Intelligent Detection of Sri Lankan Road Signs by Using Google Street View Images

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Abstract— **The detection and recognition of road signs have garnered significant attention, especially in the context of autonomous vehicle driving systems and intelligent transportation systems. Traditional methods utilize video-based techniques, but these have limitations due to factors such as cost, poor weather conditions, lighting, and low image quality. To overcome these limitations, this study investigates the utilization of Google Street View (GSV) images for road sign detection. However, the development of vision-based systems necessitates a large image dataset, which is currently scarce in Sri Lanka. Thus, the objective of this research is to generate a comprehensive dataset of Sri Lankan road signs via the detection process. This dataset can then be used for further research and development of intelligent transportation systems, driver assistance systems, and accident-avoidance systems.**

Keywords— Google Street View (GSV), Google Maps Direction API, OpenCV, Convolution Neural Network (CNN), Intelligent Transportation Systems (ITS)

I. Introduction

According to past data from 1990 to 2018 from the United Nations Office for Disaster Risk Reduction, transport accidents are a major disaster in Sri Lanka accounting for 18% of the disasters [1]

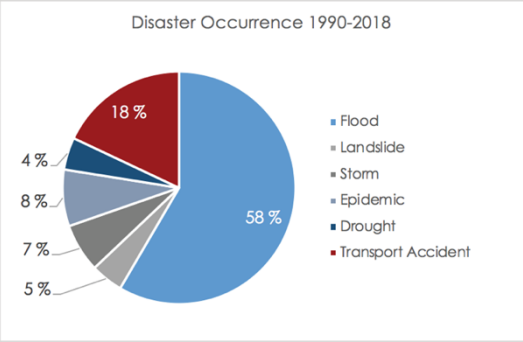
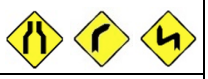


Fig. 1. Disaster occurrence between 1990-2018 [1]

Road signs provide valuable information to drivers and pedestrians which could be directly helpful to reduce road accidents to some extent. There are three main categories of road signs in Sri Lanka namely, danger warning signs, regulatory signs (prohibitory signs, restrictive signs, mandatory signs, priority signs), and directional informative signs [2].

TABLE I. Major Categories Of Sri Lankan Road Signs[2]

Type	Count	Shapes	Colours	Examples
Danger warning signs	55	Square	Yellow	
Regulatory signs	64	Circle, Octagonal	Red rim, Red	
Directional informative signs	55	Square	Blue	

The Road Development Authority (RDA) of Sri Lanka does not currently have a database of road signs with coordinates. So, it is difficult to use those data for implementing applications for reducing accidents. According to the research in the selected region, the most available road signs are pedestrian crossings. If it is possible to inform the drivers about road signs, certain road accidents that take place at pedestrian crossings could be avoided. And similarly informing about other road signs too could help to avoid certain possible accidents. Much research has used real-time video-based methods for vision-based driving assistance systems. But there are certain limitations to that method like, bad weather conditions, limited range, poor lighting conditions, and the need to operate in real-time.

To overcome these limitations, Google Maps Direction API, and Google Street View API can be used for fetching the required direction data and images while Google Street View (GSV) can be used as the source of obtaining images. GSV is a feature that was introduced in Google Maps in 2007, that provides panoramic views of either side of roadways [3].

For the detection process, OpenCV image processing based on HSV Colour detection can be used [4].

Usually, the collection of datasets for image processing requires a lot of time and is more expensive than developing

the algorithm. Publicly available datasets can be used for this purpose. However, there are only a limited amount of road sign data sets internationally as well as in Sri Lanka. A large image dataset of road signs in Sri Lanka could also be produced as a result of the process. Future research and projects would find it to be very useful.

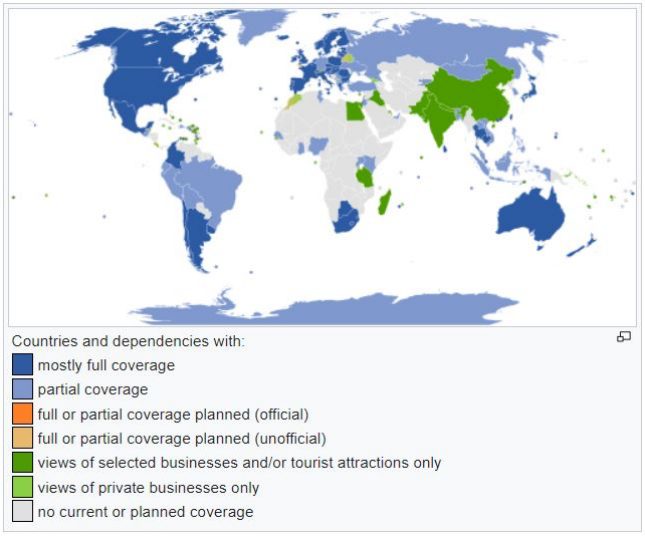


Fig. 2. Global availability of Google Street View images [5]

The rest of the paper is organized as follows. Related work on road sign downloading and detection is mentioned in section 2. The methodology is discussed in section 3. The results and discussion are presented in section 4. And the conclusions are discussed in section 5. Finally, references are stated in section 6.

II. Related Work

A. Preparing the Dataset for Road Sign Detection

Previous research utilized images obtained through GSV to identify utility poles and road signs. The process involved utilizing ArcGIS tool to generate viewpoints at 10-meter intervals along roads, and these points were subsequently used to download images from GSV.

For simplifying the process of downloading, python libraries have been used [6]. Also, it was mentioned about using a grid pattern to get all the possible coordinates to capture the images from GSV [7].

B. Process of Detecting Road Signs

For the past years, many researchers in different countries have conducted research related to the road sign detection process. Research conducted in Sri Lanka explored the use of a Convolution Neural Network (CNN) to identify road signs and deliver a voice message to drivers using a text-to-speech engine [8]. Additionally, another study focused on training a multiclass Support Vector Machine (SVM) image category classifier to detect road signs and alert drivers [9].

III. Methodology

The complete sequential process of the downloading and detection of road signs is shown in Fig. 3. The methodology is discussed under two main sub-sections. In the first section, the downloading process is discussed in detail, and in the next section, the detection process is discussed in detail.

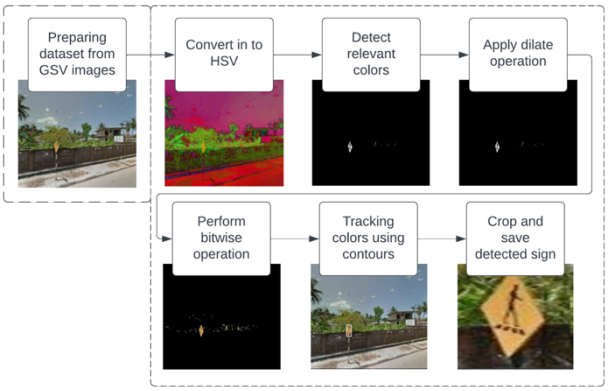


Fig. 3. The flowchart of the suggested process of road sign detection

A. Preparing Dataset for Road Sign Detection

1) Obtaining coordinates between origin and destination

To obtain direction data, Google Maps Direction API was used. Searching directions for several modes of transportation, including transit, driving, walking, or cycling, and returning multi-part directions using a series of waypoints could be done using the API.

Providing the parameters of the origin and destination is necessary to acquire the polyline of the path [10].

2) Downloading GSV Images

As the next step, the obtained polyline was converted into a set of arrays of latitudes and longitudes by using the polyline python library [11]. Then Google Street View API was used for downloading images corresponding to the obtained coordinates. In the case of image unavailability, the nearest available coordinates will be used to get the image. Since 2007, Google's Street View imagery has been recognized as the world's largest street panorama imagery database. The database was accessed via the Google Maps static Application Programming Interface (API) using the Streetview python library (https://github.com/robolyst/streetview). The API limits daily requests to 25,000, and the maximum download limit for 500 directions GSV images is 2048x2048 pixels. However, the free version is limited to a maximum image size of 480x480 pixels [7]. And images were downloaded in 4 different headings (00,900,1800,2700) as shown in Fig. 4.

TABLE 2: Parameters Required By Google Maps Direction API [10]

Parameter	Details	Input values
Destination	Address, Place ID, or coordinates of the destination	Lat, Long value/ Place name
Origin	Address, Place ID, or coordinates of the origin	Lat, Long value/ Place name
Mode	Mode of transportation used.	Driving/Walking/Bicycling
Transit mode	Preferred mode of transit	Bus, Subway, Train, Tram, Rail

TABLE 3: PARAMETER REQUIRED FOR THE GOOGLE STREET VIEW IMAGES API [7]

Red ranges	[0,114,140]-[7,196,204], [5,26,209]-[13,60,255]
Yellow ranges	[13,60,201]-[46,255,255],[14,149,91]-[25,255,255], [18,23,214]-[37,44,255], [14,136,137]-[18,215,217]
Blue ranges	[90,140,0]-[111,228,255],[83,69,144]-[101,255,255]

B. Detection of Road Signs

Initially, HSV transformation was performed to convert the image into Hue, Saturation, Value format. Then the HSV values were tuned so that red, yellow, and blue colours could be extracted from the signs. The first step involved transforming the image into the Hue, Saturation, Value (HSV) format using HSV transformation. Next, the HSV values were adjusted to extract red, yellow, and blue colors from the signs.

A colour picker program was developed to find and isolate colour ranges. The colour ranges for red, blue, and yellow as shown in Table were found using the colour picker.

TABLE 4: HSV COLOUR RANGES USED FOR DETECTION

Parameter	Details	Values
Location	Location name or coordinates	Lat/Long value
Size	Output size of image in pixels.	640×640
Heading	Heading of the camera	0-360 (North)
FOV	Horizontal field of view of the image	90 degrees
Pitch	Elevation/Depression of the camera with respect to the Street View vehicle	0

Following this, the object area features were amplified through a dilation operation. The contours of the dilated frames were then utilized to isolate the pertinent colors in the image.

And based on the areas of contours, road signs were detected. This process isolated the required contours of the image. Finally, the selected bounded area was cropped and saved as the final output image.

IV. DISCUSSION AND RESULTS

Fig. 3. Kalmunai to Akkaraipattu route

Images were downloaded for 4 different headings (0^o,90^o,180^o,270^o) as shown in Fig. 4.

(a) (b) (c) (d)

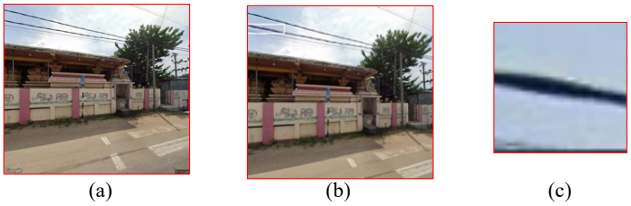
Fig. 4. Downloaded images for (a) 0^o (b) 90^o (c) 180^o (d) 270^o headings.

A total of 1,388 images were downloaded from Google Street View API and after observing manually,114 of those images were found to have a road sign. When considering duplicates, there were 73 unique road signs available. Fig. 6, and 7 show some of the results obtained by executing the road sign detection algorithm.

The following table states the results obtained after executing the detection algorithm,

(a) (b) (c)

Fig. 5. Sample results of successful detections, (a) Downloaded image, (b) Selected contours, (c) Output



(a) (b) (c)

Fig. 6. Sample results of fault detection, (a) Downloaded images, (b) Selected contours, (c) Output

TABLE 5: RESULTS OF THE DETECTION ALGORITHM

Detected	70	95.89%
Not Detected	3	4.11%
Total	73	100%

V. CONCLUSION

The paper is focused on developing an image processing-based system to detect road signs. The proposed method consists of three main phases obtaining intermediate coordinates, downloading images using GSV, and traffic sign detection. Despite the availability of several other commercial signs, buildings, and vehicles, the algorithm was able to achieve a success rate of around 95%. There are certain limitations in this process like certain road signs could be covered by obstacles, certain road signs could be blurred, certain road signs could be undetected using the detection algorithm, and certain images could be not downloaded properly. However, a very high success rate could be observed in this methodology for detecting and isolating road signs.

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