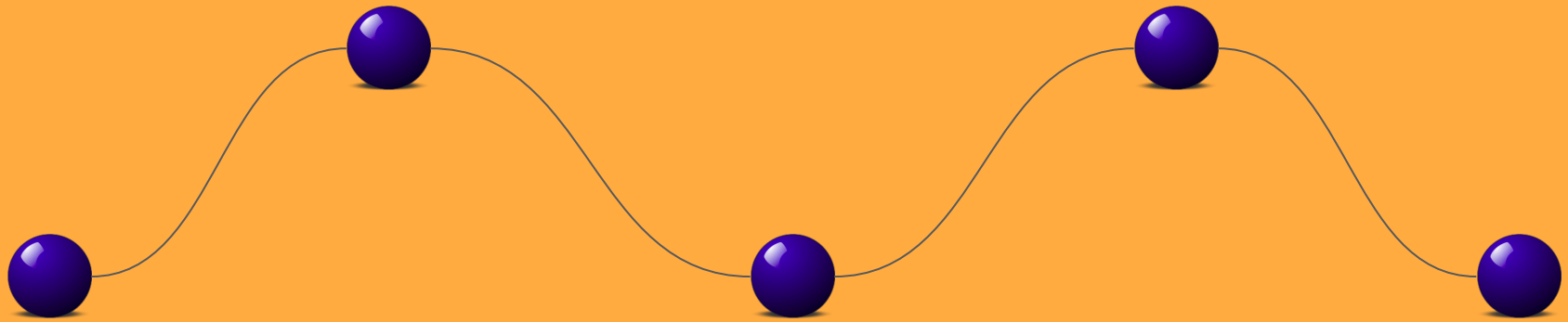
Ball Tracking



Computer Vision | Bigaziyeva Ingkar 3EN_04_C

INTRODUCTION :

Project written on C++(CLion) using OpenCV libraries, In the main case it demonstrates the use of Kalman filter to track the movements of a blue ball (we can change color) even when occlusions occur.

Green rectangle is the true measure, red box is the state estimation by Kalman Filter.

TRACKING

The software is tuned such to identify a blue ball. You can modify the color simply changing the values of the HUE “***MIN_H_BLUE***” and “***MAX_H_BLUE***” at the beginning of the code. The tracking uses what is known in literature as “**Kalman Filter**“, it is an “asymptotic state estimator”, a mathematical tool that allows to estimate the position of the tracked object using the cinematic model of the object and its “history”.

We can simply say that the Kalman filter works in two steps: **PREDICTION** and **UPDATE**. The PREDICTION step allows to predict the position of the object knowing its history, the speed of its movements and knowing the equations that identify its movements. The PREDICTION is corrected every time a measure of the state of the object is available, this correction makes the UPDATE step. Unfortunately, the measure is not perfect, each measure has errors, so PREDICTION and UPDATE are weighted using information about measure and prediction errors.

KALMAN FILTER

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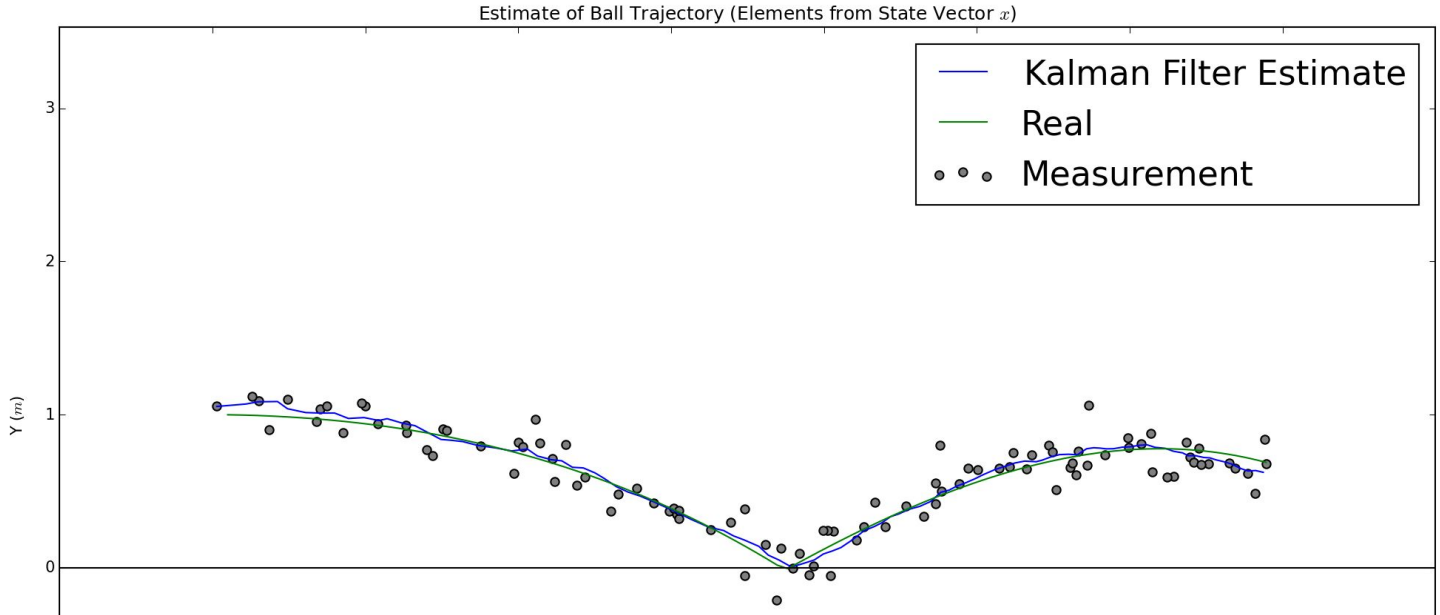
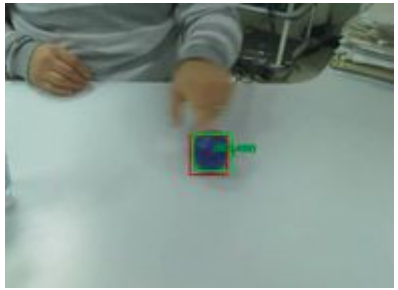


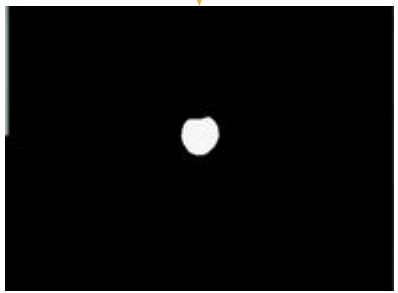
First of all lets define our system, that is the information about the ball at each instant “t”. The vector ***[x,y,v_x,v_y,w,h]*** defines the state:

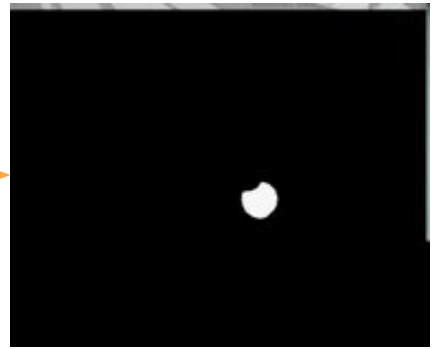
- **x, y**: centroid of the ball
- **v_x, v_y**: speed of the centroid (pixel/sec)
- **w, h**: size of the bounding box

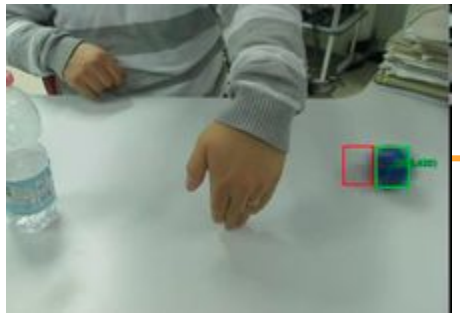
A note: the “measure vector” is used during the UPDATE phase only if the ball has been detected in the current frame, otherwise we make only the PREDICTION step. The **green** rectangle identifies the bounding box of the ball detected during the measure step. The **red** rectangleshows the “estimated state” of the ball, the result of the prediction step of the Kalman Filter. It is really interesting to note how the estimated state overlaps the measured state meanwhile the ball moves linearly, but overall it is interesting to note that the estimation of the state stays valid even if the ball is behind the bottle.

Some Examples :









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