Midterm Test

March 2nd, 2009

CSC320H1S : Introduction to Visual Computing

Duration: 50 minutes

No aids allowed

There are 5 pages total (including this page)

Given name(s): _____

Family name: _____

Student number: _____

| Question | Marks |
|---|---|
| 1 | _____/20 |
| 2 | _____/15 |
| 3 | _____/15 |
| Total | _____/50 |

# 1 Gradients and Edge Detection (20 marks total)

(a) **[5 Marks]** Give the definition of the gradient of a gray-scale image $I(x, y)$ using standard calculus notation.

(b) **[8 Marks]** Give one algorithm for automatically detecting the edge pixels in image $I$. Be as specific as possible.

(c) **[7 Marks]** Now suppose that you are given a *three-dimensional image*, represented as a 3D array, $I'(x, y, z)$, of grayscale pixels. Such 3D images are used in medical imaging and are often produced by X-ray scanning the body's interior, with pixel intensity indicating tissue density.

How would you generalize the concept of an "edge pixel" to the case of 3D images? Give an algorithm for automatically detecting the edge pixels in $I'$.

## 2 Principal Directions & Principal Curvatures (15 marks total)

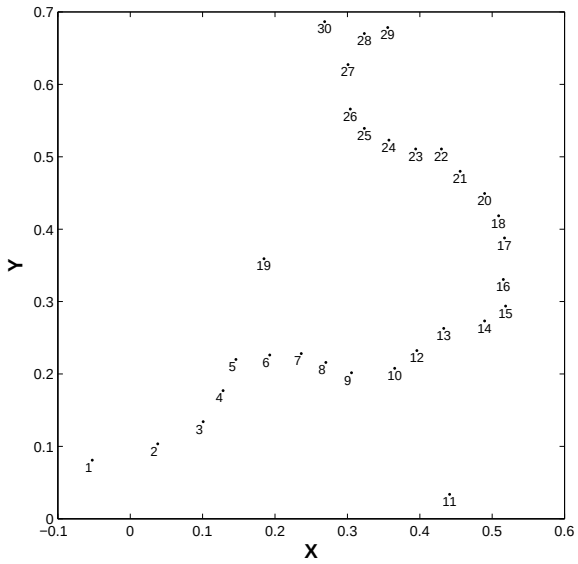
Suppose that the intensities in the neighborhood of the central pixel, $(0, 0)$, of a 2D patch $I$ are well-approximated by the polynomial

$$I(x, y) = 100x^2 - 20y^2 + 80x^3y^3 \ .$$

Compute the principal directions and principal curvatures of $I$ at pixel $(0, 0)$.

# 3 Curvature Estimation (15 marks total)

Suppose we are given 30 points, $\gamma(1), \gamma(2), \ldots, \gamma(30)$ along a curve in 2D, shown below as dots with their index next to them.




Briefly explain how you would estimate the curvature at $\gamma(20)$ in a way that is unaffected by the "outlier" points $\gamma(19)$ and $\gamma(11)$. You do not need to provide formulas/equations, but be sure to justify your reasoning.

**END OF EXAM**