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

**SIXTH SEMESTER B.Tech. (E & C) DEGREE END SEMESTER EXAMINATION**
**APRIL 2018**
**SUBJECT: COMPUTER VISION (ECE - 4038)**

**TIME: 3 HOURS** **MAX. MARKS: 50**

**Instructions to candidates**
- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. State the expression for Gaussian Kernel $G_\sigma(x, y)$. Differentiate between Gaussian averaging and uniform averaging filter. Apply 3 x 3 uniform averaging filter to the 8-bit grayscale image shown in Figure 1A and sketch the output image.

1B. Describe in detail the three different types of reflection commonly observed at a surface.

1C. Explain the Harris corner detector algorithm for detecting corners in an image.

(5+3+2)

2A. Given an image of size 256 x 256 consisting of textures only. Describe an algorithm in detail to synthesize textures, so the output image is of larger size (i.e., greater than 257 x 257).

2B. Describe the algorithm to compute Histogram of Oriented gradient features.

2C. State the mathematical expression for computing the first order and second order image gradient. Explain the need for smoothing an image before computing its gradient.

(5+3+2)

3A. Given data points $x_i$ drawn from the probability density $p(x) = \sum_i c_i e^{\frac{-(x-x_i)^2}{2\sigma^2}}$

where $x_i$ is the $i^{th}$ data point, $\sigma$ is the standard deviation of the Gaussian and $c_i$ is a constant. Show that the mean shift vector has the direction of the gradient of the density estimate. Describe in detail each step of finding the densest region in the given data using mean shift vector.

3B. Given the observed data $(x_i,y_i), i = 1,\ldots,N$ we wish to fit a line using probabilistic models. Assume the following model: $x$ coordinate is generated from a uniform distribution, and $y$ coordinate is generated by finding the point $ax_i+b$ on the line corresponding to the $x$ coordinate then adding a zero mean normally distributed random variable. Show that maximizing the likelihood of the data is equivalent to least square line fitting.

3C. Discuss the similarities between watershed segmentation and agglomerative clustering

(5+3+2)

4A. State the epipolar constraint. With the help of a diagram, define the following terms: Epipolar Plane, Epipolar line, Epipoles. Given two image points *p, p'* corresponding to the 3D scene point *P*. Suppose the image points *p, p'* and camera projection matrix are known, and we wish to estimate 3D scene point *P*. Discuss two different approaches to estimate the 3D scene point *P*.

4B. Given N edge points $(x_i,y_i), i=1,\dots,N$, describe Hough transform algorithm to fit a straight line to these points.

4C. Explain M-estimator and compare it with RANSAC.

(5+3+2)

5A. Given a training dataset $(x_1,y_1),\dots.(x_N,y_N)$ consisting of N points $(x_1,\dots.x_N)$. Each point is assigned a class label which is denoted by 1 or -1. Let $y_i$ represents the class label. Show that in support vector machine for linearly separable data, the decision boundary is determined by minimizing $norm(w)^2$, subject to $y_i(wx_i+b)\geq 1$, where $w$, $b$ are the parameters of the hyperplane. Compare support vector machine with a classifier where the class conditional densities are modeled with the histogram.

5B. Describe two different approaches to build multi-class classifier from a binary classifier. Discuss the shortcomings of each approach.

5C. Describe cross-validation used in classification.

(5+3+2)

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| 127 | 0 | 0 | 127 | 127 | 0 | 0 |
| 127 | 0 | 0 | 127 | 127 | 0 | 0 |
| 127 | 0 | 0 | 127 | 127 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
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Figure 1A