Family Name _____

First Name _____

Student Number |__|__|__|__|__|__|__|__|

Venue _____

Seat Number _____

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

No electronic/communication devices are permitted.

No exam materials may be removed from the exam room.

Computer Science and Software Engineering

EXAMINATION

Mid-year Examinations, 2019

COSC428-19S1 (C) Computer Vision

Examination Duration: 120 minutes

Exam Conditions:

Closed Book exam: Students may not bring in anything apart from writing instruments.

No calculators are permitted

Materials Permitted in the Exam Venue:

None

Materials to be Supplied to Students (if needed)**:**

- Extra sheets of write-on question paper (or answer book)

Instructions to Students:

- **Write your name and student ID above**
- This exam is worth a total of 100 marks
- Contribution to final grade: 40%
- Length: 10 questions
- Answer all questions.
- Check carefully the number of marks allocated to each question. This suggests the degree of detail required in each answer and therefore amount of time to spend on it.
- The amount of space provided also indicates the amount of detail expected.
- **Write strictly in the spaces allocated to each answer**. Do not write close to the margins, as the answer books will be scanned, and writing very close to the margin may not be picked up. If you require extra room, there is a blank page at the end of this booklet. You may also use additional sheets of paper; these must be fastened securely to your answer booklet. You should clearly indicate in the appropriate space that the answer is continued/provided elsewhere.

For Examiner Use Only

Question	Mark

Total _____

Questions Start on Page 3

1 [10 marks total)]

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. [6 marks]

(b) Explain how the choice of Gaussian kernel size affects the behavior of the Canny edge detector. [4 marks]

2 [12 marks total]

A good local image *feature* to track should:

- satisfy brightness constancy
- have sufficient 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 [6 marks]

(b) SIFT [6 marks]

3 [14 marks total]

Describe how correctly matched feature points in two images enable finding:

(a) depth values in a stereo pair of images [5 marks]
(b) optical flow points in two successive frames of video using the Lukas Kanade algorithm [5 marks]
(c) Describe how depth can be calculated from optical flow. [4 marks]

4 [16 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 [4 marks]
(b) Dilation [4 marks]
(c) Open [4 marks]
(d) Close [4 marks]

5 [12 marks total]

In the context of computer vision based 3D reconstruction, briefly describe the following:

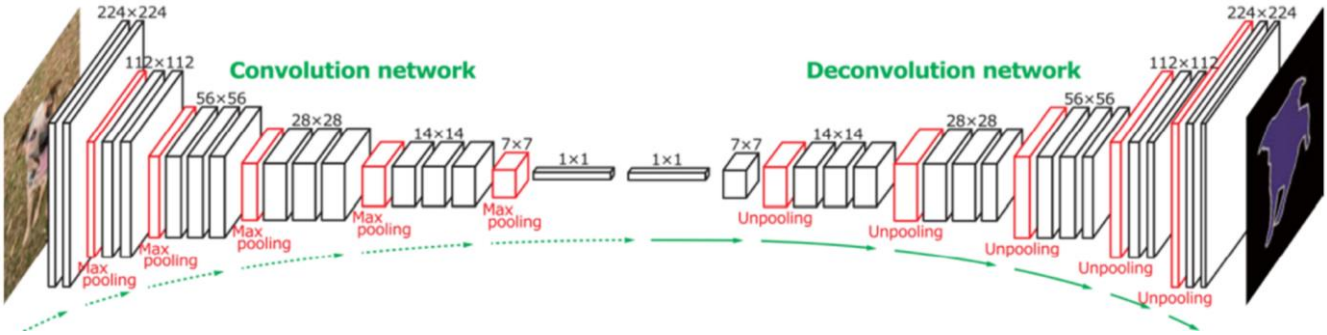
(a) Homography [4 marks]
(b) Essential matrix [4 marks]
(c) Bundle adjustment [4 marks]

6 [14 marks total]

Briefly describe the following four goals of deep learning applied to images:

(a) classification [3 marks]
(b) object detection [3 marks]
(c) dense segmentation [3 marks]
(d) instance segmentation [3 marks]

(e) State which of these four goals is achieved by the deep learning network below. [2 marks]



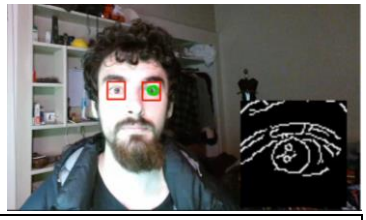
7 [6 marks total]

Deep learning (CNN) is a game changer in computer vision – and encompasses different learning approaches including *unsupervised* learning, *supervised* learning and *reinforcement* learning. Give an example for each of these *three* learning approaches. [2 marks each]

8 [16 marks total]

You are to briefly describe **only four of the following** 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).



(a) "Fatigue Detection" by locating eyes to detect blink rate.

Haar Cascade

Gaussian Blur

Canny Edge Detection

Hough Circle Transform

(b) "Billiards Top-Down Perspective Transform"

HSV Colour Space Transform

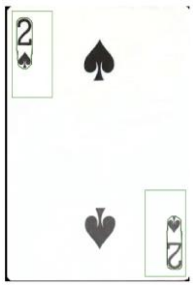
Threshold on Colour value

Canny Edge Detection

Perspective Transform

(Image Cropping)

(c) “Card Recognition”



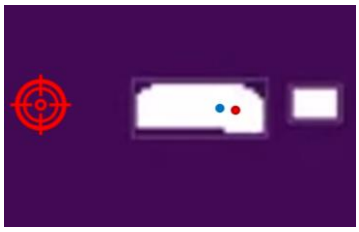
Dataset Generation

- Gaussian Filter
- Canny Edge
- Contour Detection
- Image Warping
- Convex Hull Detection

Object Detection

- You Only Look Once (YOLOv3)

(d) “Predictive Animal Tracking for Predator Identification”



Background Subtraction

Thresholding

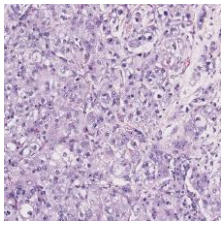
Erosion and Dilation (Opening)

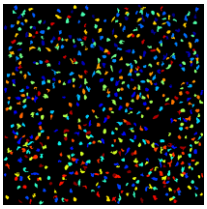
Moments of Image

Ordinary Kalman Filtering

Moving Average filtering

(e) “Cell Segmentation from Breast Cancer Whole Slide Images”





HSV conversion (and Normalise channels to use full value range)

Threshold

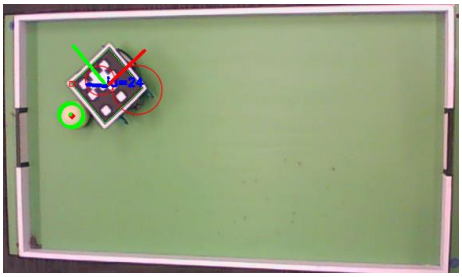
Gaussian Blur

Erosion and Dilation

(CellProfiler application)

(Blob detection)

(f) “Robot Soccer” to detect ball and robot.



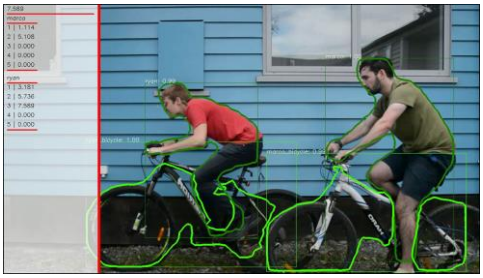
Ball detection:

- Hough Circles
- Differencing
- Blob Detection
- Colour Segmentation + Kalman
- HSV Segmentation

Robot Detection:

- Fiducial Markers

(g) “Cyclist Detection and Identification”

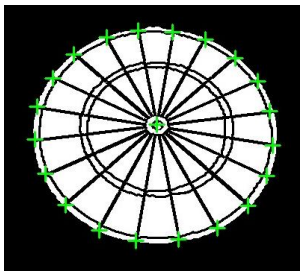


Mask R-CNN Neural Network with COCO Dataset

K-means Pixel Clustering

RGB Thresholding

(h) “Automatic Dartboard Scoring”



Difference algorithm

Hough transform algorithm

Floodfill algorithm

Dilation and Erosion algorithm

Opening and closing algorithm

Canny edge algorithm

Moments algorithm (finding the centre of threshold)

Contour generation algorithm

Random Gaussian noise algorithm

… extra space …

If you use this page, please refer to it from the original question.

End of Examination