GX1329

NATIONAL UNIVERSITY OF IRELAND, GALWAY
OLLSCOIL NA hÉIREANN

SEMESTER II, SUMMER 2000 EXAMINATION

THIRD YEAR B.A. (INFORMATION TECHNOLOGY)
HIGHER DIPLOMA IN APPLIED SCIENCE (SOFTWARE DESIGN & DEVELOPMENT)

CT336 GRAPHICS AND IMAGE PROCESSING

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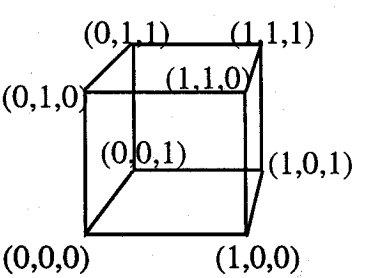
Time allowed: THREE hours

Answer any FOUR questions
All questions carry equal marks

Q.1. (a) With regard to the storage and transmission of digital images, describe in general the terms: lossy compression and lossless compression.

(b) In the context of three-dimensional graphics, describe 3 techniques used for each of the following: (i) hidden surface removal, (ii) surface shading.

(c) Presuming that the unit cube shown below is viewed using a 1-point perspective projection with the centre of projection located on the z axis at co-ordinate (0, 0, 30), calculate the (x, y) viewport (screen) co-ordinates of the 8 vertices,



1-point perspective projection where the centre of projection lies on the z axis at co-ordinate (0, 0, cp):

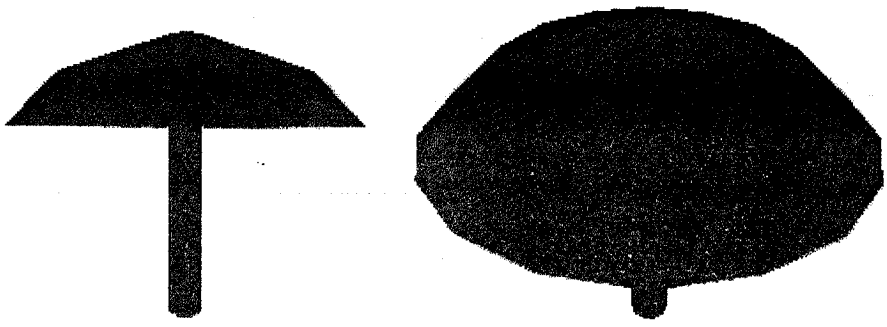
$$[M_{PERZ}] = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & -1/cp \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(d) Describe the raster graphics technique of "antialiasing", referring to both weighted and unweighted area sampling in your answer.

Q.2. (a) Discuss the mechanisms by which modern "hardware accelerated" graphics adapters provide improved graphics capabilities.

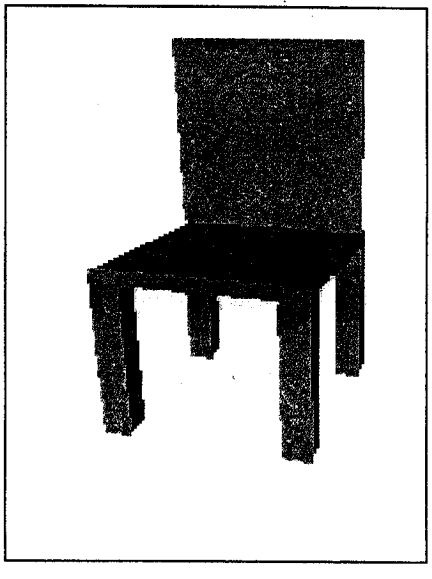
(b) Explain the term "extrusion", as it applies to 3 dimensional computer graphics. Refer in your answer to the following terms: cross section, spine, scale, orientation.

(c) The following 2 pictures show a model of a mushroom, seen from different angles. Write VRML code to create an object similar to this. Note that the most useful VRML nodes are summarised on the final page of this exam paper.

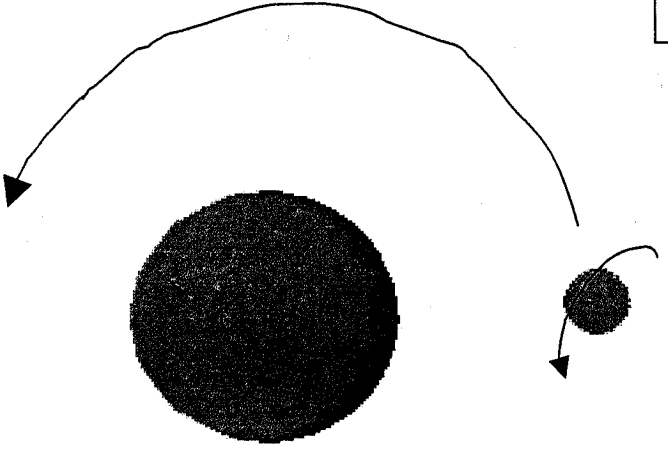


Q.3. (a) Briefly describe the following concepts in computer animation: (i) nested co-ordinate systems; (ii) keyframe animation.

(b) Write VRML code to create a chair object similar to the one pictured on the right.



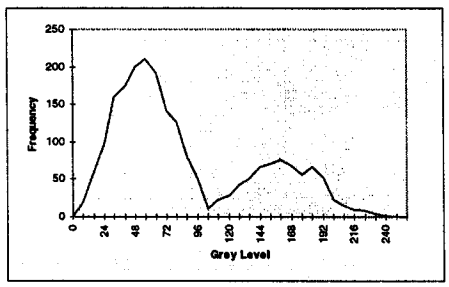
(c) The model depicted below is of two spheres. Write VRML code to create these spheres, and set up an animation in which the smaller sphere orbits the larger one, while also rotating around its own centre.

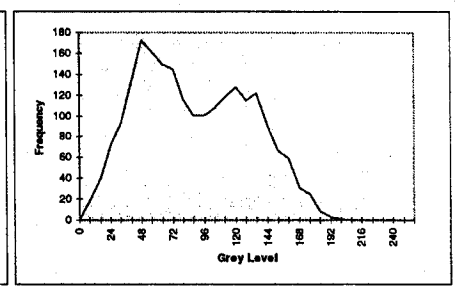


Q.4. (a) Briefly explain the difference between global (point) and local image processing operations.

(b) Describe greyscale histogram manipulation, referring in your answer to linear stretching, histogram-equalised stretching, and special stretching. In what circumstances would each of these stretches be of potential use? Provide an algorithm for histogram equalised stretching.

(c) Present an algorithm for segmenting the scene represented by the first greyscale histogram below, presuming that a bright object of interest lies on a dark background. Present a modified version of this algorithm for segmenting the scene represented by the second greyscale histogram below, in which the distinction between object and background is less well defined.



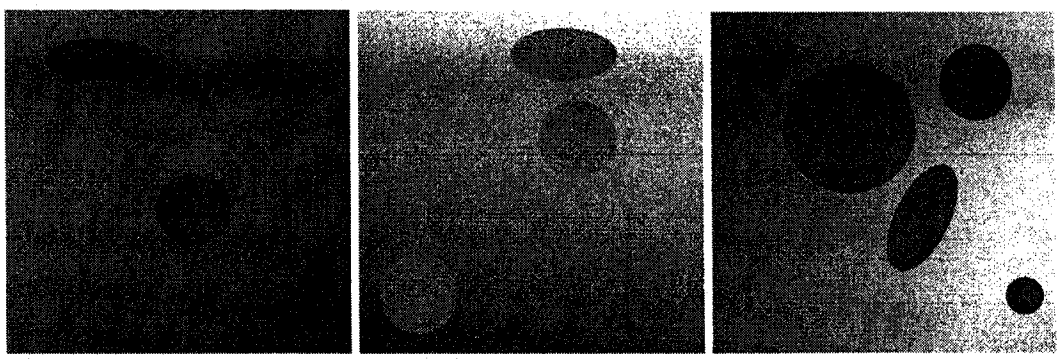


Q.5. Present the algorithms that could be used by a fully automated industrial vision system, for **identifying**, **measuring** and **classifying** apples and pears in images.

The system must automatically:

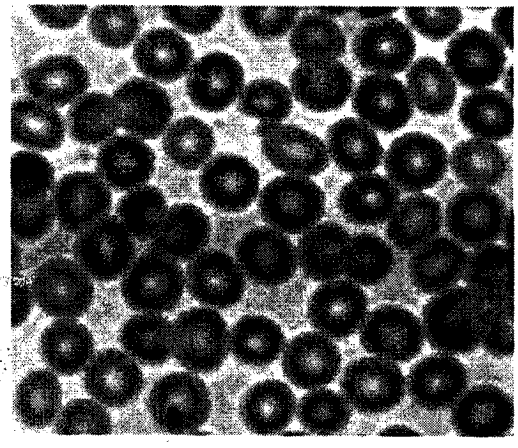
- Identify and count 'apples' (fairly circular objects)
- Identify and count 'pears' (fairly elongated oval objects)
- Estimate their sizes (in pixels) as accurately as possible

Some typical input images are shown below.



Q.6. (a) The thresholded (i.e. binary) image below is of fungal growth in a laboratory. Presuming that the total length of growth is to be monitored over time via a series of such images, provide a suitable and robust set of algorithms for automating this task.

(b) The image below is of blood cells, and it is required that a fully automated system is developed to accurately count the number of cells in images such as this. Present a suitable and robust set of image processing algorithms for this task.



Some useful VRML node information:

```
Shape
{
       geometry
       appearance
}

Transform
{
  children    [ ]
  translation 0.0   0.0   0.0
  rotation    0.0   0.0   1.0   0.0
  scale       1.0   1.0   1.0
  center      0.0   0.0   0.0
}

TimeSensor
{
  enabled             TRUE
  startTime           0.0
  stopTime            0.0
  cycleInterval       1.0
  loop                FALSE
  isActive            # eventOut
  time                # eventOut
  cycleTime           # eventOut
  fraction_changed    # eventOut
}

PositionInterpolator
{
  key    [  ]
  keyValue [  ]
  set_fraction    # eventIn
  value_changed   # eventOut
}

OrientationInterpolator
{
  key    [  ]
  keyValue [  ]
  set_fraction       # eventIn
  value_changed      # eventOut
}

Extrusion
{
  crossSection [ ]
  spine        [ ]
  scale        [ ]
  orientation  [ ]
  beginCap
  endCap
  creaseAngle
}
```

Co-ordinates for a circle-shaped cross section, suitable for extrusion:

```
1.00 0.00,    0.92 -0.38,
0.71 -0.71,   0.38 -0.92,
0.00 -1.00,   -0.38 -0.92,
-0.71 -0.71,  -0.92 -0.38,
-1.00 0.00,   -0.92 0.38,
-0.71 0.71,   -0.38 0.92,
0.00 1.00,    0.38 0.92,
0.71 0.71,    0.92 0.38,
1.00 0.00
```

```
Box
{
       size 2.0 2.0 2.0
}


Sphere
{
       radius              1.0
}

Cylinder
{
       radius              1.0
       height              2.0
       side                TRUE
       top                 TRUE
       bottom              TRUE
}

Group
{
  children    [ ]
}
```