**COMS30068: Image Processing and Computer Vision Coursework 2022 Part 2**

Submission by Ben Browne – nm20529

**Component 1 – Sphere Correspondence**

First we needed to detect circles for each View Camera image. Cv2.HoughCircles() was used with the following parameters:

Chart, bubble chart

Description automatically generatedThese parameters detected all circles with relative accuracy on subsequent runs. Param1 – the threshold for edge detection resulted in false edges when <~10, param2 – the circle vote threshold resulted in false circles <~25. A balance was required between these 2 parameters to ensure all circles were detected and radi were accurate.

Figure 1.1 – Hough Circles

Figure 1.1 – Hough Circles

Figure 1.1 – Hough Circles

In order to take points in one image and calculate the corresponding epipolar lines in the other, the *Essential* and *Fundamental* matrices had to be calculated, which both encode the epipolar geometry between both cameras.

The Essential Matrix E, is a 3x3 matrix that relates corresponding points in stereo images: x’T · E · x = 0 where x’ is the homogeneous coordinates of point in image 2 and x is the homogenous coordinates of point in image 1.

The Fundamental Matrix F, is a 3x3 matrix that also relates corresponding points in stereo images, but can be applied to non-canonical cameras where as E only applies to canonical/calibrated cameras, where the camera intrinsics K = K’ = I.

Shape

Description automatically generatedOur setup requires the computation of the Fundamental Matrix, which in turn requires the computation of the Essential matrix.

Figure 1.2 describes the epipolar geometry setup between the two cameras. To calculate E, the relationship between the 2 cameras [R (Rotation) , T (Translation)] must be defined. We can do so by finding HRL = , which allows us to calculate S = and finally **E = RS**

Figure 1.2 – Epipolar Geometry

Now we calculate **F = MTR · E · ML**, where MR = ML = K.intrinsic-1

Chart

Description automatically generatedBy analysing the image from our left camera (H1), we can create a list of detected circle centres which using the fundamental matrix, calculate it corresponding epipolar line in the right image. Shown in Figure 1.3, this gives us a 1D ‘search window’ for the corresponding point in the right image.

Finding the corresponding circle centre is then trivial, iterating through the points on the line until the centre is found.

Figure 1.3 – Corresponding Image Points

https://web.stanford.edu/class/cs231a/course\_notes/03-epipolar-geometry.pdf