MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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DEPARTMENT OF MECHATRONICS

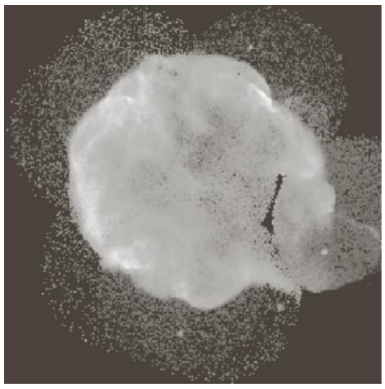
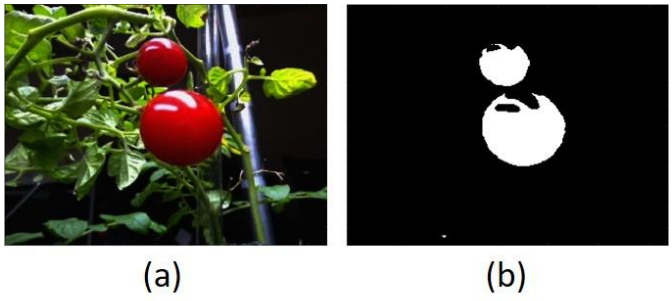
VII SEMESTER B. TECH (MECHATRONICS)
END-SEMESTER EXAM – NOVEMBER 2022

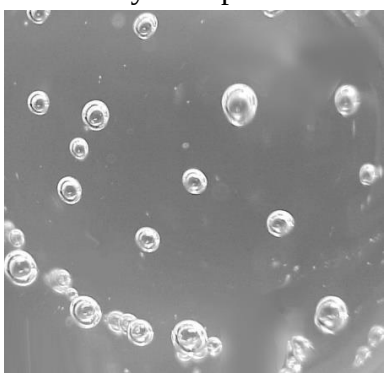
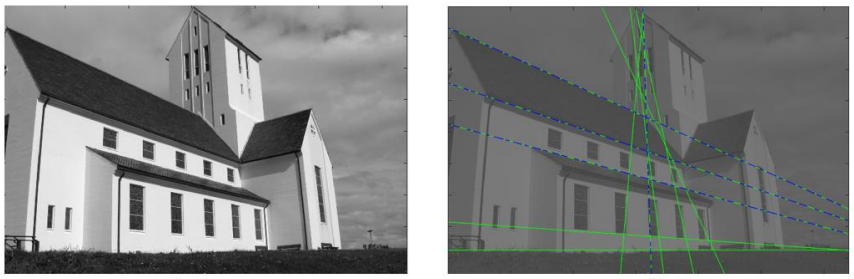
Subject: Machine Vision and Image Processing (PE-V) **Subject Code: MTE 4075**

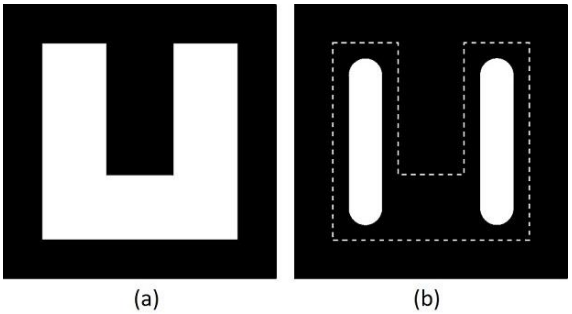
Exam Date: 23 November 2022 **Exam Time: 02:00 PM to 05:00 PM**
Time: 180 Minutes **Max. Marks: 50**

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 image shown in **Figure Q1A.** In the image shown consider the region of 1s resulting from the segmentation of the sparse regions. Develop a technique for using this region as a mask to isolate the three main components of the image: (1) sparse outer region, (2) background, and (3) dense inner region. Also, explain the algorithms used.  **Figure Q1A**	**4**	**1**	**2**	**2**	**4**
Q1B.	Analyze the red tomato image shown in **Figure Q1B (a)** for a robotic harvesting experiment, and identify the objective of the problem. Explain the different image processing steps involved in converting the image (a) to (b) in detail. (using Program/ Flowchart/ Algorithm).  (a) (b) **Figure Q1B**	**4**	**1**	**2**	**2**	**4**

Q1C.	Recommend a set of feature or feature descriptors capable of differentiating between the shapes of the characters **0** and **9**.	**2**	**1**	**3**	**5**	**5**
Q2A.	There is a fluids company that wishes to automate bubble-counting in certain process for quality control. The company has solved the imaging problem, and can obtain 8-bit images of size 800 ×800 pixels, such as the one shown in **Figure Q2A**. Each image represents an area of 8 cm square. The company wish to count the number of distinct bubbles with each image. Propose a solution to the problem. State clearly all assumptions that you make and that are likely to impact the solution you propose.  **Figure Q2A**	**5**	**1**	**3**	**5**	**6**
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**	**3**	**1**	**2**	**2**	**4**
Q2C.	In the process of optical flow estimation, highlight and elaborate the key assumption considered during estimation of pixel motion from frame 1 to frame 2.	**2**	**3**	**4**	**2**	**4**
Q3A.	**Figure Q3A** (a) and (b) show the two views of the Eiffel tower captured by camera-1 and camera-2 respectively. When we apply the SURF detector, a total of 569 and 644 corners are found in **Figure Q3A** (a) and **Figure Q3A** (b) respectively. A total of 164 corresponding points were found after matching both views. Analyze and propose the process/algorithm to find the epipolar lines intersect at the epipolar point in the projection of the second camera in the first image. Explain the algorithm used. Also, highlight the limitation of the algorithm.	**5**	**2**	**3**	**5**	**6**

	 (a) (b) **Figure Q3A**					
Q3B.	Discuss the epipolar geometry for stereo vision. Explain a method/ process to recovers the world coordinate (X, Y, Z) for each corresponding point pair. Also, discuss the limitation/ failure modes of stereo vision.	**3**	**2**	**3**	**5**	**5**
Q3C.	How lens design and tolerances affect imaging performance? Recommend ways that can be used in designing for manufacturability despite tolerances.	**2**	**2**	**3**	**5**	**5**
Q4A.	The state-space signal model for Kalman filter is as given below $x_k = \mathbf{A}\, x_{k-1} + \mathbf{B}\, u_k + w_k$ $y_k = \mathbf{C}\, x_k + v_k$ Analyze the requirement of modeling noise when implementing the Kalman filter. Also, propose a way to utilize the Kalman filter to track the self-driving car using the dynamic model prediction and object detection as measurement data.	**4**	**3**	**4**	**2**	**4**
Q4B.	For a surveillance system, propose an image processing-based solution to detect the change. State clearly all assumptions that you make and that are likely to impact the solution you propose.	**3**	**3**	**3**	**5**	**6**
Q4C.	Analyze the image shown in **Figure Q4C (a)** and identify the structuring elements and morphological operation(s) that produced the results shown in the image of **Figure Q4C (b)**. Draw the output of each morphological operation. Show the origin of each structuring element clearly. The dashed line shows the boundary of the original image and are included only for reference.  (a) (b) **Figure Q4C**	**3**	**1**	**2**	**2**	**3**

Q5A.	For a smart hassle-free parking experience, company X wants to devise a tool to detect and recognize license plates from cars/ automobiles at a gate of the entrance of a parking area. Propose an image processing-based solution to help the software designer to devise his tool. State clearly all assumptions that you make and that are likely to impact the solution you propose.	**4**	**4**	**3**	**5**	**6**
Q5B.	Identify the problem domain in which face recognition technology can be applied. Propose a face recognition-based design solution for any one problem domain. Clearly analyse the problem, state all assumptions, and give a stepwise explanation of the steps involved.	**4**	**4**	**3**	**5**	**6**
Q5C.	Explain in brief the image processing-based framework for the detection of skin cancer.	**2**	**4**	**3**	**5**	**5**