COMP425/6341 COMPUTER VISION

WINTER 2020 - (TAKE-HOME) QUIZ #2

$6^{th} April 2020$

INSTRUCTIONS: PLEASE READ CAREFULLY

- **This take-home quiz must be done individually**
- Write your answers on paper. Submit a scanned/photo of your hand-written answers via EAS
- Write your name/lastname and your student identification number on the paper before you submit it.
- Submissions will be accepted at anytime between 9am to 5pm on the day of the quiz
- The quiz has 3 pages and contains 5 regular questions (20% each).
- The maximum score is 100.
- Good luck!

REGULAR QUESTIONS (5x20%)

1. You are implementing a SIFT-like feature descriptor. A keypoint has been detected and the 16×16 local neighbourhood is given. This local neighbourhood is divided into 4×4 grid cells, each containing 4×4 pixels. Gradient orientations are given for the pixels contained in one of the grid cells as shown in the figure below.

Using the same subsequent steps as the SIFT-detector, calculate the N-vector for the given grid-cell which will be part of the final descriptor's vector. Show your calculations.

Assumptions: (i) all orientations are given in degrees, (ii) the dominant orientation of the grid cell is $0°$, (iii) all pixels have the same weight i.e. when casting a vote the weight of the vote is always 1 regardless of the location of the pixel within the grid cell, and (iv) the gradient magnitude of all pixels is 1.

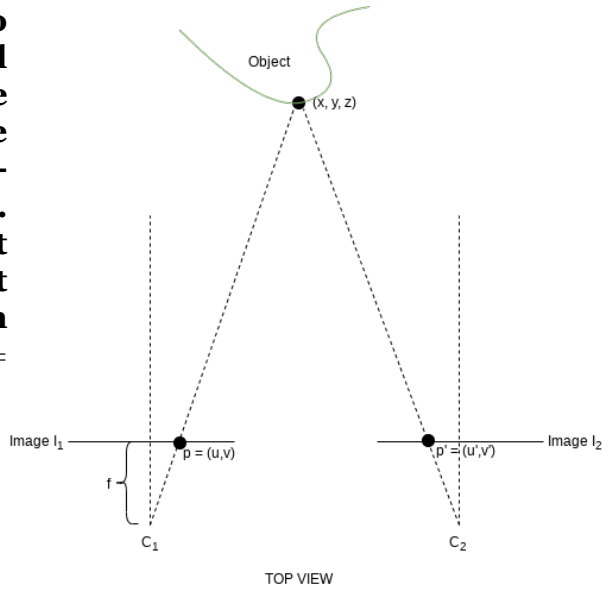
	θ = 25 θ = 30 θ = 31 θ = 41 θ = 33 θ = 35 θ = 60 θ = 85 θ = 42 θ = 40 θ = 55 θ = 80 θ = 41 θ = 44 θ = 40 θ = 23		

2. A camera is located at the origin $O(0,0,0)$, is aligned with the world axes, and has a focal length of 1000. The camera captures images of resolution 300×200 and has a perfect lens with no misalignment or distortions. A polygon is defined by the four 3D points $(-0.75,-0.5,5),(-3.75,-2.5,25),(0,1,10),(0,0,10000)$. What are the pixel coordinates (u,v) of the projected points on the image plane of this camera, and what is the shape defined (by said projected points) in image space?

3. Consider the following equation for projecting the 3D point (x,y,z) to the image point (u,v,w). Identify all intrinsic and extrinsic parameters (e.g. focal length, rotation angles, etc) and state their values.

$$\begin{bmatrix} u \\ v \\ w \end{bmatrix} = \begin{bmatrix} 1800 & 0 & 384 \\ 0 & 2200 & 512 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0.7071 & -0.7071 & 5 \\ 0 & 0.7071 & 0.7071 & -20 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

4. A stereo system consists of two cameras which have parallel optical axes as shown in the figure on the right, with a baseline of $(t_x,0,0)$. The cameras have identical intrinsic parameters f_x, f_y, c_x, c_y and no skew. Prove that projecting the 3D point (x,y,z) in the two images will result in the pixel coordinates appearing on the same scanline i.e. prove that $v == v'$.



5. A stereo system consists of two cameras which have parallel optical axes. The two cameras have identical intrinsic parameters $f_x = 1000$, $f_y = 1000$, $c_x = 300$, $c_y = 200$, $\theta_{skew} = 90^\circ$ (i.e. no skew). The first camera is located at $(-23,5,12)$. The second camera is located at $(-28,15,10)$. What are the depth values for the following matched points defined in terms of their corresponding principal points(optical centers)?

A. **Point $(26,97)$ in the left image matched with point $(76,67)$ in the right image**

B. **Point $(162,842)$ in the left image matched with point $(162,842)$ in the right image**

Calculate the 3D point (i.e. X, Y, Z) corresponding to case A above.

THE END