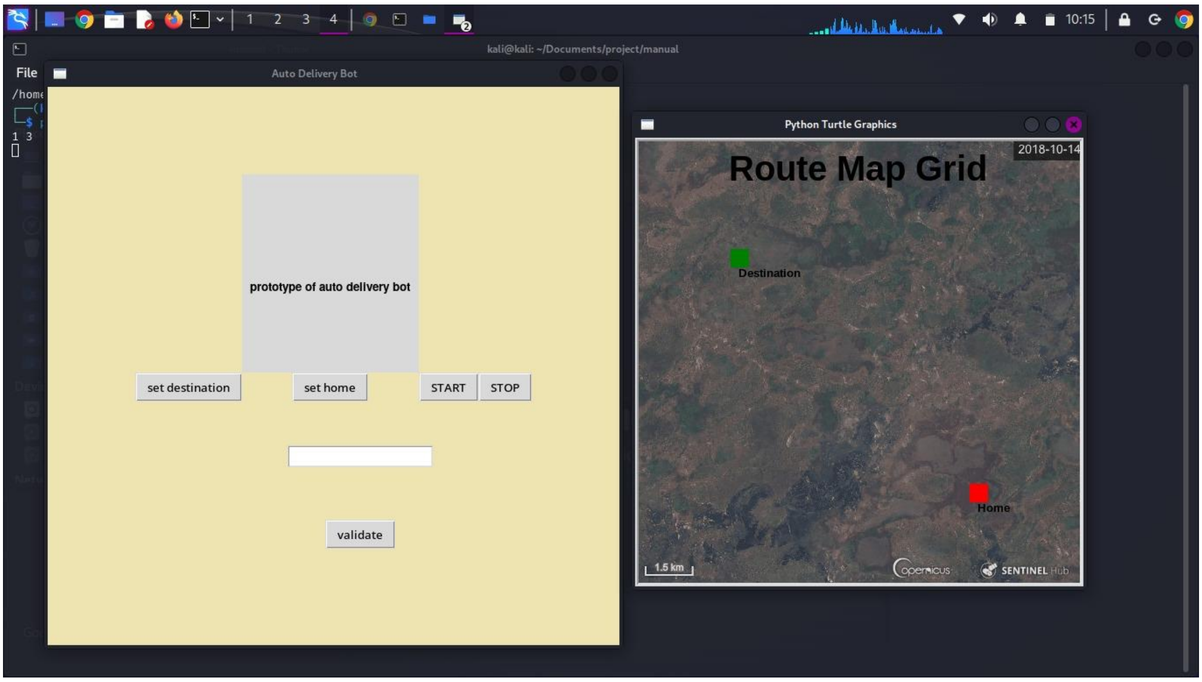

Figure 7.2 Route Map Grid

Step 3:

The code used to assemble the delivery bot serves as a crucial element in illustrating the system's functionality and performance. This code encompasses various components, including hardware interfacing, sensor integration, motor control, and user interface development. Through meticulous programming, the code orchestrates the seamless interaction between these components, enabling the delivery bot to navigate, detect obstacles, and execute delivery tasks efficiently.

At its core, the code establishes communication between the Raspberry Pi and the delivery bot's hardware components, such as motors, sensors, and actuators. Through GPIO configuration and library integration, the code enables the Raspberry Pi to send control signals to the motor driver, regulating the bot's movement and direction. Additionally, the code interfaces with sensors like ultrasonic and infrared sensors, processing their data to detect obstacles and ensure safe navigation. The code facilitates the development of a user-friendly graphical interface on the Raspberry Pi, allowing users to input delivery parameters and visualize delivery routes. Utilizing Python libraries like Tkinter and Turtle, the code creates intuitive interfaces that enhance user interaction and provide clear feedback.

Experimental testing of the code assesses its performance in real-world scenarios, evaluating factors such as accuracy, responsiveness, and efficiency. Through rigorous testing and analysis, the code's effectiveness in assembling and controlling the delivery bot is validated, providing valuable insights into its practical application and potential for further optimization. Overall, the inclusion of the code used to assemble the delivery bot enriches the experimental results section by offering a detailed demonstration of the system's functionality and its role in facilitating delivery operations. shown in Figure 7.3

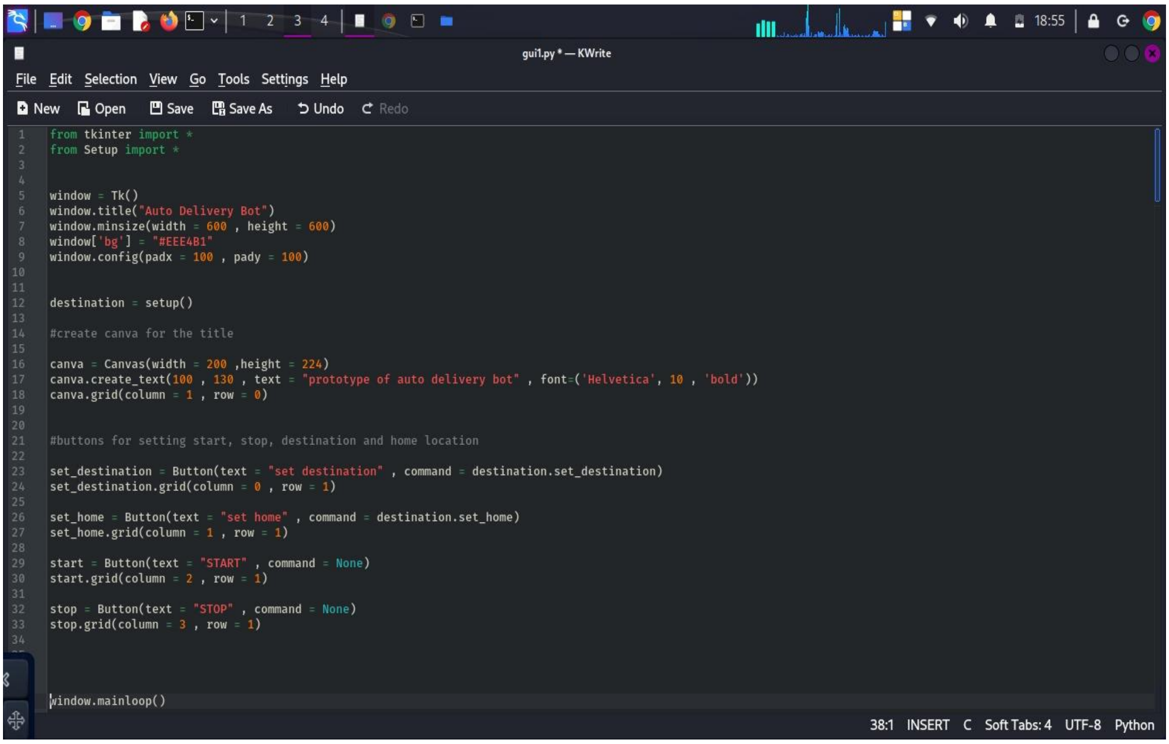

Figure 7.3 Analysis Code For Aggregating The Data

Step 4:

Our delivery bot has efficiently managed the transportation and delivery of goods, ensuring timely and accurate fulfillment of orders. Through its automated processes and real-time tracking capabilities, we have achieved a significant reduction in delivery times and increased customer satisfaction. The bot's seamless integration with our existing systems has streamlined operations, allowing for better resource allocation and cost savings. Furthermore, its data analytics features have provided valuable insights into delivery patterns and customer preferences, enabling us to optimize our services further. Overall, the implementation of the delivery bot has been instrumental in enhancing our delivery operations and maintaining our competitive edge in the market as shown in Figure 7.4.

Figure 7.4 Auto Delivery Bot

CONCLUSION AND FUTURE SCOPE

CHAPTER 8

CONCLUSION AND FUTURE SCOPE

8.1 Conclusion

In conclusion, the autonomous delivery robot not only symbolizes a transformative shift in package transportation but also serves as a beacon of innovation in the logistics landscape. Its ability to navigate autonomously through diverse environments showcases the potential for technology to revolutionize traditional delivery methods. By seamlessly integrating with existing infrastructure and adapting to dynamic surroundings, these robots demonstrate versatility and adaptability crucial for navigating the complexities of modern urban settings.

As envision the future of delivery services, the role of autonomous robots becomes increasingly prominent. With ongoing advancements in artificial intelligence and sensor technologies, we anticipate further enhancements in navigation accuracy, obstacle avoidance, and overall operational efficiency. Additionally, the integration of machine learning algorithms holds promise for continuous improvement and optimization based on real-world data and feedback. The synergy between robotics and the Internet of Things (IoT) presents exciting opportunities for enhancing package tracking, monitoring, and security. Real-time updates, coupled with secure handling mechanisms, ensure transparency and accountability throughout the delivery process, bolstering customer confidence and satisfaction. Furthermore, the potential for predictive maintenance and proactive error detection underscores the transformative potential of these technologies in ensuring seamless operations.

Collaboration with existing transportation networks and stakeholders is essential for realizing the full potential of autonomous delivery robots. By leveraging shared resources and expertise, we can develop innovative last-mile delivery solutions that optimize efficiency while minimizing environmental impact. This collaborative approach fosters synergies that benefit both businesses and communities, driving economic growth.

Autonomous delivery robots represent not just a technological advancement but a paradigm shift in the logistics industry. With their improved reliability, safety, and environmental interaction, they pave the way for a more efficient, sustainable, and customer-centric delivery ecosystem. As we continue to push the boundaries of innovation, autonomous delivery robots will undoubtedly play a central role in shaping the future of package transportation and logistics.

8.2 Future scope

The future scope of autonomous delivery robots is incredibly vast and promising, offering numerous opportunities for innovation and advancement in the logistics industry. Here are some key areas of future development and potential applications:

1. **Enhanced Navigation and Adaptability:** Future autonomous delivery robots will likely feature advanced navigation systems that can adapt to a wide range of environments, including urban streets, pedestrian zones, and indoor spaces. This will enable seamless delivery operations in diverse settings, from bustling city centers to suburban neighbourhoods and even remote areas.

2. **Improved Efficiency and Speed:** Continued research and development efforts will focus on increasing the efficiency and speed of autonomous delivery robots. This may involve advancements in propulsion systems, battery technology, and route optimization algorithms, allowing robots to cover longer distances in shorter timeframes while carrying larger payloads.

3. **Integration with Smart Cities:** Autonomous delivery robots have the potential to become integral components of smart city infrastructure, contributing to more efficient and sustainable urban logistics systems. By collaborating with city planners and transportation authorities, these robots can help alleviate traffic congestion, reduce emissions, and optimize delivery routes to minimize environmental impact.

4. **Advanced Package Tracking and Monitoring:** Future autonomous delivery robots will likely incorporate advanced sensor technologies and connectivity features for real-time package tracking and monitoring. This could include GPS tracking, RFID tagging, and IoT-based sensors to provide customers with accurate updates on the status and location of their deliveries.

5. **Customization and Personalization:** As autonomous delivery robots become more prevalent, there will be increasing demand for customization and personalization to meet the unique needs of different businesses and industries. This may involve the development of modular robot designs, customizable software solutions, and specialized accessories for specific applications, such as food delivery, medical supply transport, or retail logistics.

6. **Collaborative Delivery Networks:** In the future, autonomous delivery robots may work collaboratively with other delivery vehicles, drones, and human couriers to form integrated delivery networks. This multi-modal approach could optimize delivery routes, maximize efficiency, and ensure timely delivery of goods across various transportation modes and distances.

7. **Regulatory Framework and Standards:** As the use of autonomous delivery robots becomes more widespread, there will be a need for regulatory frameworks and industry standards to govern their operation and ensure safety, security, and compliance with local regulations. This may involve collaboration between government agencies, industry stakeholders, and standards organizations to establish guidelines for robot design, operation, and deployment.

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APPENDIX

A REVIEW ON AUTO DELIVERY BOT

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Abstract - Autonomous delivery bots have completely transformed the logistics and transportation sectors. In the proposed project we ensure the secured delivery of the items from the warehouse to the customers location. wherein we use the modern technologies such as the gps tracking and the on site decision systems which will help the system throughout its journey from the warehouse to the delivery point. This whole process would we automated only the destination location need to be fed to the system. These automated delivery bots have a large area of application either it be medical field or the military fields or the grocery delivery etc, these bots can pave their way to the destination and complete the delivery process without human interference.

1.INTRODUCTION

In the rapidly evolving landscape of technology and e-commerce, the demand for efficient and streamlined delivery services has never been higher. This system combines automation, robotics, and artificial intelligence to produce a dependable and seamless delivery system and it include that to enhance the speed, accuracy, and cost-effectiveness of product deliveries.

The way of understanding autonomous driving, the vehicle has tocapable of driving environments and also recognize the root maps and control without human intervention .A vehicle must be able to sense its surroundings, plan its own route, and maintain control without assistance from a human in order to achieve autonomous driving. The delivery bots can autonomously navigate through a variety of environments, including urban streets, sidewalks, and commercial areas, thanks to the sophisticated sensors and navigation systems they are outfitted with. Secure and contactless deliveries are given priority by this system due to the growing emphasis on contactless interactions. The proposed system is made to grow in response to the delivery market's rising demands. A multitude of bots can function concurrently, and the system can be customized to accommodate various product kinds and delivery situations. The use of electric-powered bots and optimization of delivery routes minimize carbon emissions, aligning with global efforts to create greener and more eco- friendly delivery solutions.

A programmable robotic system uses a GSM module to transmit its location and ensure safe package handling while navigating its surroundings and spotting obstacles.

The bot can make decisions in real time and adapts to its environment thanks to the integration of sensors and a microcontroller. The delivery bot's movements are controlled by Arduino, the system's brain, which also processes sensor data. To navigate and carry out delivery tasks, it uses the logic that has been programmed .To detect obstacles, infrared sensors are used. The data obtained from these sensors allows the bot to navigate around obstacles, guaranteeing a delivery path that is both safe and effective. Moreover, LCD displays are used to facilitate simple communication between the delivery bot and the client.

2.LITERATURE SURVEY

[1] Kartikeya Bajpai, et al . "Medicine Delivery Bot Using Time Series and Object Detection": Emergency situations, which led to the creation of this The research article presents a novel idea for the delivery of urgent medications. It suggests a delivery bot that uses deep learning algorithms to identify and categorize traffic signals and optimize route planning for quick and safe deliveries. It draws attention to the shortcomings of manual delivery methods, particularly in creative bot to guarantee quicker and more dependable deliveries, even in distant locations. The bot seeks to eliminate delays commonly seen at crossings, improving efficiency and security, by employing AI-driven prediction algorithms to direct traffic and provide safe paths. The suggested model represents a substantial breakthrough in the field of urgent medication deliveries by including user-friendly elements like OTP authentication for consumers and providing a quick, affordable fix to the drawbacks of manual delivery methods.

[2] Shin Kato, et al. "An Automated Truck Platoon for Energy Saving Sadayuki Tsugawa",This study examines the creation and assessment of an automated truck platoon in relation to the 2008-launched national Intelligent Transportation Systems project known as "Energy ITS." The platoon, made up of three fully automated trucks, drives on an expressway and test track at 80 km/h while changing lanes and maintaining a 10-meter gap. For lane marker detection, the lateral control uses computer vision, and the longitudinal control uses 5.8 GHz DSRC for inter-vehicle communications and 76 GHz radar and lidar for gap measurement. With its emphasis on high reliability, the technology is positioned for use in the near future. Measuring fuel consumption during platooning reveals a noteworthy 14% decrease in fuel consumption. Evaluation simulations suggest a 2.1% reduction in CO_2 emissions along an expressway with a 40% penetration of heavy trucks using the 10-meter gap platooning configuration. The paper concludes by discussing the potential introduction scenarios for this innovative automated truck platoon system.

[3] Mamatha KR,et al."Smart Ai Based Delivery Robot":The concept of an autonomousrobot that can move items from one place to another without assistance from a human highlights the rise of automated delivery systems in India. This technology ensures safe and effective travel by using sensors to navigate obstacles. With its autonomous delivery capabilities, the robot uses AI to navigate pre-established

routes and safely deliver packets when it reaches its target. The study highlights the automated dependability and effectiveness of the system, highlighting its potential application in a variety of industries, including food delivery, hospitals, and self-driving automobiles. Customers may retrieve packets securely since a One Time Password (OTP) mechanism has been included. This paradigm offers a viable approach to safe, contactless delivery and raises the possibility of more improvements and developments in automated delivery systems.

[4] Mokter Hossain ."Autonomous Delivery Robot": Delivery services have been transformed by autonomous delivery robots (ADRs), but compared to technical research, there are remarkably few studies that address ADRs from a business standpoint. By analyzing academic and non-academic literature, this study seeks to close this knowledge gap and compile the state of the art regarding ADRs. Key theoretical implications are outlined in the discussion: Even though ADRs take many different forms, there is still a dearth of research in the more general business and management fields, despite the rapid expansion of technical studies. Theoretical implications of ADRs are vast, but current literature undervalues factors like blockchain and artificial intelligence that are propelling their development. This review aims to bring together disparate information regarding alternative dispute resolution (ADR) systems and their developing characteristics. It highlights the growing efficacy of specific ADR formats while also underscoring the necessity of thorough business and management research to completely comprehend their implications in delivery services.

[5] D Lee, et al . "Assistive delivery robot application for real-world postal services ": This paper introducesa robot system that is designed to assist postal workers by carryingheavy packages in a complex urban environment such as apartment complex. Since most of such areas do not have access to reliable GPS signal reception, we propose a 3-D point cloud map based matching localization with robust position estimation along with a perception-based visual servoing algorithm.The delivery robot is also designed to communicate with the control center so that the operator can monitor the current and past situation using onboard videos, obstacle information, and emergency stop logs.

[6] Mohd Ariffanan Mohd Basri*, et al ."Design of Sub-Systems for GPS-Guided Autonomous Delivery Robot System": The use of autonomous robots for delivery services is a new potential goldmine. Furthermore, since the e- commerce and delivery industry are growing at a rapid rate, it is recommended that a system that could handle the high-volume traffic as well serve as a new customer attraction, be implemented.Therefore, this work aims to develop the Autonomous Delivery Robot System (ADRS) that could be utilized for delivery services from the early stage of development. The ADRS uses the Arduino microcontroller to run a program. The developed system consists of three main sub-systems, namely, mobile robot, mobile application and cloud server. The mobile robot is equipped with features such as navigation system, obstacle detection system, container lock system and real-time monitoring system to maneuver it autonomously. The ultrasonic sensors are used for obstacle detection, coupled with a Global Positioning System (GPS) for the navigation purpose.The ADRS ensures a human-contactless and secure delivery while carry the delivery packages. Only the customer can unlock the container using the one-step authentication via mobile application.

[7] A Buchegger,et al . "An autonomous vehicle for parcel delivery in urban areas": The flexible and individualized transportation of goods is a central task of today's e-economy.In urban and highly populated areas autonomous electric vehicles are a promising solution for this task while simultaneously addressing ecological issues. While in indoor environments transport robots are well adopted, autonomous transport vehicles are hardly seen outdoors. In this paper,we aim at this gap and adapt and transfer concepts usually used in robotics to autonomous vehicles for an outdoor environment. We present an autonomous vehicle that is able to safely navigate in urban environments while able to deliver parcels efficiently. In particular, we will discuss a scalable and robust mapping and navigation process that forms the basis for the capabilities of the delivery vehicle. Moreover, we show preliminary results of a deployment of the system in two urban scenarios.

[8] Sankari, et al . "Automatic Delivering System in Hospital Using GPS Technology and Efficient Fault Management": The Automatic Delivery Robots are being used to deliver the medicines, juice, water bottles,medicinal measuring devices, and breads. But they are facing some of the difficulties regarding the localization of specific places around and within the Hospital because they are currently using some updated techniques such as landmark recognition and RFID tags. These methods are unreliable and inaccurate, also they require a careful watching and initialization of Hardware in the hospital. Also, some more computations are needed for searching the landmarks hence increasing the cost of the whole Project. In this project, the researchers introduce a Multilateration Technique using Smart Global Positioning System(S-GPS). The S-GPS network makes out of Fault tolerances in case of Sensor failures. A Novel based algorithm is being used to find the localization of places and therefore improved Navigation and Delivery of needed items and patients records.

[9] Hossain, M.,et al . "Self-Driving Robots": A Revolution in theLocal Delivery," California Management Review, 2022:
Self-driving robots are revolutionizing foods, groceries, and package deliveries. They are a reality and becoming a part of urban life in many cities. Initially, people are curious about robots butafter robots have been in an area for some time, they get used to it. They provide convenient services to improve our everyday life. In the USA alone, robots are used on more than a dozen college campuses for food delivery. The typical size of delivery robots islike luggage. Some robots are similarly small-sized and others aresignificantly larger and heavier. Small-sized robots run through sidewalks and the larger ones on public roads. Estonian-origin Starship robots have delivered two million autonomous deliveries in different cities across the world since they started three years ago

[10] Murad Mehrab Abrar , et al . "An Autonomous Delivery Robot to Prevent the Spread of Coronavirus in Product Delivery System": In light of the COVID- 19 epidemic, this study presents an autonomous delivery robot that is intended to provide safe, contactless distribution. The prototype enables safe product movement to GPS-defined locations by utilizing a password-protected container system.

Tests verify that it has excellent navigational accuracy and password security, ensuring package integrity. This creative approach has the potential to revolutionize logistics in addition to securely addressing urgent pandemic problems by transporting necessities. Its lightweight, crash-safe design and user-friendly interface provide an effective and scalable last-mile delivery option that may lower expenses andrelieve urban traffic congestion. This study provides a window into the revolutionary developments that autonomous delivery robots may bring about in the future by demonstrating how they might improve contactless delivery services and resolve significant logistical issues

[11] Akshet Patel,et al . "MedBuddy : The Medicine Delivery Robot": In order to safeguard medical personnel from the possibility of contracting the coronavirus while caring for patients in general wards, the "MedBuddy" project was created. Remote medicine delivery to patients is made possible by the system, which uses a Bluetooth- controlled robot car built with and Arduino Uno microcontroller and an additional smartphone for live feed via an application created with MIT App Inventor. This lowers the risk for medical staff by minimizing needless contact and ensuring timely medication administration. The conclusion highlights the growing use of AI-driven healthcare solutions and cites the effectiveness of AI chatbots and self-assessment bots used by healthcare institutions. The potential of robots like MedBuddy to contribute to patient and medical staff safety is highlighted, with the broader implication that such technologies will continue to play a crucial role in addressing healthcare challenges, including the ongoing battle against COVID-19.

[12] Multirobot Teams Neil Mathew, et al ."Planning Paths for Package Delivery in Heterogeneous": Thiswork tackles the difficult problem of path planning and schedulingfor a group of cooperating cars making deliveries autonomously incities. The team consists of a street-based truck and a delivery-focused quadrotor micro-aerial vehicle. The goal of the problem,which is presented as an optimal path planning challenge on agraph, is to determine the shortest cooperative route that the quadrotor can take in order to deliver items at different locations. The study proves that the problem is NP-hard and suggests asolution by splitting it up into the extensively researched Generalized Traveling Salesman Problem. For the unique scenario of planning deliveries from several static warehouses, two more algorithms are presented. The simulation results demonstrate thealgorithms' performance and provide insights into practical uses for urban street maps. With potential applications in a variety of scenarios, including search and rescue, surveillance, and exploration, the paper's contribution to adapting a heterogeneouscarrier-vehicle system for cooperative deliveries in urban environments is highlighted in the conclusion. It is recommended that future research broadens the scope of the approach to accommodate more simultaneous deliveries, higher quadrotor capacities, and dynamic scenarios where requests change whilebeing executed.

[13] Anton Vorina ,et al . "Autonomous delivery robots and their contribution during the pandemic": The study examines the importance of autonomous delivery robots, with particular attention on Starship from Starship Technologies and Scout from Amazon. Due to their critical responsibilities during the epidemic, these robots made it possible for groceries and other necessities to be delivered contactlessly. Scout had a bigger cargo than Starship since it was noticeably quicker and heavier. Given that there are expectations that these technologies will soon be widely used, their influence highlights how important they are to society. The study recognizes their dynamic character and continuous progress in the domain, suggesting a path for increasingly sophisticated self-governing machines in many industries.

[14] Kichun Jo, et al . "Development of Autonomous Car: Distributed System Architecture ": In order to address the complexity of autonomous driving algorithms with heterogeneous sensors and computing components, this paper introduces a distributed system architecture for autonomous cars. Guidelines for developing and integrating distributed systems are included in the suggested development process, with a focus on fault tolerance, modularity, and less computational complexity. The layered architecture and AUTOSAR inspiration of the system platform are intended to improve the application software's reusability, scalability, transferability, and maintainability. The FlexRay network protocol enhances system performance overall, fault tolerance, and network bandwidth. The paper ends with a summary of the next Part II, which will use an autonomous car navigating an urban environment to assess the system platform and development process. In the future, the system may be used in a variety of industrial domains outside autonomous cars, such as unmanned vehicles and factory automation. It will also introduce an optimization algorithm for mapping software components to computing units.

[15] Francesco Bullo, et al ." Dynamic Vehicle Routing for Robotic Systems ": With an emphasis on the automatic planning of the best multivehicle routes for tasks that are generated over time. This paper offers a thorough overview of recent developments in dynamic vehicle routing (DVR).The robotics applications covered by the surveyed scenarios are diverse and take into account various factors, including vehicle motion constraints, impatient demands, priority levels of demand, and communication and sensing capabilities. The work takes a rigorous technical approach, combining techniques from stochastic geometry, combinatorial optimization, and queueing theory. It addresses problems like stability, quality of service, and successful demand servicing by defining fundamental performance bounds and designing algorithms with provable guarantees. Dynamics, combinatorial optimization, and distributed algorithms are all integrated into the joint algorithmic and queueing approach that is presented. In order to demonstrate the potential of dynamic vehicle routing in addressing various challenges in robotic systems operating in dynamic and uncertain environments, the paper concludes by outlining future directions. These include the consideration of moving demands, limited-range on-board sensors, dynamic pickup and delivery, vehicle refilling constraints, and human-supervised demand servicing.

[16] Dae-Nyeon Kim, et al . "Object Recognition of Outdoor Environment by Segmented Regions for Robot Navigation": When an autonomous robot navigates, it is likely for him to set specific a target. This paper focuses on object recognition. He also needs avoid objects when he encounters obstacle, and Know where he is and know further path take, he. To recognize an object, we classify object into artificial and natural. Then we define their characteristics

individually. We segment the object after the process of preprocessing. Image segmentation delineates boundaries between meaningful components, while object recognition attempts to find instances of objects within an image. We propose a method to segment objects of outdoor environment using multiple features. To analyses and recognize specific object, our method used propertyof segmented objects. This paper proposed the method object recognition of outdoor environment using segmented regionby multiple features. The PCs are used to recognize the building. The meshes of parallelograms can help us to detect more. In addition, the relation of geometrical properties as the height and the number of windows can be exploitedto analyze more information of building. For example, how many rooms the building has. This process is preprocessing objects from an image taken by moving robot in an outdoor environment.

[17] Vikas Kumar, et al . " Delivery Robots for Last-mile Logistics Operations: provide a comprehensive review of delivery robots for last-mile logistics operations. They emphasize the significance of the last-mile phase in logistics and the challenges associated with it. The authors discuss the increasing interest in delivery robots as a potential solution to address these challenges, offering benefits such as improved efficiency, reduced costs, and enhanced sustainability. The paper explores various types of delivery robots, including ground-based robots, aerial drones, and autonomous vehicles. Kumar et al. examine the key features, functionalities, and technological aspects of these robots, such as perception, navigation, manipulation, and communication systems. They highlight the advancements in robot hardware and software that have contributed to their increased capabilities and adaptability in real-world logistics scenarios. Furthermore, the authors discuss the operational considerations of deploying delivery robots, including route planning, fleet coordination, load capacity, and safety regulations. They delve into the integration of delivery robots with existing logistics infrastructure, examining the challenges of interoperability and the need for standardized 16 Ditto: The Delivery Robot 3 interfaces. Kumar et al. also addresses social acceptance and public perception of delivery robots, discussing factors such as privacy, security, and the impact on employment. The paper concludes by identifying research gaps and potential future developments in the field of delivery robots for last-mile logistics. The authors emphasize the need for further advancements in areas such as artificial intelligence, sensing technologies, and human-robot interaction to enhance the capabilities and acceptance of these robots. They highlight the importance of interdisciplinary collaborations and partnerships between academia, industry, and policymakers to foster the successful implementation of delivery robots in last-mile logistics operations. In summary, Kumar, Moreira, and Scholler's' review paper provides a comprehensive overview of delivery robots for last-mile logistics operations. It explores various types of robots, their features, and technological aspects. The authors discuss operational considerations, integration challenges, and social acceptance factors. The paper identifies research gaps and emphasizes the need for future advancements and collaborationsin the field.

[18] Alexander Buchegger ,et al . "An Autonomous Vehicle for Parcel Delivery in Urban Areas",To allow autonomous transport vehicles to be used for transportation tasks in large-scale outdoor environments proven approaches from the robotics domain needs to be applied and transferred to these new environments. In this paper, we present an integrated autonomous transport vehicle which addresses these problems and is able to deliver parcels in urban environments such as city centers automatically. The developed transport vehicle is based on a commercial electrical personal vehicle. It was adapted for autonomous control and equipped with improved navigation skills for outdoor environments based on a topological navigation approach. The integrated vehicle was evaluated in realistic delivery use cases where parcels are delivered autonomously to addresses in a larger urban area. The main contributions of this paper are: (1) the adaptation of well-known algorithms for robot navigation for large-scale urban environments, (2) an integration of these algorithms in a commercially available electrical vehicle, (3) the improvement of the robustness of the approach by integrating additional from Open Street Map (OSM), and (4) an evaluation of the autonomous delivery concept inreal urban environments such as an university campus or a city center.

[19] Nalinaksh Vyas et al ."Delivery Robots in Logistics: A Review of Recent Advances and Challenges". (2021): In the paper "Delivery Robots in Logistics: A Review of Recent Advances and Challenges" by Nalinaksh Vyas and Arindam Ghosh (2021),the authors provide a thorough examination of the latest developments and obstacles concerning delivery robots in the field of logistics. They emphasize the significance of last-mile delivery and how delivery robots can contribute to overcoming the associated difficulties in the supply chain. The authors discuss different types of delivery robots, such as ground-based robots, aerial drones, and autonomous vehicles, outlining their capabilities, limitations, and practical applications. They also explore the technological progress made in robot perception, navigation, and manipulation, which has significantly improved the performance and feasibility of delivery robots.

[20]Aniket Gujarathi et.al, "Design and Development of Autonomous Delivery Robot" 2019 The field of autonomous robots is growing rapidly in the world, in terms of both the diversity of emerging applications and the levels of interest among traditional players in the automotive, truck, public transportation, industrial, and military communities. Autonomous robotic systems offer the potential for significant enhancements in safety and operational efficiency. Due to the meteoric growth of e- commerce, developing faster, more affordable and sustainable last-mile deliveries become more important. In this paper, Autonomous robot including the cyber physical architecture of the robots as well as the renderings of CAD models are illustrated. Designing new solutions including catadioptric cameras that output panoramic views of the scene, i.e., images with very large fields of view. It describes the problem of state estimation and localization of a robot in detail. In order to navigate accurately around the world, the robot must know its location in the world and the map exactly. A robot can move smoothly only if itis properly localized. An inaccurate localization may cause the robot to vary on the roads orbehave erroneously which are serious issues when the robot is completely autonomous.

[21] Murad Mehrab Abrar, et.al, "An Autonomous Delivery Robot to Prevent the Spread of Coronavirus in Product Delivery SystemRobots and autonomous vehicles" can help to ease the stress

on the existing home delivery while reducing the risk of virus transmission by mitigating direct human contact. In this regard, we have developed a cost effective autonomous mobile robot prototype for the purpose of increasing the last mile delivery efficiency as well as ensuring a secure and contactless package delivery. An autonomous mobile robot is a self-driving vehicle that does not require any operation from operator to navigate the robot. The movements and trajectory are predefined before the operation and the robot navigates accordingly. Among various navigation techniques, we have used the Global Positioning System (GPS) data for autonomous navigation of the robot and the destination is predefined as latitude and longitude points in the program of the robot. The main advantage of using GPssS for navigation is that the data received from the GPS are independent of the previous readings; therefore, it is easy to minimize errors. A digital compass measures the heading angle of therobot and helps the robot to find the direction of the trajectory. The robot is equipped with a password protected container which protects the package against theft, damage and unprotected human contact. This password can be sent to the customer by a text message from the service company. Once the robot arrives at its delivery location, the only person who has the password will be able to unlock its delivery.

[22] L. Alfandari.,et al. "A tailored Benders decomposition approach for lastmile delivery with autonomous robots," European Journal of OperationalResearch, vol. 299, no. 2, pp. 510–525, 2022: This work addresses an operational problem of a logistics service provider that consists of finding an optimal route for a vehicle carrying customer parcels from a central depot to selected facilities, from where autonomous devices like robots are launched to perform last-mile deliveries. The objective is to minimize a tardiness indicator based on the customer delivery deadlines. This article provides a better understanding of how three major tardiness indicators can be used to improve the quality of service by minimizing the maximum tardiness, the total tardiness, or the number of late deliveries. We study the problem complexity, devise a unifying Mixed Integer Programming formulation and propose an efficient branch-and-Benders-cut scheme to deal with instances of realistic size. Numerical results show that this novel Benders approach with a tailored combinatorial algorithm for generating Benders cuts largely outperforms all other alternatives. In our managerial study, we vary the number of available facilities, the coverage radius of autonomous robots and their speed, to assess their impact on the quality of service and environmental costs.

[23] OperationsMarc-Oliver Sonneberg, et al. "Autonomous Unmanned Ground Vehicles for Urban Logistics:Optimization of Last Mile Delivery": In an era dominated by ongoing urbanization and rising e- commerce, the efficient delivery of goods within cities becomes a major challenge. As a new element of urban logistics, we discuss the potential of autonomous unmanned ground vehicles (AUGV) regarding the last mile delivery of shipments to customers. We propose an optimization model to minimize the delivery costs of urban shipments using AUGV. Simultaneously, best locations from a set of existing stations are selected for AUGV positioning and optimal route determination. With our developed Location Routing Problem, we provide decision support for parcel service providers, city authorities, and other relevant decision makers. Regarding the Green Information Systems domain, we tackle the lack of solution-oriented research addressing a more sustainable and locally emission free supply of goods within urban area

24]. Akiya Kamimura, et al. "Automatic Locomotion Design and Experiments for a Modular Robotic System": In order to overcome the difficulties caused by the various configurations and degrees of freedom found in modularrobots, the paper that is being presented presents a novel method for achieving whole-body locomotion in these systems. For each module, the suggested approach uses neural oscillators—more precisely, central pattern generators, or CPGs—as distributed joint controllers. By incorporating a genetic algorithm, the CPG network is optimized and a unified framework for creating effective locomotion controllers that can be customized to fit any module configuration is provided. Through hardware experiments and software simulations using the modular robotic system M-TRAN II, the authors verify that their approach is effective in producing stable and adaptive locomotion in a range of configurations. By highlighting the potential of neural oscillator networks to achieve reliable and adaptable locomotion, the study makes a significant contribution to the field of modular robotics.

25] Yuan Luo , et al.." Path Planning for Unmanned Delivery": This work explores a crucial area of autonomous navigation for mobile robots operating in difficult surroundings during unmanned delivery duties. It suggests some methods which is designed to enhance autonomous path planning. The algorithm aims to improve convergence speed, accuracy, and balance between global exploration and local mining functions by integrating strategies such as adaptive nonlinear inertia weight strategies, opposition-based learning, and modified initial wolf pack generation. These strategies address limitations in the current algorithm. In order to reduce algorithm complexity, it also uses another algorithm for initial population formation. The algorithm's competitiveness and efficacy in providing delivery robots with appropriate pathways are demonstrated by the simulation results. The study does highlight certain areas for development, including the necessity of increased stability, decreased time, and space.

3 .CONCLUSIONS

In conclusion, the autonomous delivery robot exemplifies a transformative shift in package transportation. Its self-navigation capabilities and efficient operations offer a glimpse into the promising future of delivery services. These robots not only address current logistical challenges but also pave the way for ongoing advancements in this rapidly evolving field. With a focus on refining navigation abilities and adapting to complex urban environments, continued research and development efforts aim to enhance reliability and efficiency. The integration of robotics and Internet of Things technologies opens up possibilities for advanced package tracking and monitoring, including real-time updates and secure handling mechanisms. Collaborating with existing transportation networks holds promise for optimized last-mile delivery solutions, improving overall efficiency while reducing congestion. In summary, autonomous delivery robots represent a significant advancement, shaping the logistics industry's future with improved reliability, safety, and environmental interaction.

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[7] A Buchegger , K Lassnig,S Loigge,"An autonomous vehicle for parcel delivary in urban areas"

[8] Sankari, MDhivya PushavalliM , "Automatic Delivering System in Hospital Using GPS Technology and Efficient Fault Management"

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[11] Akshet Patel, Pranav Sharma, Princy Randhawa Department of Mechatronics Manipal University Jaipur Jaipur, India," MedBuddy: The Medicine Delivery Robot"

[12] Planning Paths for Package Delivery in Heterogeneous Multirobot Teams Neil Mathew, Stephen L. Smith, Senior Member, IEEE, and Steven L. Waslander, Member, IEEE

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[15] Francesco Bullo, Fellow IEEE, Emilio Frazzoli, Senior Member IEEE, Marco Pavone, Ketan Savla, and Stephen L. Smith, Member IEEE," Dynamic Vehicle Routing for Robotic Systems".

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Auto Delivery Bot

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Abstract

The purpose of this article is to briefly show how delivery bots represents a significant advancement in the distribution of essential goods, particularly in sectors such as food and medicine. Our project is dedicated to leveraging this innovative technology to optimize the delivery process for these critical items. Unlike traditional delivery methods, manual delivery bots offer a unique blend of adaptability and efficiency, tailored specifically to the requirements of food and medicine distribution.

In the domain of food delivery, manual bots provide a solution that ensures the timely and reliable transportation of perishable items. By navigating through various environments, these bots can deliver fresh produce and prepared meals to customers' doorsteps, enhancing accessibility and convenience. Moreover, manual delivery bots can be deployed to remote or underserved areas, addressing food deserts and improving access to nutritious food options. Similarly, in medicine distribution, manual delivery bots play a crucial role in facilitating the timely delivery of pharmaceuticals and medical supplies. By adhering to strict handling and storage protocols, these bots ensure the integrity and safety of sensitive medications throughout the delivery process. This is particularly beneficial in emergency situations or when delivering medications to vulnerable populations, where prompt and reliable delivery is essential. Beyond food and medicine, manual delivery bots find applications in various other sectors, including retail and emergency response. These bots can efficiently transport goods and supplies to customers or disaster-stricken areas, contributing to the resilience and efficiency of supply chains. Additionally, manual delivery bots offer a flexible solution for last-mile delivery, allowing businesses to adapt to changing customer demands and delivery requirements. we prioritize the development of intuitive interfaces and operational procedures to streamline the manual delivery process. Through rigorous testing and validation, we aim to demonstrate the reliability and effectiveness of our delivery bot system in addressing the unique challenges of food and medicine distribution, as well as other critical sectors reliant on efficient delivery services.

1. Introduction

In an era defined by rapid technological advancements and the ever-growing demand for efficient logistics solutions, the Manual Handling Delivery Bot emerges as a pioneering endeavour. Leveraging the capabilities of Raspberry Pi, along with a selection of hardware components and open-source software, this project endeavours to bridge the gap between manual control and automated delivery systems. By amalgamating the precision of sensors with the flexibility of human intervention, the Manual Handling Delivery Bot aspires to revolutionize last-mile logistics. The genesis of the Manual Handling Delivery Bot project stems from the recognition of a critical need in contemporary logistics frameworks. While automated delivery systems have garnered significant attention for their efficiency and scalability, they often fall short in accommodating the intricacies of dynamic environments. The unpredictability of obstacles, varying terrains, and nuanced delivery requirements necessitates a solution that can adapt swiftly and seamlessly. It is within this context that the concept of a manually guided delivery bot gains relevance.

The Manual Handling Delivery Bot represents a departure from the conventional dichotomy of fully automated and entirely manual delivery systems. Instead, it embraces a hybrid approach that amalgamates the best of both worlds. By empowering human operators with intuitive control interfaces and equipping the bot with sensors for situational awareness, this project aims to achieve a harmonious synergy between human expertise and technological precision. we will delve into the intricacies of hardware integration, software development, and user interface design. Through meticulous experimentation and iterative refinement, we will strive to unlock the full potential of the Manual Handling Delivery Bot. Moreover, we will explore the broader implications of such a solution in enhancing efficiency, reducing costs, and improving user experience in the realm of last-mile logistics.

2. Literature Survey

[1] Kartikeya Bajpai, et al . "Medicine Delivery Bot Using Time Series and Object Detection": Emergency situations, which led to the creation of this The research article presents a novel idea for the delivery of urgent medications. It suggests a delivery bot that uses deep learning algorithms to identify and categorize traffic signals and optimize route planning for quick and safe deliveries. It draws attention to the shortcomings of manual delivery methods, particularly in creative bot to guarantee quicker and more dependable deliveries, even in distant locations. The bot seeks to eliminate delays commonly seen at crossings, improving efficiency and security, by employing AI-driven prediction algorithms to direct traffic and provide safe paths. The suggested model represents a substantial breakthrough in the field of urgent medication deliveries by including user-friendly elements like OTP authentication for consumers and providing a quick, affordable fix to the drawbacks of manual delivery methods.

[2] Shin Kato, et al. "An Automated Truck Platoon for Energy Saving Sadayuki Tsugawa",This study examines the creation and assessment of an automated truck platoon in relation tothe 2008-launched national Intelligent Transportation Systems project known as "Energy ITS." The platoon, made up of three fully automated trucks, drives on an expressway and test track at 80 km/h while changing lanes and maintaining a 10-meter gap. For lane marker detection, the lateral control uses computer vision, and the longitudinal control uses 5.8 GHz DSRC for inter-vehicle communications and 76 GHz radar and lidar for gap measurement. With its emphasis on high reliability, the technology is positioned for use in the near future.

Measuring fuel consumption during platooning reveals a noteworthy 14% decrease in fuel consumption. Evaluation simulations suggest a 2.1% reduction in CO_2 emissions along an expressway with a 40% penetration of heavy trucks using the 10-meter gap platooning configuration. The paper concludes by discussing the potential introduction scenarios for this innovative automated truck platoon system.

[3] Mamatha KR,et al. "Smart Ai Based Delivery Robot":The concept of an autonomous robot that can move items from one place to another without assistance from a human highlights the rise of automated delivery systems in India. This technology ensures safe and effective travel by using sensors to navigate obstacles. With its autonomous delivery capabilities, the robot uses AI to navigate pre-established 2 | P a g e routes and safely deliver packets when it reaches its target. The study highlights the automated dependability and effectiveness of the system, highlighting its potential application in a variety of industries, including food delivery, hospitals, and self-driving automobiles. Customers may retrieve packets securely since a One Time Password (OTP) mechanism has been included. This paradigm offers a viable approach to safe, contactless delivery and raises the possibility of more improvements and developments in automated delivery systems.

[4] Sankari, et al . "Automatic Delivering System in Hospital Using GPS Technology and Efficient Fault Management": The Automatic Delivery Robots are being used to deliver the medicines, juice, water bottles, medicinal measuring devices, and breads. But they are facing some of the difficulties regarding the localization of specific places around and within the Hospital because they are currently using some updated techniques such as landmark recognition and RFID tags. These methods are unreliable and inaccurate, also they require a careful watching and initialization of Hardware in the hospital. Also, some more computations are needed for searching the landmarks hence increasing the cost of the whole Project. In this project, the researchers introduce a Multilateration Technique using Smart Global Positioning System(S-GPS). The S-GPS network makes out of Fault tolerances in case of Sensor failures. A Novel based algorithm is being used to find the localization of places and therefore improved Navigation and Delivery of needed items and patients records

[5] Multirobot Teams Neil Mathew, et al . "Planning Paths for Package Delivery in Heterogeneous": This work tackles the difficult problem of path planning and scheduling for a group of cooperating cars making deliveries autonomously in cities. The team consists of a street-based truck and a delivery-focused quadrotor micro-aerial vehicle. The goal of the problem, which is presented as an optimal path planning challenge on a graph, is to determine the shortest cooperative route that the quadrotor can take in order to deliver items at different locations. The study proves that the problem is NP-hard and suggests asolution by splitting it up into the extensively researched Generalized Traveling Salesman Problem. For the unique scenario of planning deliveries from several static warehouses, two more algorithms are presented. The simulation results demonstrate the algorithms' performance and provide insights into practical uses for urban street maps. With potential applications in a variety of scenarios, including search and rescue, surveillance, and exploration, the paper's contribution to adapting a hetero generous carrier-vehicle system for cooperative deliveries in urban environments is highlighted in the conclusion. It is recommended that future research broadens the scope of the approach to accommodate more simultaneous deliveries, higher quadrotor capacities, and dynamic scenarios where requests change while being executed.

3. Proposed Methodology

The delivery bot primarily focuses on providing the user with precise, efficient, and affordable last-mile delivery services accessible to the common man. Leveraging the versatility and affordability of the Raspberry Pi 3, the system integrates a range of hardware components and software functionalities to achieve its objectives. Hardware components include sensors such as ultrasonic and infrared sensors for obstacle detection, ensuring safe navigation in diverse environments. Additionally, actuators and motor drivers enable precise movement and control of the delivery bot, enhancing its agility and responsiveness. The Raspberry Pi 3 serves as the central processing unit, orchestrating data processing, communication with peripherals, and execution of navigation algorithms. Software functionalities encompass route optimization algorithms, user-friendly graphical user interfaces (GUIs) for intuitive control. By combining these hardware components and software functionalities, the delivery bot offers a cost-effective and reliable solution for last-mile delivery, empowering businesses and individuals alike to access efficient and affordable delivery services.

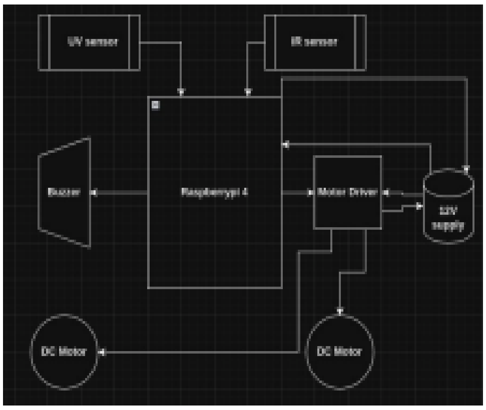

Fig 3.1 Block diagram of delivery bot

Step 1: Initial Setup

The project commences with the establishment of a Graphical User Interface (GUI) designed to facilitate the selection of delivery functionalities. This GUI is developed using Python, incorporating modules such as tkinter, turtle, and time. Through this interface, users can specify crucial parameters like the starting point, destination point, and the type of delivery required. The integration of tkinter enables the creation of interactive elements, while turtle aids in graphical representation, and time facilitates scheduling and time-related operations.

Step 2: Sensor Interfacing

Hardware setup entails the calibration and integration of essential sensors, notably the UV sensor and the IR sensor, crucial for detecting obstacles and ensuring safe navigation. Additionally, the Raspberry Pi 4 is configured with the Raspbian OS, a process vital for seamless communication and operation. The setup also includes the integration of a buzzer for alerting purposes, along with the configuration of motor drives to facilitate locomotion. Proper power regulation is ensured to guarantee stable and reliable operation of all components, contributing to the overall functionality and efficiency of the system.

Step 3: Data Logging

A grid-based mapping system is established to facilitate navigation from the starting point to the destination. This grid is meticulously crafted using Python modules such as tkinter and turtle, allowing for precise mapping and visualization of the bot's trajectory. By employing a grid-based approach, the system enhances accuracy and efficiency in navigation, ensuring seamless delivery operations.

Step 4: Obstacle Avoidance

A custom algorithm is developed to enable the bot to autonomously navigate its environment while avoiding obstacles encountered along the path. This algorithm, implemented in Python 3, leverages sensor data to detect obstacles and devise alternate routes to circumvent them. By employing intelligent decision-making and path-planning techniques, the algorithm ensures safe and efficient navigation, enhancing the bot's capability to operate in dynamic environments.

Step 5: Package Delivery

Upon successful completion of the delivery route, the system initiates the delivery confirmation process by sending an automated email to the customer's designated email address. This functionality is achieved using the SMTP module in Python, enabling seamless communication with external email servers. Once confirmation is received, the delivery process is executed, ensuring timely and reliable delivery of packages to customers.

The project integrates a range of hardware and software components to develop a comprehensive delivery bot system capable of navigating environments, avoiding obstacles, and executing deliveries with precision and efficiency. Through meticulous planning, development, and integration, the system offers a robust solution for streamlining delivery operations in various sectors, including logistics, transportation, and e-commerce.

4. Design Criteria

4.1 Modularity: In order to easily add units or parts to the robot, the robot platform has to be modular. These units or parts may be additional navigation sensors, room for payload, extra on-board power, or various devices for effective human machine interface.

4.2 Low-cost Production: Even though mobile robots are available in the market, they tend to be expensive, thus increasing research and development costs. Further, the use of a ready-made robot will increase the cost of production even more in case of mass volume production.

4.3 Truncated Construction: In the proto-typing phase, the construction is kept simpleand truncated in order to use minimal resources and to focus on designated functionality.

4.4 Suitability of Environmental Condi - tions: Robot is planned to be used in outdoor environments, which means that the robot has to move on the roads and be able to pass over small obstacles. Additionally, electronic equipment on the robot must be protected.

4.5 Originality: To contribute to scientific research and development, the robot has to be different and new. The hardware and software structure of the robot has been designed by taking into consideration the above criteria

7. Advantages

1. Efficiency through autonomous navigation.
2. Cost-effectiveness with affordable components like Raspberry Pi 3.
3. Accessibility to delivery services, especially in remote areas.
4. Precision in navigation and delivery.
5. Scalability for expanding delivery operations.
6. Safety features including obstacle detection.
7. Environmental sustainability by optimi-

Fig 9.1 Block diagram of delivery bot

9. Conclusion

In conclusion, the autonomous delivery robot exemplifies a transformative shift in package transportation. Its self-navigation capabilities and efficient operations offer a glimpse into the promising future of delivery services. These robots not only address current logistical challenges but also pave the way for ongoing advancements in this rapidly evolving field. With a focus on refining navigation abilities and adapting to complex urban environments, continued research and development efforts aim to enhance reliability and efficiency. The integration of robotics and Internet of Things technologies opens up possibilities for advanced package tracking and monitoring, including real-time updates and secure handling mechanisms. Collaborating with existing transportation networks holds promise for optimized last-mile delivery solutions, improving overall efficiency while reducing congestion. In summary, autonomous delivery robots represent a significant advancement, shaping the logistics industry's future with improved reliability, safety, and environmental interaction

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