TRAFFIC LIGHT DETECTION

By

Ajmal S

Under the Guidance of

Prof. Lelitha Devi Vanajakshi

Professor

Department of Civil Engineering

Indian Institute of Technology Madras

Abstract

The traffic light detection system is one of the key components of the vision traffic law enforcement system, such as red-light runner detecting, turning against traffic light, and stopping at the non-stopping zone. An automatic traffic light detection system at intersections is presented here. The method proposed is fully based on image processing. The traffic light detection results are verified manually and they are all proved correct.

Method based on image processing

1. Defining the region of interest

The region of interest is the portion of the frames where traffic lights are present. OpenCV and NumPy array slicing are used to get the regions of red, yellow, and green light separately. Since every image that is read in, gets stored in a 2D array (for each color channel). Regions are cropped by specifying the height and width (in pixels), shown in figure1. Then, each selected region's size is increased to understand red-yellow-green light conditions better.
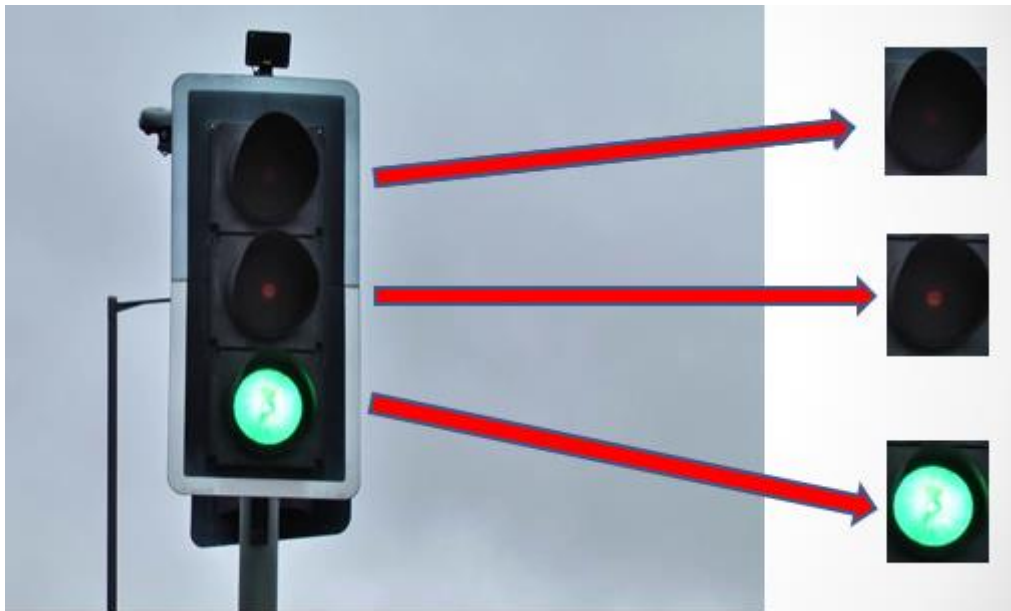

Figure 1: Regions of red, green and yellow lights are selected separately.

2. Thresholding

Thresholding is a type of image segmentation where we change the pixels of an image to make the image easier to analyze. To obtain a thresholded image, the original image is usually converted into a grayscale image and then applied the thresholding technique. This method is also known as Binarization as we transform the image into a binarized form, i.e., if the value of a pixel is lesser than the threshold value, convert it to 1(White). If the pixel value is greater than the threshold value, convert it to 0(Black). For each color, different threshold values are selected. Whenever the light is on, then only we get black pixels. Otherwise, the image only has white pixels. Figure 2 clearly illustrates the thresholding step.
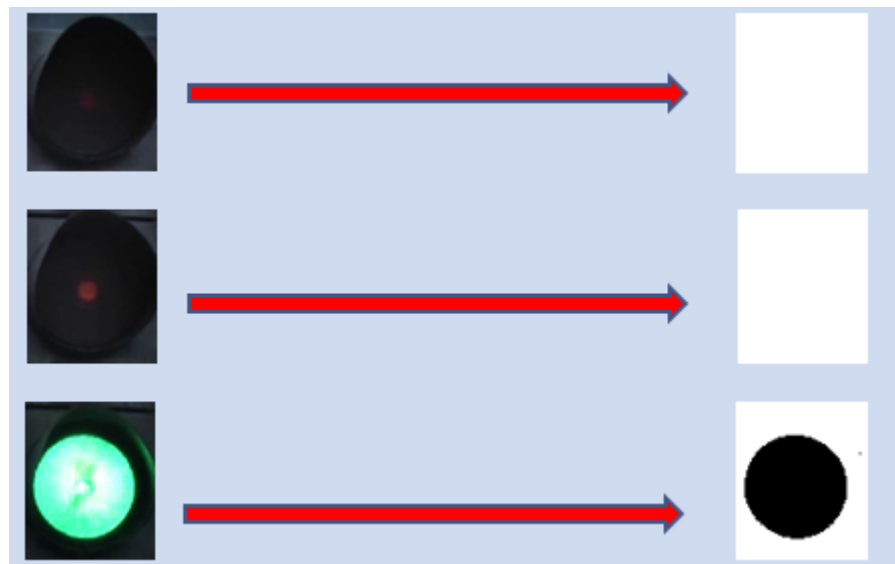

Figure 2: Thresholding is applied separately to red-yellow-green regions.

3. The detecting stage

Traffic light detection outputs the timing of red-yellow-green light conditions. It first counts the number of black pixels in the thresholded images. NumPy provides a function sum() that returns the sum of all array elements in the NumPy array. This sum() function can be used to count the number of black pixels. Based on the black pixel values, we find out when red, yellow, and green lights were "ON". We define the state of the light as "ON" if the number of black pixels in the current frame is higher than a particular threshold value. The threshold values are selected separated for each color.

Results

The input video is taken by a CCTV camera of the Nandanam signal intersection, containing 25 frames per second of 1920 x 1080 resolutions. After feeding the video to the program generates red, green, and yellow "ON" light timings. The detection sequence of the traffic light is the red referencing "ON" light first, and then the yellow "ON", finally the green "ON". The traffic light detection results are verified manually, and they are all proved correct. Table 1 shows the result obtained from the program and manually checking with the video.

	From the code(in sec)				Manually(in sec)		
Cycle	Red ON	Green ON	Yellow ON	Cycle	Red ON	Green ON	Yellow ON
1	--	32.44	97.4	1	--	32	97
2	101.4	243.4	308.4	2	101	243	308
3	312.4	452.36	517.36	3	312	452	517
4	521.36	662.44	727.4	4	521	662	727
5	731.4	873.4	938.4	5	731	873	938
6	942.4	1082.36	1147.36	6	942	1082	1147
7	1151.36	1292.36	1357.36	7	1151	1292	1357
8	1361.36	1502.32	1567.32	8	1361	1502	1567
9	1571.32	1712.28	1777.28	9	1571	1712	1777
10	1781.28	1922.36	1987.36	10	1781	1922	1987
11	1991.36	2132.32	2197.32	11	1991	2132	2197
12	2201.32	2342.28	2407.28	12	2201	2342	2407
13	2411.28			13	2411		

Table 1: Timing of red, green and yellow "ON" light were calculated using the program and manually by checking the video. The video was of duration 40 min 24 sec.

References

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