The objective of these notes is to give some ideas for predicting the location of the ball at some point in the future.

The predictor will have ~~several~~ several benefits:

(1) It will filter noise from the cameras

(2) It will provide an estimate of where the ball will be in the (still) future.

Let $b(t) = \begin{pmatrix} b_x(t) \\ b_y(t) \end{pmatrix}$ be the (x, y) position of the ball at time t.

Assuming that the ball has been kicked, and that the table is flat, and that the ball rolls without friction (i.e. without slipping), then the dynamics for the ball are given by Newton's 2nd law

$$m\ddot{b} = F_{applied} = 0$$

$$\Rightarrow \quad \ddot{b} = 0$$

Integrating both sides gives

$$\int_{\tau=t}^{t+T} \int_{\sigma=t}^{\tau} \ddot{b}(\sigma)\, d\sigma\, d\tau = \int_{\tau=t}^{t+T} \int_{\sigma=t}^{\tau} 0 \, d\sigma\, d\tau$$

$$\iff \int_{\tau=t}^{t+T} \left(\dot{b}(\tau) - \dot{b}(t) \right) d\tau = 0$$

$$\iff b(t+T) - b(t) - \dot{b}(t)(t+T-t) = 0$$

$$\iff \boxed{b(t+T) = b(t) + T\dot{b}(t)}$$

This equation provides an estimate of the position of the ball at time $t+T$ given the position and velocity at time T.

Recall that

$$\dot{b}(t) = \lim_{\tau \to 0} \frac{b(t) - b(t-\tau)}{\tau}$$

$$\simeq \frac{b(t) - b(t-\tau)}{\tau}$$

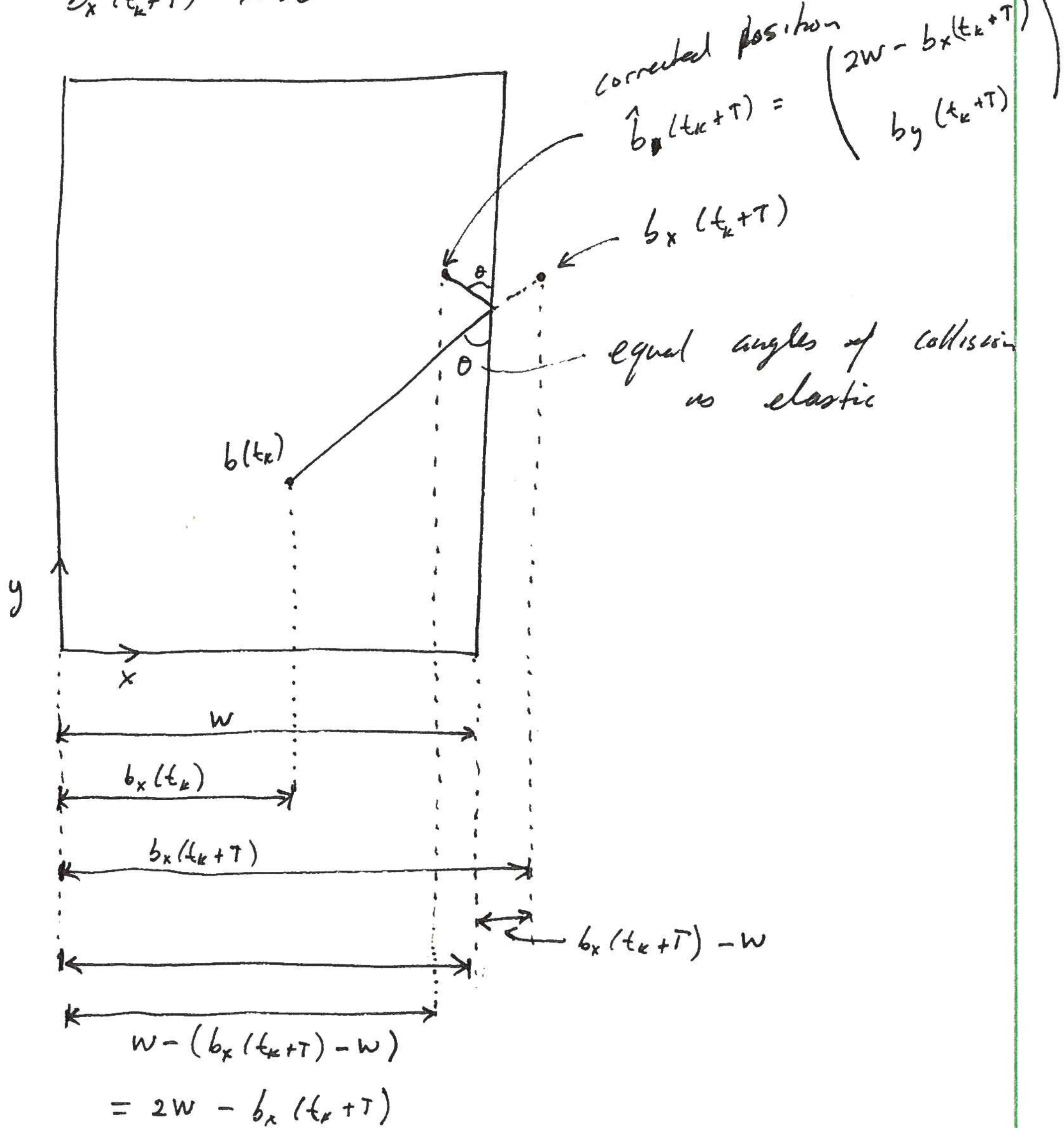
$\therefore$ at the k^{th} sample

$$\dot{b}(t_k) \simeq \frac{b(t_k) - b(t_{k-1})}{t_k - t_{k-1}}$$

$$\therefore \quad \boxed{b(t_k + T) = b(t_k) + T\left(\frac{b(t_k) - b(t_{k-1})}{t_k - t_{k-1}}\right)}$$

This equation assumes, of course, that the ball does not collide with anything over the period T.

Case I $\quad b_x(t_k+T) > W$



other cases derived similarly.

what about prediciting the position of your oponent?

- could use a similar method, but will likely be much less acurate.