1 - Building a digital camera obscura

2 - Anaglyph camera obscura

3 - Image Correction

The goal of this part is to remove distortion that is formed due to the fact that the pinhole camera’s image is drawn on a plane (rather than a sphere). In order to correct this, we find, for every point in the warped image, corresponding points in distorted image, and copy the image value.

\[ x_d(i) \text{ and } y_d(i) \text{ are points in the distorted image that correspond to } x_n(i) \text{ and } y_n(i) \text{ in the warped image, respectively. In the typical case, there are just 4 corners (i.e. } x_d \text{ and } y_d \text{ are corners of the distorted image. } x_n \text{ and } y_n \text{ are corners of the warped image). } x_d, y_d, x_n, y_n \text{ are in the form of} \]

\[ x_d = [ \text{corner}_1 x, \text{corner}_2 x; \]
\[ \quad \text{corner}_3 x, \text{corner}_4 x ] \]

\[ X_n \text{ and } Y_n \text{ are all the points in the warped image. } X_d \text{ and } Y_d \text{ are corresponding points in the distorted image.} \]

\[ [X_n, Y_n] = \text{meshgrid}(\text{size}_x, \text{size}_y); \]

\[
\begin{align*}
\% \text{ Given } f_x(x_n, y_n) &= x_d, \\
\% \text{ the output is } &f(X_n, Y_n) \\
X_d &= \text{interp2}(x_n, y_n, x_d, X_n, Y_n); \\
\% \text{ Given } f_y(x_n, y_n) &= y_d, \\
\% \text{ the output is } &f(X_n, Y_n) \\
Y_d &= \text{interp2}(x_n, y_n, y_d, X_n, Y_n); \\
\end{align*}
\]

for \( i = 1:3 \)

\[
\begin{align*}
\% \text{ g(x, y) = img(x, y, i) } \\
\% \text{ the output is } &g(X_d, Y_d) \\
\text{NEW_IMG}(:,:,i) &= \text{interp2}(\text{IMG}(:,:,i), X_d, Y_d); \\
\end{align*}
\]

end
The first two `interp2` find, for each point, \((X_n(i,j), Y_n(i,j))\), in the warped image, a corresponding point, \((X_d(i,j), Y_d(i,j))\), in the distorted image. Then, for each corresponding point, \((X_n(i,j), Y_n(i,j))\), the last `interp2` interpolates the image value; which will be an image value of the new image at \((X_d(i,j), Y_d(i,j))\).

4 - Anaglyph camera obscura: A device to measure distances to objects

We want to derive the relationship between the distance between a pinhole camera to the object, \(z\), and the distance between objects shown on the image plane, \(d\).

\[
\frac{z}{p} = \frac{z + f}{d} \\
z = \frac{f \cdot p}{d - p} \Leftrightarrow d = \frac{f \cdot p}{z} + p
\]

(1)

where \(p\) is the distance between the pinholes and \(f\) is the distance between pinholes’ wall and image plane.

From Eq (1), we notice that, when \(z\) goes to infinite (really far away), \(d = p\). Hence, the distance between the objects on the image plane can NEVER be smaller than the distance between pinholes.

Remark

Many students forgot to flip horizontally (left to right and right to left).