EE 428: Computer Vision

Homework 4: Magic Wand

Instructor: Jonathan Ventura

In this assignment you will implement a script to detect a colored ball, estimate its 3D position, and draw a 3D cube over the ball. You could imagine using this technique to implement a 3D mouse or a VR game controller.

The intrinsic parameters of the camera are given in the file `iphone_calib.txt` and the radius of the ball is 3 cm. You need to figure out how to calculate the (X,Y,Z) coordinates of the ball using your knowledge of pinhole projection.

To install required dependency `imageio` with video support, try either `pip install "imageio[ffmpeg]"` or `pip install "imageio[pyav]"`.

Code requirements

Your code must fill in the empty methods in the `MagicWand` class in `magicwand.py`. To run the script do `python magicwand.py <video filename>`.

Notes on the methods to fill in:

- `preprocess_image` : Convert the image to grayscale and return the result of Canny edge detection (`skimage.feature.canny`).
- `detect_circles` : Detect circles in the edge map using the Hough transform (see this page). You can play around with the parameter settings until you find something reasonable. - `project` : Project a 3D point to 2D. Note that `self.focal` , `self.centerx` , `self.centery` contain the necessary intrinsics parameters.
- `draw_line_3d` : Draw a projected 3D line -- this should make use of `draw_line_2d` .

Report

Provide a short explanation of your solution. Be sure to document any sources you used in preparing your code, including websites and AI tools.

Discussion questions

Once you have the ball tracker implemented and working, inspect the results and answer the following qualitative evaluation questions:

1. Does the ball detector seem accurate? Explain when it fails to detect the ball and hypothesize why it fails.
2. Would it be possible to correctly rotate the 3D box according to the ball's orientation? Why or why not? If not, how could we physically modify the magic wand so that we could calculate the correct rotation of the box?

Submission instructions

Submit your Python script `magicwand.py` and report (PDF or docx). Please do not put them in a zip file, just submit the files directly.