

Time To Collision

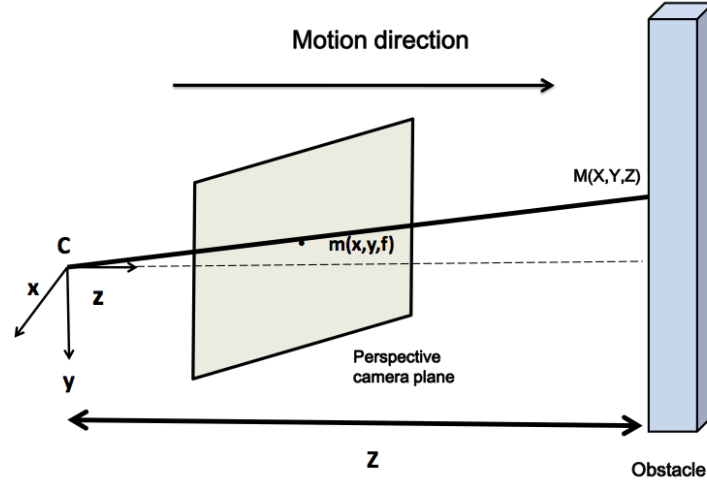


FIGURE 1 – Time to collision or time to contact (TTC)

The time to collision is the time for a robot before reaching an obstacle. In this practical, we suppose the simplest case where the robot is in translation along the optical axis of an embedded camera (see fig. 1). Thus, the TTC is the ratio T :

$$T = -\frac{Z}{\dot{Z}} \quad (1)$$

where Z is the distance from the center of projection to the object and \dot{Z} is the velocity. We will describe two methods to compute T .

1. **Indirect method** : Show that the TTC can be obtained in the image plane with :

$$T = \frac{x}{\dot{x}} = \frac{y}{\dot{y}} = \frac{\sqrt{x^2 + y^2}}{\sqrt{\dot{x}^2 + \dot{y}^2}} \quad (2)$$

where (x, y) are the coordinate of the 3D point in the image plane.

2. **Direct method** : Using the brightness constancy assumption, show that T is solution of :

$$\frac{1}{T}(xI_x + yI_y) + I_t = 0 \quad (3)$$

where I_x, I_y, I_t are the partial derivatives of the image w.r.t. x, y, t .

Using a least squares formulation, show T is also given by :

$$\frac{1}{T} = -\frac{\sum GI_t}{\sum G^2} \quad (4)$$

with $G = xI_x + yI_y$ and the sum is over all pixels of a region of interest.

3. Compare and discuss the two methods on *Cathedral sequence*.