EXAM COMPUTER VISION EXAMPLE TEST

October 22, 2008, 9:00 hrs

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During the exam you may use the book, lab manual, copies of sheets and your own notes.

Put your name on all pages which you hand in, and number them. Write the total number of pages you hand in on the first page. Write clearly and not with pencil or red pen. ***Always motivate your answers.*** *Good luck!*

Problem 1. (**2.5 pt**) Given a camera with unknown camera constant f, which images a parallelogram $ABCD$ via perspective projection on the plane $z = f$ (**ccc**-system). The sides AB and AD are at a known angle α, see Fig. 1. Furthermore, one corner of the parallelogram is known: $A = (0, 0, 3)$.

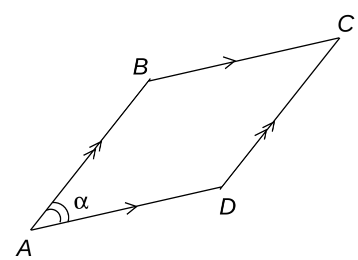

Figure 1: *Four line segments forming a parallelogram.*

The vanishing point of the parallel sides AB and DC is $(u_\infty, v_\infty) = (2, 1)$.
The vanishing point of the parallel sides AD and BC is $(u'_\infty, v'_\infty) = (-1, -2)$.

a. (1.5 pt) Compute the camera constant f as a function of α.

b. (1 pt) The equation of the plane V containing the parallelogram, has the form:

$$V : \quad a\,x + b\,y + c\,z + d = 0.$$

Determine the constants a, b, c, d, assuming $\alpha = \pi/2$.

Problem 2. (**2 pt**) Consider a cylinder with an axis parallel to the x-axis, with equation

$$z = d - \sqrt{r^2 - y^2}, \qquad -r \leq y \leq r$$

The cylinder has a Lambertian surface with constant albedo $\rho_S = 1$, and is illuminated from below by a light source at a very large distance, from a direction defined by the unit vector (a, b, c). The camera is on the negative z-as.

Show that the image intensity under orthografic projection is given by

$$E(x, y) = \frac{by - c\sqrt{r^2 - y^2}}{r}$$

Problem 3. (**2 pt**) Consider the use of snakes to segment a simple grey-scale image given in Fig. 2(a). The aim is to find the contour of the dividing bacterium as shown in Fig. 2(b) (i.e., it need not be split into two parts).

a. (0.75 pt) Which is the best initialization for an expanding snake (i.e. with a force at right angles to the snake in the outward direction). Discuss why it works in the best case, and how and why it should fail in the others.

b. (0.5 pt) As (a), but for a contracting snake.

c. (0.75 pt) At which points of the contour must the smoothness constraint for a snake be relaxed to get the best fit?

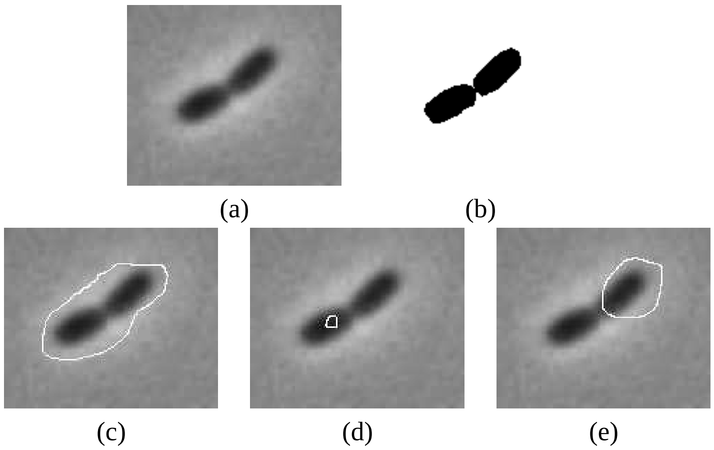

Figure 2: *Phase-contrast image of bacterium: (a) original image; (b) ideal object shape; (c), (d) and (e) initial position of snake superimposed on (a) in white.*

Problem 4. (**2.5 pt**) Consider a parabolic surface of the form

$$z = d + ax^2 + by,$$

a. (1.5 pt) Assuming a homogeneous texture with texture constant ρ_0 determing the observed texture density $\Gamma(u, v)$ under parallel projection ($u = x$,$v = y$).

b. (1.pt If we do not know ρ_0, can b be infered from the image? What other technique could be used in combination with shape from texture to resolve this?