UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

University of Canterbury

Mid-year Examinations 2016

Prescription Number: COSC 428

Paper Title: Computer Vision

Time Allowed: 2 hours

Number of Pages: 5

- This exam is worth a total of 100 marks
- Contribution to final grade: 40%
- Length: 11 questions
- Answer *all* questions.
- Calculators are *not* allowed.
- *This is a closed book test*.
- Use the separate *Answer Booklet* for answering *all* questions.

1 (6 marks total)

Briefly describe:

a) Homography, H [2 marks]
b) Essential matrix, E [2 marks]
c) Bundle adjustment, BA [2 marks]

2 (10 marks total)

ArUco and AprilTags are two algorithms that find the six degree-of-freedom pose between a camera and a fiducial maker. Briefly describe these two algorithms. [5 marks each]

3 (6 marks total)

(a) Name the three stages of a convolutional neural network (deep learning) in the order that they operate from an input image. [3 marks]
(b) Name three commonly used deep learning frameworks [3 marks]

4 (6 marks)

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

5 (8 marks)

Assume that you already have a reliable model of the camera's intrinsic parameters, have removed any radial distortion and now wish to perform natural feature registration (NFR).
(a) List the five steps of the natural feature **registration** algorithm [5 marks]
(b) Name three natural feature **registration** algorithms [3 marks]

6 (12 marks)

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

7 (4 marks)

Write the equations for finding the
(a) gradient direction (angle) of an edge [2 marks]
(b) gradient strength (absolute value) of an edge in an image [2 marks]

8 (10 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. [8 marks]
(b) Explain how the choice of Gaussian kernel size affects the desired behavior of the Canny edge detector. [2 marks]

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9 (10 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 and compare the following two good local feature detection algorithms:

(a) Harris detector [5 marks]

(b) Scale-Invariant Feature Transform (SIFT) [5 marks]

10 (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]

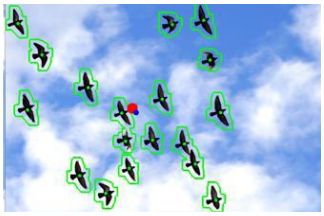
(c) Describe how depth can be calculated from optical flow. [4 marks]

11 (16 marks)

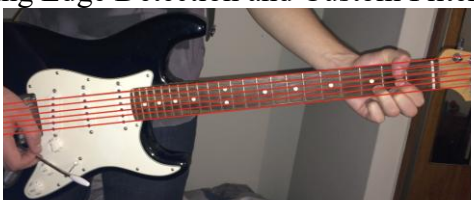
You are to briefly describe **only four of the following** 2016 class projects [for 4 marks each] by just listing (one per line) at least four algorithmic steps, **naming the algorithms** used in the order they were used.

Do not select your own or similar project (e.g. face recognition projects do not select other face recognition projects, etc).

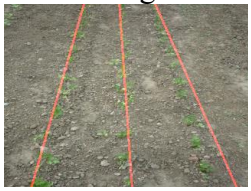
(i) "Detection and Tracking of Flying Birds"



(ii) "Guitar String Detection using Edge Detection and Custom Filtering"



(iii) "Detecting Tramways in Crops for Robot Navigation"

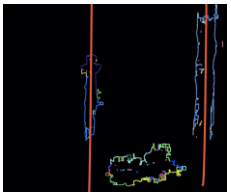


(iv) Detecting hand pose for “Self-Aware Standing Desk: Height Adjustment through Gesture Control”

(v) “Hands Free Wound and Skin Lesion Perimeter Detection”

(vi) Using a fiducial marker for “Automatic UAV landing”

(vii) “Real-time UAV Collision Avoidance Based on Environment Modeling”



(viii) “Iris Pattern Detection for Automated Identification of Hoplodactylus Chrysosireticus Geckos”

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