Final Exam 2014

Prescription Number: COSC428

Paper Title: *Computer Vision*

Time allowed: TWO hours

Number of pages: 4

- This exam is worth a total of 100 marks

- Contribution to final grade: 40%

- Length: 9 questions

- Answer *all* questions.

- Calculators are *not* allowed.

- *This is a closed book test*.

- Use the separate *Answer Booklet* for answering *all* questions.

1 (12 marks total)

Briefly describe advantages and/or disadvantages of the following four different types of camera technologies **for acquiring image depth values**. [1 mark for each advantage _or_ disadvantage cited]

(a) structured light camera   [3 marks]
(b) time-of-flight camera   [3 marks]
(c) stereo camera   [3 marks]
(d) LIDAR (Light Detection And Ranging) [3 marks]

2 (12 marks)

How do pixels in a camera differ from the photoreceptors in the human retina in terms of colour space, distribution of colour, sensitivity, and resolution? (Use diagrams in your answer.)

3 (9 marks)

Describe the three colour spaces, CIE, RGB and HSV, using diagrams and explain their respective strengths and weaknesses and where and how they are most commonly used.

4 (12 marks)

Describe how correctly matched points in two images enable finding:
(a) depth values in a stereo pair of images [4 marks]
(b) optical flow points in two successive frames of video using the Lukas Kanade algorithm [4 marks]
(c) Describe how depth can be calculated from optical flow. [4 marks]

5 (6 marks)

A good local image feature to track should:
- satisfy brightness constancy
- have sufficient texture variation
- not have too much texture variation
- correspond to a "real" surface patch
- not deform too much over time

(Such good local image features are used for matching the same point in a stereo pair of images or in successive frames of video.)

Taking into account the above features, describe the Harris detector

6 (13 marks)

A good edge detector should have:
- Good Detection: filter responds to edge, not noise.
- Good Localization: detect edge near true edge.
- Single Response: one per edge.

(a) Describe how the Canny edge detection algorithm accomplishes the above attributes of a good edge detector. [9 marks]
(b) Explain how the choice of Gaussian kernel size affects the behavior of the Canny edge detector. [4 marks]

7 (8 marks)

In order for a natural feature registration algorithm to work well it must be robust to common image transformations and distortions. List eight such image transformations and distortions.

8 (12 marks total)

Briefly describe the following morphological operators and explain what effect they have on an image and why they have such an effect:
(a) Erosion [3 marks]
(b) Dilation [3 marks]
(c) Open [3 marks]
(d) Close [3 marks]

9 (16 marks)

You are to briefly describe **only four** of the following 2014 class projects [for 4 marks each] by listing at least four algorithmic steps (for each of the four projects), naming the algorithms used in the order they were used. **Do not select your own or similar project** (e.g. face recognition projects do not select other face recognition projects, etc).

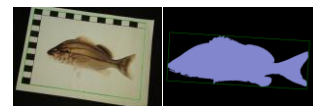(i) "Read a Resistor by Image Processing" to determining the colour band sequence for resistance value.
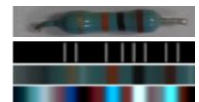
(ii) Measure heart rate by "Calculating a Vagal Tone Index using Webcam Photoplethysmography"

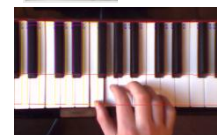(iii) Use a Kinect camera for "Computer Control with Hand Gestures"

(iv) Determine an "Orientation independent measurement of fish length"

(v) Find out who left their dirty dishes in the sink with "Automated Kitchen Surveillance"

(vi) Locate piano keys for a "Visual Piano Tutor"

(vii) Fill in depth image holes by "Stereo Disparity Map Inpainting Using Linear Interpolation"

(viii) "Estimating positions of Pool balls" on a pool table.

END OF PAPER