Week 2: Camera Theory

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1 Introduction

In the MonoSLAM approach presented by Davison, the primary sensor information is gathered from a **single** low-cost digital camera. The following section, first and foremost, aims to present a mathematical and geometrical approach to the modelling of the aforementioned camera in its ideal form. Thereafter, the ideal model can be modified to incorporate the effects of non-idealities such as distortion. This section will also provide a sufficient approach to reconstruct an estimate of the original three dimensional position form a sequence of two dimensional data contained within the cameras images.

1.1 The Pinhole Camera Model

This classical model provides a reasonable approximation of a three-dimensional point in world and approximates this position according to a 2-dimensional plane. Though this model is widely utilised in the computer vision field, it is important to note that the model itself is an approximation that incorporates a number of assumptions. The models convenience as well as its simplicity make it a popular choice within practice. The model though, can be adapted to limit certain assumptions and better approximate the properties that coincide with available digital cameras.

1.1.1 Description of the Model

The pinhole camera model can be described as a two-dimensional plane, containing the projections of the three dimensional coordinate. The process of representing a 3D coordinate in terms of a 2D coordinate is known as *perspective projection*. The two-dimensional plane is commonly referred to as the *pinhole plane* which contains a infinitesimal hole at its centre - the *pinhole*. The camera possess its own 3D coordinate system with coordinate axes X_C, Y_C and Z_C (also referred to as the cameras *optical axis*). The pinhole is situated at the origin of this 3D coordinate system - this is also referred to as the *optical centre*, O. The image plane is located at a positive distance f from the optical centre O along the negative Z_C-axis and is parallel to the pinhole plane.

Figure 1: default