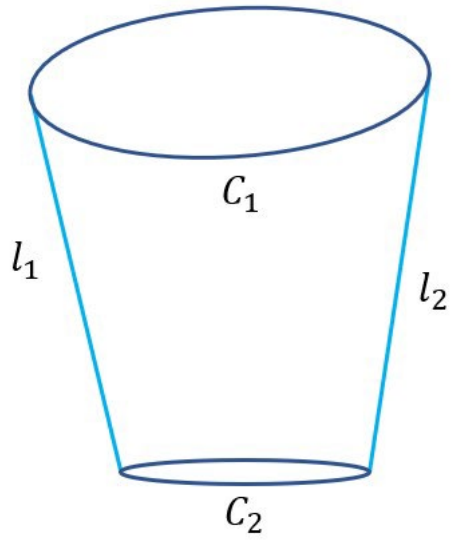
Homework 2022-2023

Scene. A right (axial-symmetric) cone together with two (or more) circular cross sections. *(A circular cross section of a right cone is a circumference centered on the symmetry axis and perpendicular to the symmetry axis).*

Image. A single image is taken of the above described cone by an uncalibrated, zero-skew, **natural** camera. (*A natural camera has square pixels, so that* $f_X = f_y$. *Hence its calibration matrix only depends on just three unknown parameters, namely the focal distance* f *and the two coordinates* U_o, V_o *of the principal point*). The apparent contour of the cone is extracted, consisting of two straught lines l_1, l_2 and two conics C_1, C_2 (that are image of the two visible cross sections).



Part 1: **Theory**

1. From C_1, C_2 find the horizon (vanishing) line h of the plane orthogonal to the cone axis.
2. From l_1, l_2, C_1, C_2 find the image projection a of the cone axis.
3. From l_1, l_2, C_1, C_2 (and possibly h and a), find the calibration matrix K.
4. From h and K, determine the orientation of the cone axis wrt to the camera reference.
5. How would you use K, h, the axis orientation and the image V of the cone vertex in order to compute the cone semi-aperture angle α?

Part 2: **Matlab**

1. Consider the real image below. Using feature extraction techniques (**including** those implemented in **Matlab**) plus possible manual intervention, extract both the straight lines of the cone apparent contour and image of useful circular cross sections.
2. Write a Matlab program that implements the solutions to problems 1 – 4 (and, to get an extra point, 5).