MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

DEPARTMENT OF MECHATRONICS

II SEMESTER M. TECH (INDUSTRIAL AUTOMATION AND ROBOTICS)
END-SEMESTER EXAM – JAN-MAY 2024

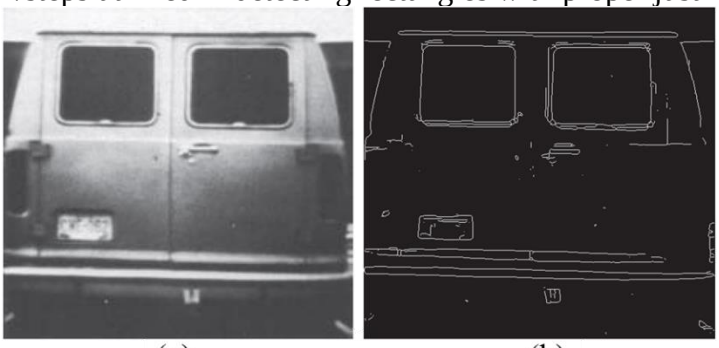
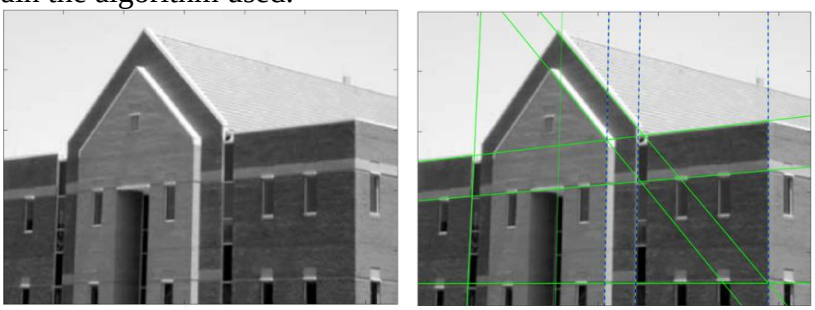
Subject: Machine Vision and Image Processing (PE-III) **Subject Code: MTE 5409**
Date: 09 May 2024
Time: 3 Hrs **Exam Time 09:30 AM to 12:30 PM** **MAX. MARKS: 50**

Name:……, Registration No:……..

Instructions to Candidates:

- ***Answer ALL the questions.***
- *Missing data may be suitably assumed and justified.*

Q. No.	Problem Statement	M	CO	PO	LO	BL
Q1A.	Analyze the binary image and the disk structuring element shown in the lower right of the image (a) of **Figure Q1A**. Set A consists of all the foreground pixels (white), except the structuring element, B, which you may assume is just large enough to encompass any of the random elements in the image. Identify the objective of the problem. Explain the different morphological/ logical image processing steps involved in converting the image (a) to (b).  (a) (b) **Figure Q1A**	5	1	3	1	3
Q1B.	An astronomer is working with an optical telescope. The telescope lenses focus images onto a high-resolution, CCD imaging array, and the images are then converted by the telescope electronics into digital images. Working late one evening, the astronomer notices that new images are noisy and blurry. The manufacturer tells the astronomer that the unit is operating within specifications. Trying to improve the situation by conducting controlled lab experiments with the lenses and imaging sensors is not possible because of the size and weight of the telescope components. Assume that the only images you can obtain are images of stellar bodies. Formulate the problem statement and recommend a digital image processing solution with detailed explanation for sharpening images. State clearly all assumptions that you make and that are likely to impact the solution you propose.	5	1	4	2	5

Q2A.	Analyze the 534x566 gray level image of the rear of the vehicle shown in **Figure Q2A(a)**. The identified objective is to select an algorithm for finding rectangles whose sizes makes them suitable candidates for license plates, as shown in **Figure Q2A(b)**. Elaborate on the image processing algorithm/steps utilized in detecting rectangles with proper justification.  (a) (b) **Figure Q2A**	4	2	4	2	4
Q2B.	Analyze the image shown in **Figure Q2B (a)** and identify the different image processing steps involved in converting the image (a) to (b). Explain the algorithm used.  (a) (b) **Figure Q2B**	4	2	4	2	4
Q2C.	Identify the two region features that are invariance to camera motion: translation, rotation about the object's centroid and scale factor. Justify your selection.	2	2	3	1	3
Q3A.	Weed detection is important to minimize the negative impacts of weeds on agriculture harvesting and ensure optimal crop yield, quality, and profitability. So, propose an image-based weed detection system to automate the detection process. Analyze the situation, clearly state all assumptions, and provide a step-by-step description of the actions involved.	5	3	4	5	6
Q3B.	Recommend suitable motion estimation techniques for estimating, (1) large (10s of pixels) image motion; (2) small image motion. Also, provide a brief overview of each recommended technique.	3	3	4	1	5
Q3C.	Examine the aperture problem with the context of optical flow estimation and explore strategies for addressing it.	2	3	3	2	4
Q4A.	Identify the key challenges faced in the localization of underwater robotic vehicles (URV) due to the uncertainty of sensor data, and propose a way to address these challenges through various fusion techniques and algorithms. Discuss how factors such as sensor noise, uncertainty, and heterogeneous sensor modalities influence the design and implementation of fusion systems in URV platforms.	4	3	5	3	6
Q4B.	Developing a vision-based grasping system for a robot manipulator involves employing the SURF algorithm to extract point features from both current and reference target images. To enhance the accuracy of	4	4	4	3	6

	feature-matching outcomes, corresponding point pairs (inliers and outliers) needs to be estimated. Analyze and propose an algorithm for estimating the fundamental matrix from corresponding point pairs extracted from two images of the same scene captured from different positions and cameras. Elaborate the algorithm used.					
Q4C.	Examine the real-time challenges posed by occlusion in dense stereo matching for stereo vision's 3D structure estimation. Also, propose solutions to prevent the failure due to this effect.	2	4	3	2	4
Q5A.	Visible and infrared image fusion plays a vital role in modern agriculture by providing valuable insights into crop health, environmental conditions, and field variability. Propose a visible and infrared image fusion method to improve agriculture practices, boost productivity, and support sustainable agriculture. Analyze the situation, clearly state all assumptions, and provide a step-by-step description of the actions involved.	5	5	4	5	6
Q5B.	Hand gesture recognition can transform farming by providing user-friendly and safe ways for farmers to control machinery. This could lead to better productivity, resource use, and sustainability in agriculture. Propose a vision-based hand gesture recognition system to help the farmers in the agriculture process. Analyze the situation, clearly state all assumptions, and provide a step-by-step description of the actions involved.	5	5	4	5	6