# Background Research

The project I have picked is to design a system that can calibrate a cutting table using multiple inexpensive cameras as opposed to the large expensive camera array currently in use. Involved will be aspects of computer vision, networking and others. To start off with the project, I have decided to focus on the computer vision aspect first, as I am most unsure about that field and I think it will decide the implementation requirements for the networking side of the project.

After doing some initial research into computer vision, I realised that I needed to acquire a more fundamental understanding of its basic principles like matrices and linear transformations. To aid with this, I watched a YouTube series [1] which helped me develop an understanding for linear algebra. From this, I moved onto the basics of computer vision, such as the pinhole camera model that is assumed in algorithms. In this model it said that each point in the image plane has a straight line through the pinhole of the camera to its corresponding point in space

The main complication this has for computer vision applications is that a dimension is "lost" due to 3D space being draw onto a 2D plane, which makes discerning distance especially difficult. Another issue that must be overcome is that this model does not perfectly represent a camera in the real world, as each has its own unique characteristics that distort the images it produces - this is known as the intrinsic parameters of the camera. This is where camera calibration is required to correct for these imperfections. The typical approach nowadays is to use a known chessboard pattern, shown in various images at various positions and angles to the camera [3, 4], so that the projection error can be calculated, and a camera calibration matrix generated that best fits the geometry of the known chessboard.

A different calibration technique, as detailed in [5, 6, 7] is to use a self-identifying calibration pattern. These self-identifying patterns are useful in calibrating a multi-camera array, especially when the field of view of the cameras overlaps little or not at all. This is because when using a more conventional calibration technique with a non-self-identifying chessboard pattern, if part of the pattern in the image is occluded from one of the cameras, that camera cannot use the image for calibration. Calibration in the presence of partial calibration pattern occlusion is possible with self-identifying patterns because the region of the pattern that each camera sees can be calculated, due to each square being unique, and therefore still useful for calibrating the camera despite the occlusion. Unfortunately, I could only find one example [12] of self-identifying pattern camera calibration online so these may be out of the scope of the project.

The Picamera v2[9] has a range of sensor modes which support different resolutions, with varying fields of view and possible framerates. I will have to carry testing to decide on which sensor mode will be suitable for project. The cutting table head can move up to 2000mm per second and the cameras will be 100mm from the cutting bed so a balance between enough resolution to decode the markers and a high enough framerate to keep up with the movement of the head will have to be found.

References

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