



A Fuzzy Logic based Approach for Replacing Mouse by Facial Expressions for People with Disability in Movement

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ABSTRACT: Many authors had proposed solutions in the past three decades for replacing the mouse for people with disability in the movement who have not yet received a fair chance like others to use the standard input devices of a personal computer. In the camera-based systems, the web camera is used as the mouse that reduces the overhead of using head-mounted devices. Tracking the user's facial expression of different users with different head pose through the camera and converting accurately into the mouse cursor movement and click events are the research challenges and opportunities. The current systems lose the tracked feature during the user's unintentional head movements and they are only comfortable in moving the cursor on a slanting direction. The proposed system applies fuzzy logic in its decision-making to simplify and improve the efficiency of controlling the cursor and its interactions on the Graphical user interfaces to make the people with disability in the movement to use the computer conveniently and easily. The system addresses the problem of feature loss by mapping the mouse cursor movement only with the intentional head movement ignoring the usual head movements. The system also achieves the horizontal and vertical movement of the cursor. The mouse operations are replaced by the head movement and the eyes-blinks captured by the camera. The head movement controls the mouse cursor; left and right eye-blinks replace the actions of the left-click and right-click of the mouse.

Keywords: alternative mouse; assistive technology; camera mouse; gesture recognition; hands-free computing; people with disability.

Abbreviations: GUI, graphical user interface; ROI, Region of Interest; open CV, Open Source Computer Vision Library; CPU, central processing unit; GHz, gigahertz; GB, gigabyte; RAM, random-access memory.

I. INTRODUCTION

About 3 Cr persons are 'disabled' in India as per the Census report 2011. 20% of the disabled persons in India are having a disability in movement, which is about 5.4 million. Persons who are paralysed, not having either both the arms or both the legs and unable to move but crawl are considered as Persons with Disability in movement [1]. People with disability in the movement have not yet received a fair chance like others to incorporate themselves in the world of Information Technology. Their mobility impairment makes them difficult to use the keyboard and mouse, the standard input devices of a personal computer. Many mouse replacement solutions had been proposed in the past three decades. Few solutions rely on special hardware and software designed specifically for people with disability in movement such as Hutchinson *et al.*, [2]. Few solutions were developed that can be used only for specific and very limited applications such as Takami *et al.*, [3]. Most of the mouse replacement solutions were driven by high-cost hardware system such as Morimoto *et al.*, [4]. Most of the mouse replacement solutions require special hardware that enable the user to operate the computer by usually wearing on and operating through the face or head such as [5-14]. To

witness more advancement in the head-mounted technology used for replacing the physical mouse, few solutions have tracked the eye gaze movements to control the mouse cursor on the screen such as [15-19]. To reduce the overhead of using high-cost hardware system and head-mounted devices, few solutions capture user's head motions with web cameras to control the mouse pointer such as [20-44]. Naturally, people look at the object they wish to interact with. Hence few works are done on moving the mouse cursor based on eye movement to make more effective than tracking the head movement and other parts of the head or face such as [45-47, 20-22]. To accurately estimate what a user is focusing on the computer screen, the user's gaze direction should be tracked and not just the eye movements. Eye gaze pointing is a very spontaneous means of pointing and almost no training is required for the user. Few works were focused on tracking eye gazes such as [48-51]. Many systems use speech recognition as a user interface to maintain simplicity for mapping the mouse click events such as [10, 27, 35]. Few camera-based mouse replacement solutions had implemented mouse click events like dragging, left-click, right-click, single click and double click such as [20-22, 25-40, 42, 44, 45, 46, 52, 53, 54]. The survey on mouse replacement solutions for people

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Controlling Mouse Navigation Through 3D Head Movement

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Abstract: Various results have been proposed in the past decades to capture the user's head motions through a camera to control the navigation of the mouse pointer to enable the people with disability in the movement to interact with computers. Movement of the facial feature is tracked to estimate the movement of the mouse cursor in the computer screen. Synchronizing the rate of movement of the head with the mouse cursor movement is identified as the challenge as the head movement is three dimensional but the sequence of images captured by the web camera is two dimensional. The proposed system is an innovative approach of capturing the three-dimensional head rotation through the usual web camera that captures the image in two dimensions.

Index Terms: 3D head movement, Assistive technology, Camera mouse, Controlling mouse cursor, Hands-free computing, People with disability in movement.

1 INTRODUCTION

ABOUT 5.4 million people in India have a disability in movement as per the census 2011 [1]. They have not received an equitable chance like others to access the computers easily due to their inconvenience of using the standard input devices of the computer. As on-screen virtual keyboards can be used to simulate the physical keyboard, an alternative solution to emulate the mouse cursor movement and click operations is highly desirable to support the people with disability in movement. Various results have been proposed in the past decades to capture the users' head motions through a camera to control the navigation of the mouse pointer to enable the people with disability in the movement to interact with computers. Palleja et al. [2], Kim et al. [3], Frank et al. [4], Epstein et al. [5] and John et al. [6] have proposed the mouse replacement solutions that translate the user's head movements to mouse cursor movements. Nabati et al. [7], Zhu et al. [8], Kumar et al. [9], Woramon et al. [10], Manresa [11] and Gyawal et al. [12] have presented an approach to control the mouse pointer by tracking the face region. Javier et al. [13], Chathuranga et al. [14], Bian et al. [15], Gorodnichy et al. [16], Mohamed et al. [17] and Morris et al. [18] have tracked nose region to control the mouse pointer. Chairat et al. [19] and Parmar et al. [20] have tracked the region between the eyes whereas Eric et al. [21] locates the tracking point near the upper lip to simulate the mouse cursor movement. Betke et al. [22], Akram et al. [23] and Connor et al. [24] use the feature selected by the attending care such as the tip of the nose, eye, lip and converts them into the mouse pointer movement on the screen. Yunhee et al. [25], Fathi et al. [26] and Kim et al. [27] have proposed the systems to implement the mouse cursor movement by tracking the users' eye movement whereas Magee et al. [28], Sugano et al. [29], Uma et al. [30], Valenti et al. [31] and M. Nasor et al. [32] have attempted tracking the eye gazes.

2 PROBLEM STATEMENT

Many proposed solutions have used OpenCV Haar Cascade object detection algorithm proposed by Viola and Jones [33] to capture the users' head motions through a camera for controlling the navigation of the mouse pointer in the computer monitor screen. The horizontal and vertical movement of the mouse cursor is controlled by the respective horizontal and vertical movement of the head. The rate of movement of the head will not synchronize with mouse cursor movement as the head movement is three dimensional but the sequence of images captured by the web camera is two dimensional. Fig. 1 shows the average variation in vertical position of the mouse cursor between the current frame and previous frame when the 2D head is captured and the head is moved from top to bottom in almost a constant rate. The users' head is captured as a rectangular subset of the image using Haar Cascade classifier algorithms of OpenCV. The mid-point of the rectangular subset is considered for calculating the variation.

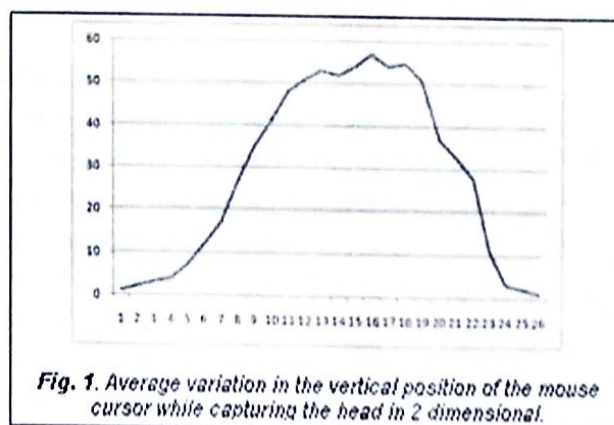


Fig. 1. Average variation in the vertical position of the mouse cursor while capturing the head in 2 dimensional.

Similarly, Fig. 2 shows the average variation in the horizontal position of the mouse cursor between the current frame and previous frame when the 2D head is captured and the head is moved from left to right in almost a constant rate.

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