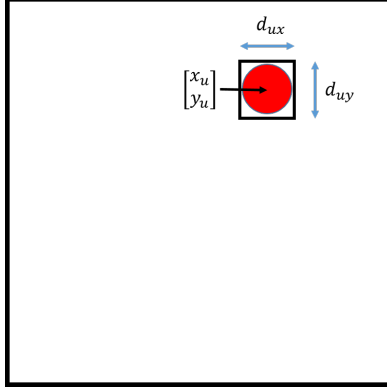


The following is a model of a single frame from the camera. In this frame, the red circular object represents the back of the interaction tool. The back of the interaction tool is called the target. The width of the target along the x dimension of the image is d_{ux} and the width along the y dimension is d_{uy} . The midpoint of the target is $\vec{\mathbf{x}}_{\mathbf{U}} = \begin{bmatrix} x_u & y_u \end{bmatrix}^{\mathbf{T}}$.



These measurements are related to the hidden state $\vec{\mathbf{x}}_{\mathbf{C}} = \begin{bmatrix} x_C & y_C & z_C \end{bmatrix}^{\mathbf{T}}$ in the following way:

$$\vec{\mathbf{y}} = \mathbf{h}(\vec{\mathbf{x}}) = \begin{bmatrix} x_u \\ y_u \\ d_{ux} \\ d_{uy} \end{bmatrix} = \begin{bmatrix} \frac{f_x x_C}{z_C} \\ \frac{f_y y_C}{z_C} \\ \frac{d_C}{z_C \sqrt{\frac{1}{f_x^2} + \frac{1}{f_y^2}}} \\ \frac{d_C}{z_C \sqrt{\frac{1}{f_x^2} + \frac{1}{f_y^2}}} \end{bmatrix}$$