

Family Name _____

First Name _____

Student Number

--	--	--	--	--	--	--	--	--	--

Venue _____

Seat Number _____



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, 2018

COSC428-18S1 (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
----------	------

[illegible]

Total

Questions Start on Page 3

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 [8 marks total]

In the Canny edge detector, describe the impact of varying the

- (a) σ (Gaussian kernel size) [4 marks]
- (b) threshold [4 marks]

3 [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]

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 [12 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]

6 [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.

7 [6 marks]

Describe how to remove noise from a 3D point cloud using PCL (Point Cloud Library).

8 [6 marks]

List three advantages of fiducial marker tracking over natural feature tracking and list three advantages of natural feature tracking over fiducial marker tracking.

9 [8 marks]

PyTorch and TensorFlow are two popular deep learning frameworks. Describe two advantages for each of these two frameworks.

10 [16 marks]

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) “Wheelchair Docking” at a desk used an Intel Realsense D435 camera to locate a desk immediately in front of the wheelchair.



Gaussian Blur

Convolution

Thresholding

Opening and Closing

Contours

Deprojection

(b) “Navigation of Robotic Platform using a single webcam”



HSV

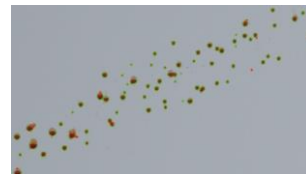
Binary

opening and closing

canny

Hough

(c) “Blood Spatter Segmentation”



Convert to HSV

Opening morphological operation

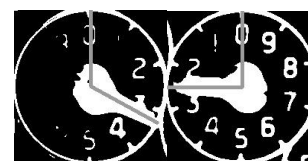
Otsu Thresholding

Hough Circle Transform

Contours Found with Suzuki Border Algorithm

Fit ellipses

(d) “Automated Electricity Meter Dial Reading”



Blur Image with Gaussian

Hough Circles (to find ROI)

Convert to binary

Otsu’s Algorithm for Thresholding

Bresenham's Line Algorithm

Convert angle to integer

(e) “Always Clean Kitchen” to detect dishes left behind



Background Subtraction and Thresholding

Morphological Transforms

Canny Edge Detection

Contour Detection and Size Comparison

(f) “REAL-time Hand Gesture Recognition Using Webcam”



HSV to filter skin colour

Haar Feature-based Cascade Classifier to detect and mask face

contour analysis to separate hand

Use Convolutional Neural Network to classify hand pose (number of fingers)

(g) “Book Call Number Detection”



Grayscale

Canny Edge

Dilation

Tesseract OCR

(h) “Crop-row Detection for Agricultural Robots”



HSV to threshold green

transform to birds-eye view

skeleton (morphology)

mean-shift clustering

fit lines

transform back into perspective view

... extra space ...

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

End of Examination