ENPM 809T – Autonomous Robotics

HW 3 - Traffic Signal Detection – Raspberry Pi

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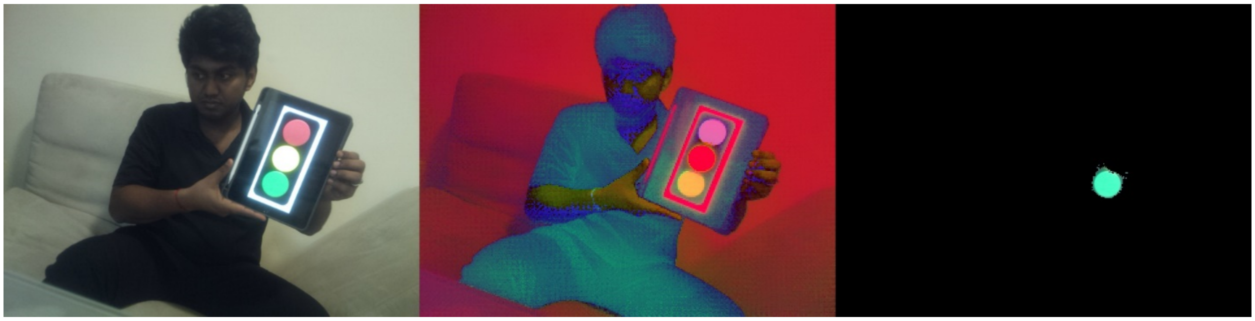
Step 1: HSV Masking

1. Image is captured using Raspberry Pi's PiCamera as a RGB image (Figure 1-a)
2. Captured image is converted into HSV color space for robustness since color and intensity ranges are unique for various colors in HSV space. (Figure 1-b)
3. A mask is generated by thresholding the corresponding range for green color. The mask is used to separate required green region of captured image (Figure 1-c)



(a) (b) (c)

Figure 1

Step 2: Contours and Bounding circle

1. On the masked green image in (Figure 1-c), Eroding and dialation are done to remove small noisy green areas.
2. Contours are found on the morphed image and enclosing circle is taken and its center is calculated using Moment and a circle is drawn on the detected green region.

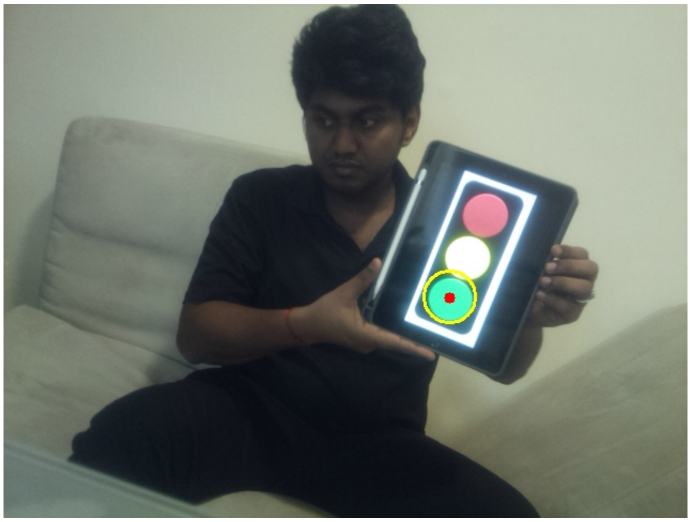


Figure 2

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Step 3: Video Feed

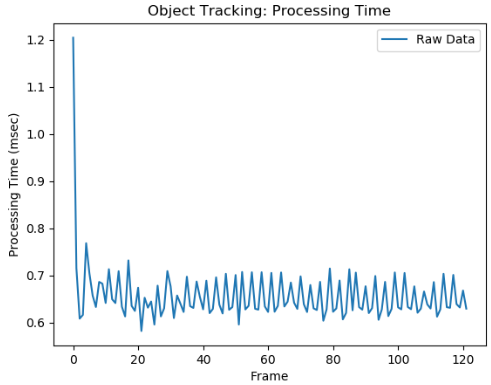
1. The previous steps are iteratively done for each frame captured from the Raspberry Pi camera to identify the green signal and the final video is saved.

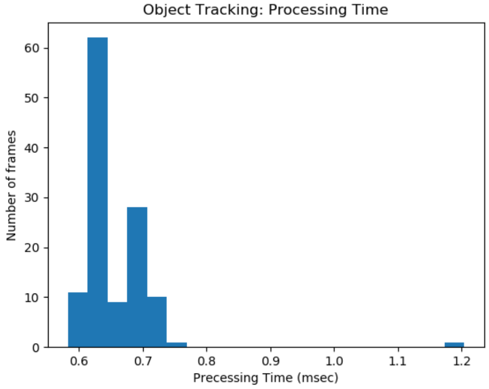
Step 4: Video Upload

Traffic Signal Detection - https://youtu.be/O2t40MkK4hw

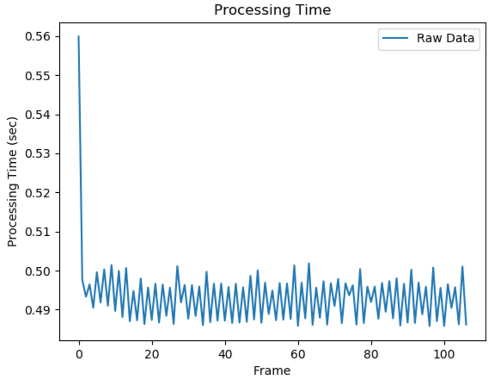
Step 5: Analysis of hardware perfomance limitaions

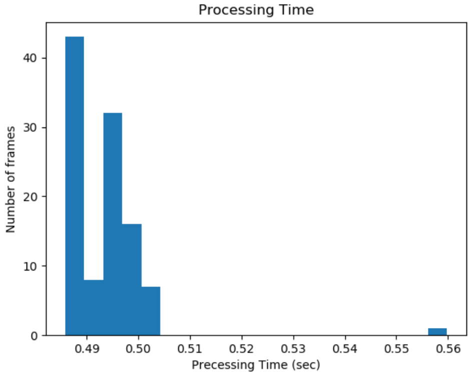
1. Using datetime module, time required to process each frame is calculated and are logged to a text file.
2. Perfomance graphs are generated for each time step and corresponding histograms are shown below (Figure 3).





3. In contrast, the performance for each time step without the detection pipeline and with just read operation of the Raspberry Pi’s Pi Camera module is shown below.





Hence, on an average the proposed Pipeline adds only ~0.5fps, However, the frame rate normally hovers about ~60fps even for a bare PiCamera read operation which will rise safety in terms of scenarios involving obstacle avoidance with very sudden occlusions. Therefore, the perception module is more suitable for goal/object detection during path planning which would be very robust as shown in the result video.