Assignment 3

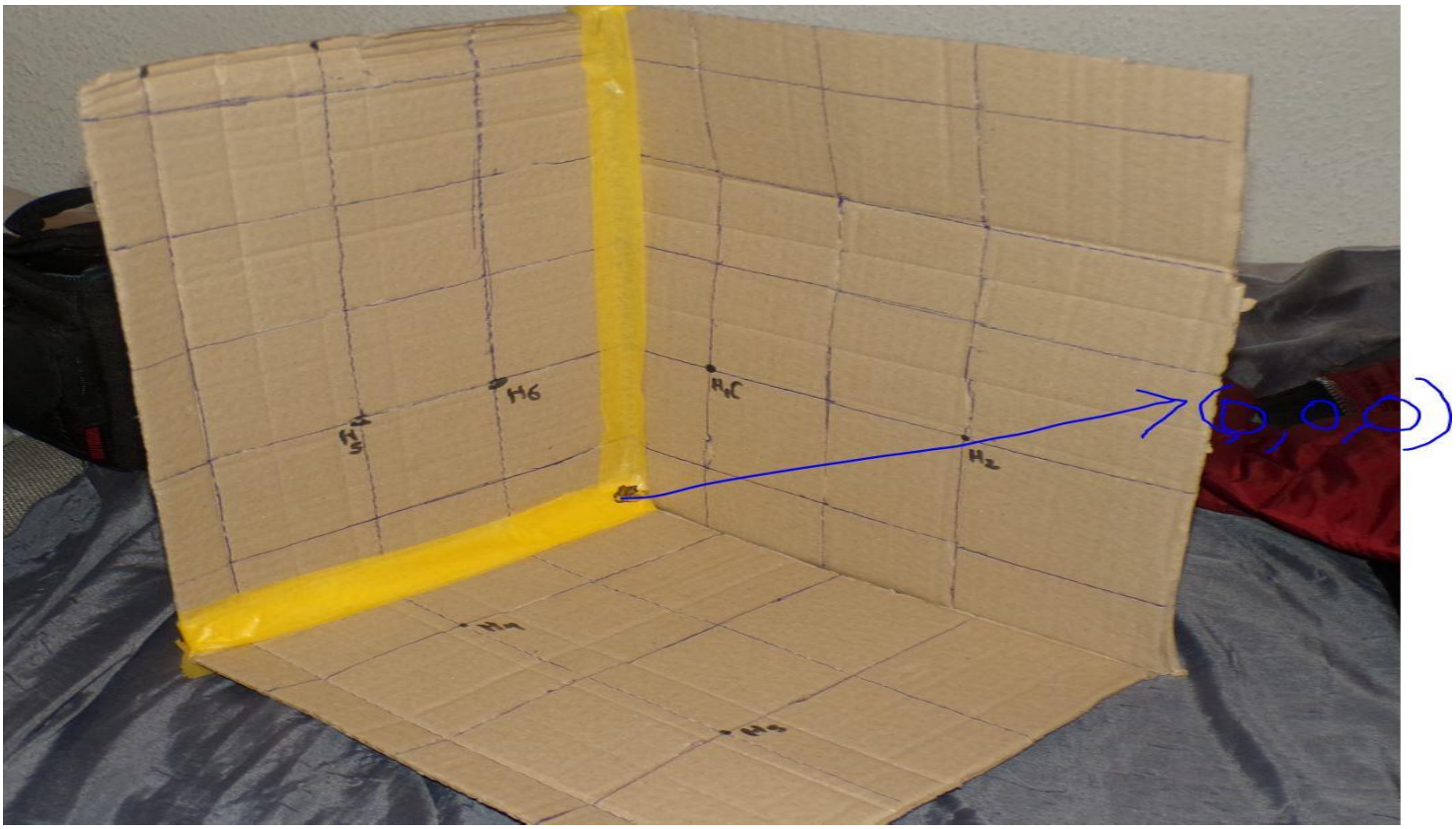
Photogrammetry Computer Vision

Image Acquisition:

The calibration object consists of three carton boxes arranged perpendicularly, secured in place with tape and a specialized adhesive. The control points on each box facilitates precise calibration. The coordinate measurements are taken at intervals of 10cm (approximately 3.94 inches) along the

x, y, and z axes. The imaging system employs a Kodak PIXPRO AZ425 camera equipped with an effective image sensor resolution of 20.68 megapixels and a total image sensor pixel count of 21.14 megapixels. The camera features a powerful 42x optical zoom, TTL Autofocus, and various resolution options, including 1920x1080 at 30fps, 1280x720 at 60fps/30fps, 640x480 at 30fps, and Film Grande Vitesse 640x480 at 120fps. This setup ensures accurate and high-quality imaging for calibration purposes.

Control Point Measurements:



The reference point is established at the intersection of the three perpendicular carton boxes, chosen as the origin. The distances between the x, y, and z axes are measured using a folding ruler, ensuring a consistent 10cm (approximately 3.94 inches) separation for each axis. In our methodology, the right-hand rule is employed to define positive directions: the right-hand thumb points in the positive x-direction, the index finger in the positive y-direction, and the middle finger in the positive z-direction. To ensure accuracy, a folding ruler is utilized to measure the coordinates of six control points along the x, y, and z axes. Each measurement is taken at a 10cm interval. The origin, serving as the reference point, enhances precision. To mitigate parallax errors and systematic inaccuracies, each measurement is repeated four times, and the average is calculated. This meticulous approach contributes to the reliability and precision of our recorded measurements.

Extracted Parameters and their Meaning:

Interior Orientation:

The interior orientation of the parameters of the camera is described by the calibration matrix Kmatrix in the source-code. From the source code,

$$Kmatrix = \begin{bmatrix} 1331.1 & -64.2 & -747.3 \\ 0 & 1159.5 & -168.9 \\ 0 & 0 & 1 \end{bmatrix}$$

This means that:

Principle Distance α_x = 1331.1[pix] which is the perpendicular distance from the projection center to the image plane.

α_y = 1159.5

Skew Factor *S* = -64.2 which represents any non-orthogonality between the axis.

Principle Point X_0, Y_0 = -747.3, -168.9 [pix] which is the section of the image axis with the image plane.

Aspect Ratio α_y / α_x = 1159.5/1331.1 = 0.871.

Exterior Orientation:

The Projection Centre from the source code is obtained as

C = (654.3287, 730.9564, 700.9538, 1) X 10^6 [mm]

The rotation matrix obtained from the source code is expressed as:

$$R = \begin{bmatrix} 0.8366 & -0.0519 & -0.5454 \\ -0.1720 & -0.9700 & -0.1715 \\ -0.5202 & 0.2373 & -0.8204 \end{bmatrix}$$

From the above, The rotation angle are computed as follows;

$$\omega = arctan\frac{0.2373}{-0.8204} = -16.13°,$$

$$\varphi = -\arcsin(-0.5202) = -31.35°, \quad K = arctan\frac{-0.1720}{0.8366} = -11.62°$$

Calibration Process Commentary:

The calibration process involved obtaining the 3D coordinate of the object and then obtaining the 2D coordinate of the object's image. A direct linear transformation/homography was performed to obtain the projective matrix. The projective matrix is then used to obtain the camera parameters.

The camera orientation is determined by calculating the rotation matrix from the projective matrix using RQ decomposition and the camera quality is determined by its orientation in three dimensional space.