Department of Computer Science, University of Bristol

COMS30087: Image Processing and Computer Vision

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3-D from Stereo: Lab Sheet I

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The aim of lab sheets I and II is to prepare you for undertaking part II of the coursework assignment on stereo vision. All are designed to give you insight into the use of stereo in computer vision for estimating depth from two or more images and obtaining a 3-D reconstruction of a scene. It will also provide you with practical experience of coding up theoretical concepts in 3-D computer vision, carrying out experiments and analysing the performance of algorithms. This lab sheet prepares the ground by familiarising you with the 3-D simulator used in lab sheet II and in the assignment. The simulator is written in Python and uses Open3D (`www.open3d.org`) Follow the tasks set out below. You are strongly encouraged to keep copies of all versions of your code and associated results.

1. Download and run the 3-D simulator as described below.
2. When you run the simulator you should see 3 spheres on a plane and the world coordinate system shown using three arrows for the X (red), Y (green) and Z (blue) positive directions. Add another sphere on the plane so that it is not touching the other 3 spheres.
3. You should also see two png images stored in your current directory. View the images. They show views of the scene captured from two virtual cameras (VCs) - labelled camera 0 and camera 1 in the code. See if you can work out the approximate 3-D orientation and position of each camera.
4. Add another sphere to the scene so that its centre projects to the centre of the image capture by camera 0. Run the simulator and check that the sphere does lie in the centre of image captured by camera 0.

   Hint: *In camera coordinates, such a sphere will lie along the vector which lies along the camera's principle axis. Determine that vector and set its length to the distance that you want the sphere centre to be from the camera COP. Now convert the vector into world coordinates and use this to position a sphere in the scene.*
5. Change the depth of the new sphere so that it sits on the plane. **Hint**: *you need to compute the distance from the COP to the plane.*
6. Repeat the above but this time place the sphere so that its centre projects to a point horizontally to the right of the image centre. Again, change the depth so that the sphere sits on the plane.
7. **EXTRA**. Try introducing additional VCs so that they capture more views of the scene from different viewpoints. Check that the stored images match your expectations.

Downloading and running the 3-D simulator

1. Down load a copy of LabI-v1.py or LabI-v2.py. Both have the same functionality but may be OS dependent. Try v1 first and then v2. v2 recommended for MacOS. If neither work, contact a TA.
2. Install a virtual environment using conda: `conda create -n ipcv python=3.8`
3. Activate the virtual environment: `conda activate ipcv`
4. Install opencv: `pip install opencv-python`
5. Install open3d: `pip install open3d`
6. Run the simulator, eg: `python LabI-v1.py`

You may want to use the following recommended versions for certain packages if you are not using a Linux system:

- For Mac user, we recommend Python is 3.8 or 3.9, numpy 1.21.5 and Open3D 0.16.0
- For Windows user, we recommend Python 3.8, numpy 1.23.3 and Open3D 0.11.2