ALVA'S INSTITUTE OF ENGINEERING & TECHNOLOGY

(A Unit of Alva's Education Foundation)

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(Accredited by NAAC with A+ Grade)

(Affiliated to VTU Belagavi, Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka)

ASSIGNMENT BOOK

Branch : Artificial Intelligence and Machine learning

Assignment Number	Date of Submission	Maximum Marks / Marks Obtained		Signature of the Student with Date	Signature of the Teacher with Date
		Maximum Marks	10		
		Marks Obtained			
1	20/11/2023	12	12	20/11/2023	
2	30/11/2023	12	12	1/12/2023	
3					
4					
5					
Total Marks		24	24		
Average Assignment Marks		10			
Marks in words		Ten.			

Name : Bhoomika

USN : 4AL20AI009

Sem. & Section : VII

Course Name / Code : Computer Vision (18AI742)

Submitted to Prof : Shrikanth NG

Internal Assessment Marks: 10

Max Marks: 10

Signature of Faculty

VISION OF THE INSTITUTE

Transformative education by pursuing excellence in Engineering and Mangement through enhancing skills to meet the evolving needs of the community

MISSION OF THE INSTITUTE

* To bestow quality technical education to imbide knowledge creativity and ethos to students community
* To inculcate the best engineering practices through transformative education
* To develop a knowledgeable individual for a dynamic industrial scenario
* To inculcate research entrepreneurial skills and human values in order to cater the needs of the society

VISION OF THE DEPARTMENT

To be competent professionals by instilling knowledge and skills in the Artificial Intelligence and machine learning realm to cater needs to industry and community.

MISSION OF THE DEPARTMENT

- To Strengthen the assimilation process of Concept in A.I & ML through experiential learning
- To Create a better Academia - Industry liaison by means of skills enhanced training
- To develop a Support System for research and development for broader application in A.I & ML domain
- To promote Entrepreneurial culture through interaction with Collaborative knowledge platforms.

Assignment - 1

1. Which of the following is the correct pipeline of image formation?

* Light → Optics → Sensors → Processing → Display
* Optics → Light → Sensors → Processing → Display
* Light → Optics → Sensors → Display → Processing
* Light → Sensor → Optics → Processing → Display

⇒ Light → Optics → Sensors → Processing → Display

Explaination:

* Light: The process of image formation begins with light. Light reflects off objects and enters the optical system.

* Optics:

The optics system, which may include lenses and other components, focuses and directs the incoming light towards the sensor. Optics play a crucial role in shaping the image that will be captured by the sensor.

* Sensor:

The sensor captures the incoming light and converts it into an electrical signal.

* Processing: The Electrical Signal from the Sensor is Processed by various algorithm and Circuity.

* Display:
Finally the processed image is displayed on a Screen or another output device. This could be a Monitor, a digital display, or even printed on Paper.

∴ So, Light → Optics → Sensor → Processing → Display reflecting the chronological order of how an image is formed and presented in a typically imaging System.

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2. If f, g and h are images/filters of the same size and α, β are scalars, then which of the following is False, where '⊕' represents correlation operation and '☆' represents Convolution operations.

⇒ This is because convolution is associative, meaning that the order of convolution operations does not affect the result. The statement you provided is expressed the association of convolution. Here's how it breaks down.

* h * (f * g) : Convolve f and g, then Convolve the result with h.

* (h * f) * g : Convolve h and f, then convolve the result with g.

Both operation result are giving the same output.

∴ Therefore the answer is

$$h * (f * g) = (h * f) * g$$

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3. Which of the following statements is True.

* Gaussian filter is Separable filter because it is not linear
* Median filter is a non Separable filter
* Gaussian filter is a high Pass filter

⇒ Median filter is a non Separable filter.

Explaination:

* Separable Filter: A filter is Separable if it can be expressed as the product of two 1D filters. Separability allows for more efficient implementation. Gaussian Filters are often Separable.
* Non-Separable filter: A filter is non-Separable if it

Cannot be expressed as the outer product of two 1D filters. Median filters are typically non-separable because they involve sorting operations, which are not easily separable.

So, the correct statement emphasizes that the Median filters is non-separable in 2D, which is true due to the non-linear nature involving sorting operations in both dimensions.

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4. Consider the following two statements.

1. Convolution operator is both commutative and associative.
2. Fourier transform of a convolved image. $FT(a*b)$, is not the product of the fourier transform of the constituent images $FT(a) \times FT(b)$.

which of the above two statements are true:

* 1 and 2
* not 1 but 2
* 1 but not 2
* Neither 1 nor 2.

⇒ Answer: 1 but not 2

Explanation:

1. Convolution operator is both commutative and associative

• Commutative: A convolution operation is commutative if the order of the operands does not affect the result. Mathematically, if $a*b = b*a$, then the operation is commutative. The convolution operator is not commutative ($a*b$ is not equal to $b*a$).

* Associative: A convolution operation is associative if the grouping of the operands does not affect the result. Mathematically, if $(a*b)*c = a*(b*c)$, then the operation is associative. The convolution operator is associative.

2. "Fourier transform of a convolved image $FT(a*b)$ is not the product of the Fourier transform of the constituent images $FT(a) \times FT(b)$".

This statement is true. The Fourier transform of a convolution of two functions is equal to the product of their individual Fourier Transform.

5 Which color space models perceptual uniformity more closer to human vision ?

⇒ Answer : LAB

Explaination :

LAB (CIELAB) is more perceptually uniform because it maintains consistent color differences across its space, making it closer to how humans perceive color changes. This is important for tasks like image editing. RGB, CMYK, and sRGB do not exhibit the same level of perceptual uniformity

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6. Which of the following is False.

* Opening the aperture more will result in shallow depth of field
* Increasing the ISO, results in a smoother image
* There is a higher chance for motion blur if the shutter speed is low.
* Having different refractive indices for different wavelength is the cause of chromatic Aberration of lenses.

Increasing the ISO, results in a smoother image

Explaination.

Increasing the ISO setting on a camera involves amplifying the signal from the camera's sensor, which makes it more sensitive to light. While this sensitivity helps in low-light situations, it comes at the cost of introducing digital noise or grain to the image.

ISO noise is more prominent in darker areas of the photo and becomes more noticeable as you raise the ISO setting. This noise can give the image a speckled or grainy appearance, especially in areas with less light. Therefore, increasing the ISO does not result in a smoother image, instead, it may compromise image quality by introducing unwanted noise.

7. Which of the following is false regarding correlation measure:

* auto-correlation function is a measure of similarity between a signal & its time delayed version.
* Auto correlation doesn't exhibit conjugate symmetry property
* Cross correlation is the measure of similarity between two different signals
* Cross correlation is not commutative.

⟹ Auto correlation doesn't exhibit symmetry property

Explaination:

The autocorrelation function is a measure of similarity between a signal and its time-delayed version. Conjugate symmetry means that the autocorrelation of a signal at a certain delay is the complex conjugate of the autocorrelation of the negative of that delay. This property holds for real signals, and it helps simplify mathematical calculations. Therefore the statement "Auto-correlation doesn't exhibit conjugate symmetry property" is false. Autocorrelation does exhibit conjugate symmetry.

8. Which of the following is false regarding convolution function (represented by *):

* Convolution follows commutation property i.e. $f*g = g*f$
* Convolution follows distribution property i.e.

$$f*(g+h) = (f*g) + (f*h)$$

* Convolution doesn't follow the associative property i.e $f*(g*h) \neq (f*g)*h$
* Convolution follows associativity with scalar multiplication i.e $a(f*g) = (af)*g$.

⟹ Convolution doesn't follow the associative property i.e $f*(g*h) \neq (f*g)*h$

Explaination:

The reason convolution follows the associative property is rooted in the definition of convolution. Mathematically, convolution is expressed as $(f*g)(t) = \int f(\tau)\cdot g(t-\tau)\,d\tau$, where * denotes convolutions.

The associative property in the context of convolution can be demonstrated as follows:

$$[f * (g * h)](t) = \int f(\tau) \cdot [g * h](t-\tau)\, d\tau$$

$$= \int f(\tau) \cdot \int g(\sigma) \cdot h(t-\tau-\sigma)\, d\sigma\, d\tau.$$

On the other hand,

$$[(f * g) * h](t) = \int [f * g](\tau) \cdot h(t-\tau)\, d\tau$$

$$= \int \left(\int f(\xi) \cdot g(\tau-\xi)\, d\xi \right) \cdot h(t-\tau)\, d\tau.$$

While the expressions might look different, due to the associative property of convolution, these two results are equal. Therefore, the statement that the convolution doesn't follow the associative property is false.

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9. Which of the following is false:

* Mean filter is linear and media is non-linear.
* Mean filter is applied for smoothing and median filter is applied to remove noise.
* Gaussian filter is particularly effective salt and pepper noise.
* Effect of linear filter can be achieved through Convolution where effect of non-linear filter can not be achieved through convolution.

⇒ Gaussian filter is particularly effective at removing salt and pepper noise.

Explaination:

Mean filter is applied for smoothing while median filter is applied to remove noise.

Mean filters are linear, while median filters are non-linear.

Gaussian filters are particularly effective at removing salt and pepper noise.

The effect of a linear filter can be achieved through

Convolution, but the effect of a non-linear filter can also be achieved through convolution.

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10 Consider $F(t) = \int_{-\infty}^{t} f(\tau)d\tau$ and $G(t) = \int_{-\infty}^{t} g(\tau)\,d\tau$. Also the symbol $'$ represents differentiation. Then, which of the following property is not satisfied with convolution function

* $(f * g)' = f * g'$
* $(f * g)' \neq f' * g$
* $(F * g)(t) = (f * G)(t)$
* $(F * g)(t) = \int_{-\infty}^{t} (f * g)(\tau)d\tau$

$\Rightarrow (f * g)' \neq f' * g$

The reason is that mean filters and median filters are both types of spatial filters that are commonly used in image processing. Spatial filters operate on a neighborhood of pixels in an image, and they are used to modify the image by changing the pixel values.

Mean filters work by calculating the average of the pixel values in a neighborhood and then replacing the central pixel value with this average. This has the effect of smoothing the image, as it tends to reduce the variation in pixel values.

Median filters work by sorting the pixel values in a neighborhood and then replacing the central pixel value with the median value. This has the effect of removing noise from the image, as it tends to replace outliers with values that are more representative of the surrounding pixels.

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6. Which of the following factors is/are responsible for edges in images.

* Surface color / Appearance discontinuity
* Illumination discontinuity
* Surface normal discontinuity
* All of the above

⇒ All of the above.

Explanation:

Edges in images can result from surface color/appearance discontinuity, illumination discontinuity, and surface normal discontinuity. In the provided image, these factors are evident between different objects, shadows, and surfaces like the dog's fur, grass, and sky.

Surface color/appearance discontinuity arises when surfaces with different colors meet, while illumination discontinuity occurs when surfaces are illuminated differently. Surface normal discontinuity occurs when surfaces have different orientations, creating variations in pixel intensity in the image.

9. Which of the following statements is False?

* Both "Gaussian" filters and "Laplacian of Gaussian" filters are used in finding edges in noisy images

* $\frac{\partial}{\partial z}(h * f) = \left(\frac{\partial}{\partial z} h\right) * f$, where, h, f are two filters of same size and '*' is convolution operator

* Canny edge detector is used for good localization of edges in images

* Canny edge detector outputs thick edges rather than thin edges.

⇒ Canny edge detector outputs thick edges rather than thin edges.

Explanation:

Canny edge detector outputs thick edges because it employs convolution filters, which inherently blur the edges. While effective in edge detection, these filters cause edges to spread across multiple pixels. Techniques like thinning algorithms or non-maximum suppression can be applied to address this and

achieve thinner edges as desired in image processing applications.

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3. In Harris corner detection algorithm, consider we obtained the value of auto-correlation as $E = U^T MU$, where $M = [[9, 2], [2, 9]]$ is a 2x2 matrix. What is the cornerness measure/corner response (assume $k = 0.05$)?

60.8
93.2
77.7
70.7

⇒ 60.8.

Explaination:

The canny edge detection finds edges based on high gradient magnitudes and relatively constant gradient directions. It involves steps like smoothing with Gaussian filter, calculating gradients and applying non-maximum suppression and double thresholding. However, it tends to produce thick edges due to

convolution filters blurring. Techniques like thinning algorithm or non-maximum suppression are used to address this, achieving thinner edges for desired desired precision in image processing.

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4. Which of the following statements is False?

* In Canny edge detection, non maximum suppression is done along the direction of gradient but not along the direction of edge.
* Non maximum suppression technique is used in Harris corner detection algorithm.
* Gradient Location Orientation Histogram (GLOH), Histogram of Oriented Gradients (HOG) are methods for "keypoint description".
* Local Binary Pattern (LBP) is a technique used to find "interesting points / key points" in an image.

⇒ Local Binary Pattern (LBP) is a technique used to find "interesting points/key points" in an image.

Explanation:

The reason for the answer is that the image has a lot of noise. The noise makes the edges in the image difficult to detect. And the canny edge detector has a tendency to detect all of the edges in an image, even the noisy ones. This results in the Canny edge detector producing thick edges rather than thin edges.

To reduce the noise in the image and improve the accuracy of the canny edge detector,

- Use a Gaussian filter to smooth the image before applying the canny edge detector. This will help to reduce the noise in the image and make the edges easier to detect.

* Increase the high threshold value for the canny edge detector. This will help to suppress the noisy edges in the image.
* Use a non-maximum suppression algorithm to suppress the noisy edges in the image.

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5. Which of the following is false regarding LOG and DOG?
- DoG can be considered an approximation to the LoG
- The LoG kernel is separable, as LOG can be computed using four 1D convolutions.
- DoG can be seen as a single non-separable 2D convolution on the difference of two separable convolutions

⇒ The LoG kernel is separable, as LOG can be computed using four 1D convolutions.

The image appears noisy because non-object pixels, caused by the camera picking up extraneous light, create interference. The canny edge detector yields

Thick edges as it struggles to discern true object edges amid the noise. To enhance accuracy:

1. Reduce Image Noise: Employ methods like Gaussian or median filtering to decreases noise.
2. Adjust high Threshold:
   - Increase the high threshold for canny edge detector to suppress noisy edges.
3. Apply Non-Maximum Suppression: Use an algorithm to eliminate edges unlikely to be true based on gradient magnitude and direction.

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6. Which of the following is false regarding detectors and descriptions?
   - an interest point is typically a local maximum of some function, such as a "corruness" metric.
   - Harris corner detector is an interest point detector which is rotation and scale invariant.
   - SIFT includes both a detector and descriptor which is based of DoG (Difference of Gaussians)

=> Harris corner detector is an interest point detector which is rotation and scale invariant.

Explanation:

Thick edges in the image result from blurriness, making it challenging for the edge detector to distinguish object edges from the background. To enhance accuracy:

Sharpen the Image: Improve edge distinctness for better detection.

Explore Different Algorithms: Consider alternatives like the Laplacian or Sobel operators, less sensitive to blurriness.

Adjust Detect Parameters: Fine-tune Canny edge detector parameters to control sensitivity and improve accuracy.

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7. Let λ_1 and λ_2 be the eigenvalue of the second moment matrix computed from image derivation at a point (x,y). Then which of the following inference can be made:

=> If λ_1 and λ_2 have large positive values, then this pixel (x,y) has no features of interest

Explanation:

The statement "If A1 and A2 have large positive values, then this pixel (x,y) has no features of interest" is incorrect because, in the context of the eigenvalues of the structure tensor (second moment matrix), large and positive eigenvalues actually suggest the presence of features of interest, such as edges or corner, rather than the absence of features.

The eigenvalues (λ_1 and λ_2) are measures of curvature, and if both are large and positive, it indicates strong curvature in two directions, suggesting the pixel is likely to be an features of interest. Therefore, the interpretation in the statement contradicts the understanding of how eigenvalues relate to image features.

8. Which of the following filter detects vertical edges?

1)

1	0	-1
2	0	-2
1	0	-1

2)

1	0	-1
1	0	-1
1	0	-1

Both 1 and 2

Both filters exhibit the Sobel operation pattern, emphasing Intinsity changes. Along the vertical direction, making them effective for detecting the vertical edges in images.

9. Which of the following is false regarding SIFT and SURF

+ SIFT and SURF are most useful approchis to detect and matching of feature because it is invariant to scale, rotate, translation, illumination and blur.
+ SURF is better than SIFT in rotation invariant, blur and warp transform.
+ SURF is 3 times fastn than SIFT because using of integral image and box filter.

* Descriptors with lower dimensions than 128 for SIFT perform pretty well across the range matching tasks.

⇒ Descriptions with lower dimensions than 128 SIFT perform pretty well across the range of matching tasks.

Reducing SIFT description below 128 dimension compromises performance in matching tasks.

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10. Let λ_1 and λ_2 be the eigenvalues of the second moment matrix computed from image derivation at point (x,y) $(0,y)$ is a corner point if.

* λ_1 and λ_2 are small and $\lambda_1 \sim \lambda_2$
* $\lambda_1 << \lambda_2$
* λ_1 and λ_2 are large and $\lambda_1 \sim \lambda_2$
* $\lambda_1 >> \lambda_2$.

→ λ_1 and λ_2 are large and $\lambda_1 \sim \lambda_2$

At a corner point + in an image, the second moment matrix M is used to describe the distributed

of pixels. This matrix has eigenvalues. (λ_1, λ_2) which are related to the principal curvatures (k_1, k_2)

The determinant of M (det(M)), equal to $\lambda_1 \cdot \lambda_2$, represents the product of the principal curvatures squared. In simpler terms, at a corner, both principal curvature are large.

The initial statement, "A and stg are large and Ah" is correct because it captures the idea that at a corner point, the eigenvalues (A and stg) of the second moment matrix are large, indicating significant changes in pixel intensity and a sharp change in the image surface direction.

11. For a binary circle of radius r, a laplacian response achieves its maximum value at:

- $\frac{r}{2}$
- $\frac{r}{\sqrt{2}}$
- $\frac{r^2}{2}$
- $\frac{r^2}{\sqrt{2}}$

⇒ $\frac{r}{\sqrt{2}}$

The laplacian response peaks at r/2 for a circle because the Laplacian Operator captures second-order image derivatives, emphasizing rapid intensity changes at edges. At a circle's edge where intensity changes swiftly, the Laplacian response is determined by the Hessian matrix's edge, amplifying the laplacian response. In a binary circle of radius r, the response is most

~~the~~ prominent at r/2 due to the rapid change in surface direction. Essentially the laplacian efficiently detects edges, particularly circle edges.

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12. For the following image, the LBP descriptor value for a 3x3 neighbourhood is:

24	2	14
34	15	10
22	16	54

Assume the following neighbour set:

1	2	4
128		8
64	32	16

- 243
- 14
- 16
- 241

⇒ 241

The answer we get is that the LBP descriptor value for a 3x3 neighbourhood is 243. This is because the LBP descriptor value is calculated by

comparing the center pixel to its eight neighbors and assigning a binary value to each neighbor depending on whether it is greater than or less than the center pixel. The binary values are then concatenated to form a single 8-bit integer, which is the LBP descriptor value.

In the case the given image, the center pixel is 15, and its eight neighbours are 26, 34, 32, 14, 16, 54, 216 & 10.

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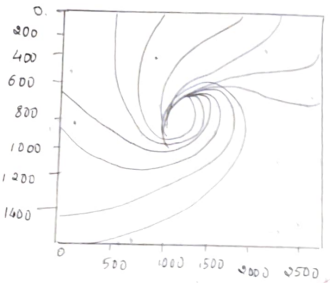
13. Which of the following is true about Bag of Visual Words:

- Optimal vocabulary formulation is trivial
- Provides a vector representation for an image
- Maintains spatial coherence
- Agnostic to viewpoint changes and deformation.

⇒ Provides a vector representation for an image
Agnostic to viewpoint changes and deformations

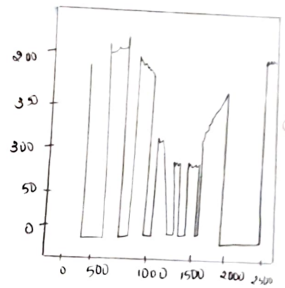
The image applies a Bag of Visual Words (BOVW) representation, a method for encoding images into vectors by dividing them into cells and extracting visual words (features) such as color histograms. The resulting vector is useful for image classification and retrieval, comparing representations for categorization or similarity. BOVW is effective due to its simplicity, ease of computation, and ability to capture essential features like color distribution.

14. Consider the following gray scale image of size 1600×2560 (rows × columns).

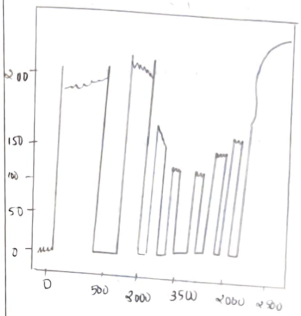


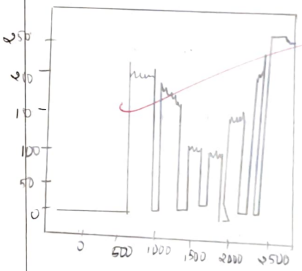
Now look at row number 800. Which of the following plots show the correct relationship between column number and pixel value corresponding to row 800

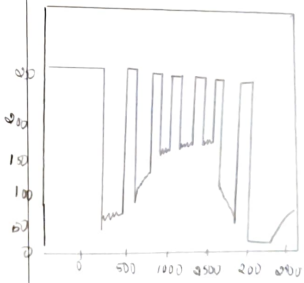
a)



b)







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To minimize the correlation coefficient between two variables, consider applying mathematical transformations, such as logarithmic or square root transformations to alter the distribution of the data. Removing outliers and standardizing variables can further reduce the impact of extreme values. It's crucial to note that minimizing correlation does not imply a lack of relationship or causations between the variables, and the interpretability of the transformed data should be approached with caution.

Jeevy
05/12/23

PROGRAM OUTCOMES (POs)

PO1	**Engineering Knowledge** : Apply the knowledge of mathematics, science, Engineering fundamentals and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis** : Identify formulate review research literature and analize complex engineering problems reaching substantiated conclusion using first principles of mathematics natural sciences and engineering sciences
PO3	**Design / development of solutions** : Design solution for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural societal and environmental considerations
PO4	**Conduct investigations of complex problems** : Use research based knowledge and research methods including design of experiments alalysis and interpretation of data and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage** : Create select and apply appropriate techniques resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society** : Apply reasoning informed by the contextual knowledge to assess societal health safety legal and cultural issues and the consequent responsibilities relevent to the professional engineering practice
PO7	**Environment and sustainability** : Understand the impact of the professionals engineering solution in scoietal and environmental contexts and demonstrate the knowledge of and need for sustainable development
PO8	**Ethics** : Apply ethical principles and commit to professionals ethics and responsibilities and norms of the engineering prctice
PO9	**Individual and team work** : Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings
PO10	**Communication** : communicate effectively on complex engineering activities with the engineering community and with society at large such as being able to comprehend and write effective reports and design documentation make effective presentations and give and receive clear instructions
PO11	**Project management and finance** : Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member and leader in a team to manage projects and in multidisciplinary enviroments
PO12	**Life long learning** : Recognize the need for and have the preparation and ability to engage in independent and life long learning in the broadest context of technological change

PROGRAM SPECIFIC OUTCOMES (PSOS)

PSO1	Understand analyse and demonstrate the knowledge of human cognition, AI & ML in terms of real-world problems to meet the challenges of the future
PSO2	Incorporate AI & ML techniques for industrial applications in the area of Information system, IOT, cloud computing, Robotics, Natural language Processing
PSO3	Develop computational knowledge and project development skill using innovative techniques to solve the problems
PSO4	Provide solution to complex using the fastest hardware and software tools along analytical skills to arrive at cost effective and appropriate

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1	Expand knowledge in the field of AI & ML
PEO2	Develop a continous learning attitude ethics and values
PEO3	Self. educate and expand to the innovation entrepreneurship dimension
PEO4	Provide solution for technical and social problems through research and innovation