Speed Estimation using Optical Flow

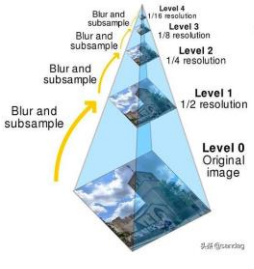
Professor: 鄭桂忠 教授
Group member: 張鈞

Introduction and motivation: Traditionally, system of speed estimation system relies on radar detector, the method of estimating speed is by sending wave to target object then get the result from the reflecting wave. In this project, a visual-based approach of speed estimation is proposed, in which the kernel of speed estimation is optical flow techniques. Therefore, the speed estimation system consists of three main modules: image processing, target motion tracking and actual speed transformation.

Processing progress:

1. Acquire every frame of image from video, then low pass filter will use blurring matrix in Fig.1 to make convolution with image, then the features in image will pop out.
2. Delete rows and columns that is even numbered and repeat this process four times (Fig.2).
3. Lucas-Kanade module calculates the position of target object from frame to frame (Fig.3), in this stage, it requires module to restore the original optical flow using shrink image.
4. Use pre-measured value of moving distance of object and some environmental data to restore the real speed of object.

1/16	1/8	1/16
1/8	1/4	1/8
1/16	1/8	1/16



$$I(x+\delta x, y+\delta y, t+\delta t) = I(x,y,t) + \frac{\partial I}{\partial x}\delta x + \frac{\partial I}{\partial y}\delta y + \frac{\partial I}{\partial t}\delta t + H.O.T.,$$

$$\frac{\partial I}{\partial x}\delta x + \frac{\partial I}{\partial y}\delta y + \frac{\partial I}{\partial t}\delta t = 0 \text{ or}$$

$$\frac{\partial I}{\partial x}\frac{\delta x}{\delta t} + \frac{\partial I}{\partial y}\frac{\delta y}{\delta t} + \frac{\partial I}{\partial t}\underbrace{\frac{\delta t}{\delta t}}_{=1} = 0 \text{ and finally :}$$

$$\frac{\partial I}{\partial x}v_x + \frac{\partial I}{\partial y}v_y + \frac{\partial I}{\partial t} = 0.$$

Fig 1.2.3.techniques used in system

Final result:

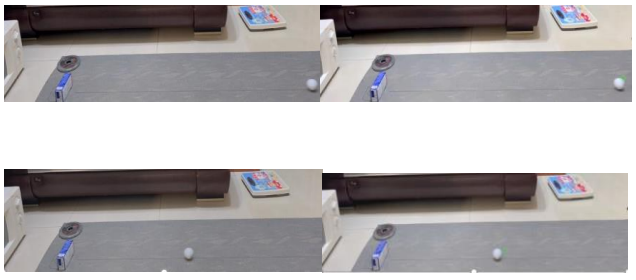


Fig 4.5.Image between original and analyzed

Final material was filmed in doored, because the environment is more controllable and easy to measure. In tracking the position of object, it is very obvious that image pyramid helped the stability of tracking consistency and processing speed of the system. To transfer the real speed of object, the shooting angle of camera is fixed with all the distance related to calculating been measured.