MINI PROJECT-II

(2021-22)

"TRAFFIC SIGN CLASSIFICATION"

Project Report

Institute of Engineering & Technology

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Declaration

I/we hereby declare that the work which is being presented in the Bachelor of technology. Project **"Traffic Sign Classification"**, in partial fulfillment of the requirements for the award of the ***Bachelor of Technology*** in Computer Science and Engineering and submitted to the Department of Computer Engineering and Applications of GLA University, Mathura, is an authentic record of my/our own work carried under the supervision of **Md. Farmanul Haque, Technical Trainer, Dept. of CEA,GLA University.**

The contents of this project report, in full or in parts, have not been submitted to any other Institute or University for the award of any degree.

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Certificate

This is to certify that the project entitled "Book Finder App", carried out in Mini Project – I Lab, is a bonafide work by Uttam Singh and Prateek Rai, and is submitted in partial fulfillment of the requirements for the award of the degree Bachelor of Technology (Computer Science & Engineering).

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Presenting the ascribed project paper report in this very simple and official form, we would like to place my deep gratitude to GLA University for providing us the instructor Md. Farmanul Haque, our technical trainer and supervisor.

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And at last but not the least we would like to thank our dear parents for helping us to grab this opportunity to get trained and also my colleagues who helped me find resources during the training.

Thanking You

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ABSTRACT

This thesis presents a system to recognise and classify road and traffic signs for the purpose of developing an inventory of them which could assist the highway engineers' tasks of updating and maintaining them. It uses images taken by a camera from a moving vehicle. The system is based on three major stages: colour segmentation, recognition, and classification.

Four colour segmentation algorithms are developed and tested. They are a shadow and highlight invariant, a dynamic threshold, a modification of de la Escalera's algorithm and a Fuzzy colour segmentation algorithm. All algorithms are tested using hundreds of images and the shadow-highlight invariant algorithm is eventually chosen as the best performer. This is because it is immune to shadows and highlights. It is also robust as it was tested in different lighting conditions, weather conditions, and times of the day. Approximately 97% successful segmentation rate was achieved using this algorithm.

Recognition of traffic signs is carried out using a fuzzy shape recogniser. Based on four shape measures - the rectangularity, triangularity, ellipticity, and octagonality, fuzzy rules were developed to determine the shape of the sign. Among these shape measures octangonality has been introduced in this research. The final decision of the recogniser is based on the combination of both the colour and shape of the sign. The recogniser was tested in a variety of testing conditions giving an overall performance of approximately 88%.

Classification was undertaken using a Support Vector Machine (SVM) classifier. The classification is carried out in two stages: rim's shape classification followed by the classification of interior of the sign. The classifier was trained and tested using binary images in addition to five different types of moments which are Geometric moments, Zernike moments, Legendre moments, Orthogonal Fourier-Mellin Moments, and Binary Haar features. The performance of the SVM was tested using different features, kernels, SVM types, SVM parameters, and moment's orders. The average classification rate achieved is about 97%. Binary images show the best testing results followed by Legendre moments.

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CHAPTER-1

1. INTRODUCTION

1.1 CONTEXT

This Deep Learning Project “Traffic Sign Classification” has been submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering at GLA University, Mathura supervised by Md. Farmanul Haque. This project has been completed approximately three months and has been executed in modules, meetings have been organized to check the progress of the work and for instructions and guidelines.

1.2 MOTIVATION

Road and traffic signs must be properly installed in the necessary locations and an inventory of them is ideally needed to help ensure adequate updating and maintenance. Meetings with the highway authorities in both Scotland and Sweden revealed the absence of but a need for an inventory of traffic signs. An automatic means of detecting and recognising traffic signs can make a significant contribution to this goal by providing a fast method of detecting, classifying and logging signs. This method helps to develop the Inventory accurately and consistently. Once this is done, the detection of disfigured or obscured signs becomes easier for human operator.

Road and traffic sign recognition is the field of study that can be used to aid the development of an inventory system (for which real-time recognition is not required) or aid the development of an in-car advisory system (when real-time recognition is necessary). Both road sign inventory and road sign recognition are concerned with traffic signs, face similar challenges and use automatic detection and recognition. A road and traffic sign recognition system could in principle be developed as part of an Intelligent Transport Systems (ITS) that continuously monitors the driver, the vehicle, and the road in order, for example, to inform the driver in time about upcoming decision points regarding navigation and potentially risky traffic situations.

1.3 OBJECTIVE

The overall aim is to develop a system that can be used for traffic sign inventory. This system can assist local or national authorities in the task of maintaining and updating their road and traffic signs by automatically detecting and classifying one or more traffic signs from a complex scene (like the one shown in Figure 1.2) when captured by a camera from a vehicle.

The main strategy is to find the right combination of colours in the scene so that one colour is located inside the convex hull of another colour and combine this with the right shape. If a candidate is found, the system tries to classify the object according to the rimpictogram combination and give the result of this classification.

The objectives are thus:

1. To understand the properties of road and traffic signs and their implications for image processing for the recognition task.

2. To understand colour, colour spaces and colour space conversion.

3. To develop robust colour segmentation algorithms that can be used in a wide range of environmental conditions.

4. To develop a recogniser that is invariant to in-plane transformations such as translation, rotation, and scaling based on invariant shape measures.

5. To identify the most appropriate approach for feature extraction from road signs.

6. To develop an appropriate road sign classification algorithm.

7. To evaluate the performance of the aforementioned methods for robustness under different conditions of weather, lighting geometry, and sign.

1.4 EXISTING SYSTEM

There are various model present for Traffic Signal Classification with less accuracy. Their references are below:

1. US Department of Transportation, "Intelligent Transportation Systems, URL: http://www.its.dot.gov/its_overview.htm," 2006.
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1.5 SOURCES

The source of our project (including all the project work, documentations and presentations) will is available at the following link

https://Github.com/Uttamsingh11/MiniProject-II

CHAPTER -2

SOFTWARE REQUIREMENT ANALYSIS

2.1 IMPACT OF TRAFFIC SIGN ON DAILY LIFE

Road and traffic signs, traffic lights and other traffic devices are used to regulate, warn, guide or inform road users. They help achieve an acceptable level of road traffic quality and increase safety with orderly and predictable movement of all traffic, both vehicular and pedestrians [3, 4].

Road and traffic signs are designed to be easily recognised by drivers mainly because their shapes and colours are readily distinguishable from their surroundings [5]. The Swedish Road Administration is in charge of defining the appearance of all signs and road markings in Sweden. Traffic signs in Sweden are fully regulated by this administration. They are placed two meters from the road and the base-sign is at a height of 1.6 meters for roads used by vehicles with motors. According to the Road Administration, the maximum number of signs on a single pole is three with the most important sign at the bottom. In accordance with European signs, all signs are designed to have a reflective layer added on selective parts of the sign. Most Swedish road signs use pictograms to indicate the message of the sign. However, there are some exceptions in which text replaces pictograms. The STOP sign is one example of this kind of sign. All signs use Swedish text except the STOP sign where the English “STOP” word replaces the Swedish “STOPP” word. The usual background colour on warning and prohibition signs on most European signs is white, whereas this colour is yellow in Sweden. The reason is to enhance the visibility of the signs during winter time. White signs would be very hard to see in snowfall conditions. A thicker rim is used for warning and prohibition signs in Sweden compared with their European counterparts.

Road and traffic signs are characterised by a number of features which make them recognisable with respect to the environment:

- Road signs are designed, manufactured and installed according to strict regulations.
- They are designed in fixed 2-D shapes such as triangles, circles, octagons, or rectangles.

- The colours of the signs are chosen to contrast with the surroundings, which make them easily recognisable by drivers.
- The colours are regulated by the sign category.
- The information on the sign has one colour and the rest of the sign has another colour.
- The tint of the paint which covers the sign should correspond to a specific wavelength in the visible spectrum.
- The signs are located in well-defined locations with respect to the road, so that the driver can, more or less, anticipate the location of these signs.
- They may contain a pictogram, a string of characters or both.
- In every country the road signs are characterised by using fixed text fonts, and character heights.
- They can appear in different conditions, including partly occluded, distorted, damaged and clustered in a group of more than one sign.

2.2 PROBLEM STATEMENT

A normal road in the middle of most cities in the world like the one shown for Stockholm, presents a complex scene. It may include people, vehicles with different colours, a number of shops and their signs, and a number of traffic signs to control the traffic on this road. Fundamentally, if a person is asked to point out the traffic sign in the image, they can do this easily.

Figure 1: A traffic scene in the middle of Stockholm.

However, from the point of view of computer vision, this image contains some difficulties which are addressed here:

• The existence of a number of similar objects (either in colour or in shape) in the scene.

• The presence of obstacles in the scene which can partially or totally occlude the sign.

• The amount of information in the scene is vast and time is needed to analyse the scene and extract the desired information.

2.3 HARDWARE AND SOFTWARE REQUIREMENTS

Processor	Intel core i5s/RYZEN 3
Operating System	Windows 10
RAM	4+ GB
Hard Disk	64 GB
Hardware Devices	Computer System

Table 1: Software Requirements

Technology Implemented	Deep Learning(CNN, pandas, matplotlib, keras)
Language Used	Python
Development Environment	Pycharm
Interface	GUI

Table 2: Hardware Requirements

2.4 MODULES AND FUNCTIONALITIES

Since that time many research groups and companies have shown interest, conducted research in the field, and generating an enormous amount of work. Different techniques have been used to cover different application areas (see next Section), and vast improvements have been achieved during the last decade.

The identification of the road signs is achieved through two main stages:

- ❖ Detection
- ❖ Recognition.

In the detection phase, the image is pre-processed, enhanced, and segmented according to the sign properties such as colour or shape or both. The output is a segmented image containing potential regions which could be recognised as possible roadsigns. The efficiency and speed of the detection are important factors because they reduce the search space and indicate only potential regions.

In the recognition stage, each of the candidates is tested against a certain set of features (a pattern) to decide whether it is in the group of road signs or not, and then according to these features they are classified into different groups. These features are chosen so as to emphasize the differences among the classes. The shape of the sign playsa central role in this stage and the signs are classified into different classes such as triangles, circles, octagons. Pictogram analysis allows a further stage of classification. By analysing pictogram shapes together with the text available in the interior of the sign, it iseasy to decide the individual class of the sign under consideration. A prototype of road sign detection and recognition system is shown in Figure 3.1. The system can be implemented by either colour information, shape information, or both. Combining colour and shape may give better results if the two features are available, but many studies have shown that detection and recognition can be achieved even if one component, color or shape, is missing. For the purpose of clarity.

2.5 TRAFFIC SIGN CLASSIFICATION

- Driver Support System (DSS) can detect and recognise road signs in real time. This helps to improve traffic flow and safety [15, 16], and avoid hazardous driving conditions, such as collisions. Traffic sign detection and classification is one of the subjects which are not studied deeply. Research groups have focused on other aspects of sign detection, more related to the development of an automatic pilot, such as the detection of the road borders and/or the recognition of obstacles in thevehicle's path e.g. other vehicles or pedestrians. Other systems are able to give warnings to drivers when they exceed the speed limit. Future Intelligent Vehicles would take some decisions about their speed, trajectory, etc. depending on the signs detected. Although, in the future, it can be part of a fully automated vehicle, now it can be a support to automatically limit the speed of the vehicle, send a warning signal indicating excess speed, warn or limit illegal manoeuvres or indicate earlier the presence of a sign to the driver. The general idea is to support the driver in sometasks, allowing him or her to concentrate on driving.
- Highway maintenance: This is used to check the presence and condition of thesigns. Instead of an operator watching a video tape, which is a tedious work becausethe signs appear from time to time and the operator should pay a great attention to find the damaged ones, the road-sign detection and recognition system can do this job automatically for the signs with good conditions and alerts the operator whenthe sign is located but not classified.
- Sign inventory: The many millions of roadway signs necessary to keep roadways safe and traffic flowing present a particular logistical challenge for those responsible for the installation and maintenance of those signs. Road signs must be properly installed in the necessary locations and an inventory of those signs must bemaintained for future reference.
- Mobile Robots: Landmarks similar to road and traffic signs can be used to automatically mobilize robots depending on the detection and recognition of these landmarks by the robot [16].

CHAPTER- 3

SOFTWARE DESIGN

3.1 USE-CASE DIAGRAM:

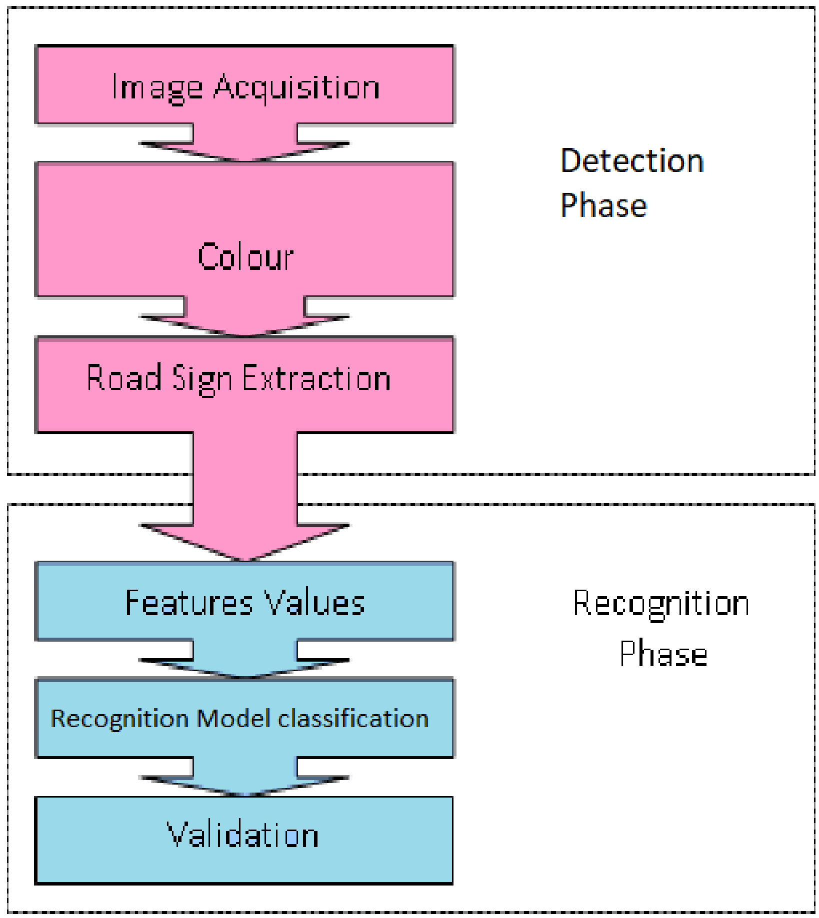

Figure 2: A block diagram of the road sign recognition and classification.

CHAPTER – 4

TECHNOLOGY USED

4.1 DEEP LEARNING

Deep learning is a machine learning technique that teaches computers to do what comes naturally to humans: learn by example. Deep learning is a key technology behind driverless cars, enabling them to recognize a stop sign, or to distinguish a pedestrian from a lamppost. It is the key to voice control in consumer devices like phones, tablets, TVs, and hands-free speakers. Deep learning is getting lots of attention lately and for good reason. It's achieving results that were not possible before.

Figure 3: deep learning

In deep learning, a computer model learns to perform classification tasks directly from images, text, or sound. Deep learning models can achieve state-of-the-art accuracy, sometimes exceeding human-level performance. Models are trained by using a large set of labeled data and neural network architectures that contain many layers.

In a word, accuracy. Deep learning achieves recognition accuracy at higher levels than ever before. This helps consumer electronics meet user expectations, and it is crucial for safety-critical applications like driverless cars. Recent advances in deep learning have improved to the point where deep learning outperforms humans in some tasks like classifying objects in images.

While deep learning was first theorized in the 1980s, there are two main reasons it has only recently become useful:

1. Deep learning requires large amounts of **labeled data**. For example, driverless car development requires millions of images and thousands of hours of video.
2. Deep learning requires substantial **computing power**. High-performance GPUs have a parallel architecture that is efficient for deep learning. When combined with clusters or cloud computing, this enables development teams to reduce training time for a deep learning network from weeks to hours or less.

4.2 PYCHARM

PyCharm is a dedicated Python Integrated Development Environment (IDE) providing a wide range of essential tools for Python developers, tightly integrated to create a convenient environment for productive Python, web, and data science development.

Figure 4: Pycharm

CHAPTER -5

IMPLEMENTATION AND USER INTERFACE

5.1 IMPLEMENTATION OF TRAFFIC SIGN

A system to detect and recognise road and traffic signs should be able to work in two modes; the training mode in which a database can be built by collecting a set oftraffic signs for training and validation, and a prediction mode in which the system can recognise a traffic sign which has not been seen before. A system

to recognise road and traffic signs is depicted in Figure 5.1. It consists of a number of modules which work together to perform this recognition. These modules are as follows:

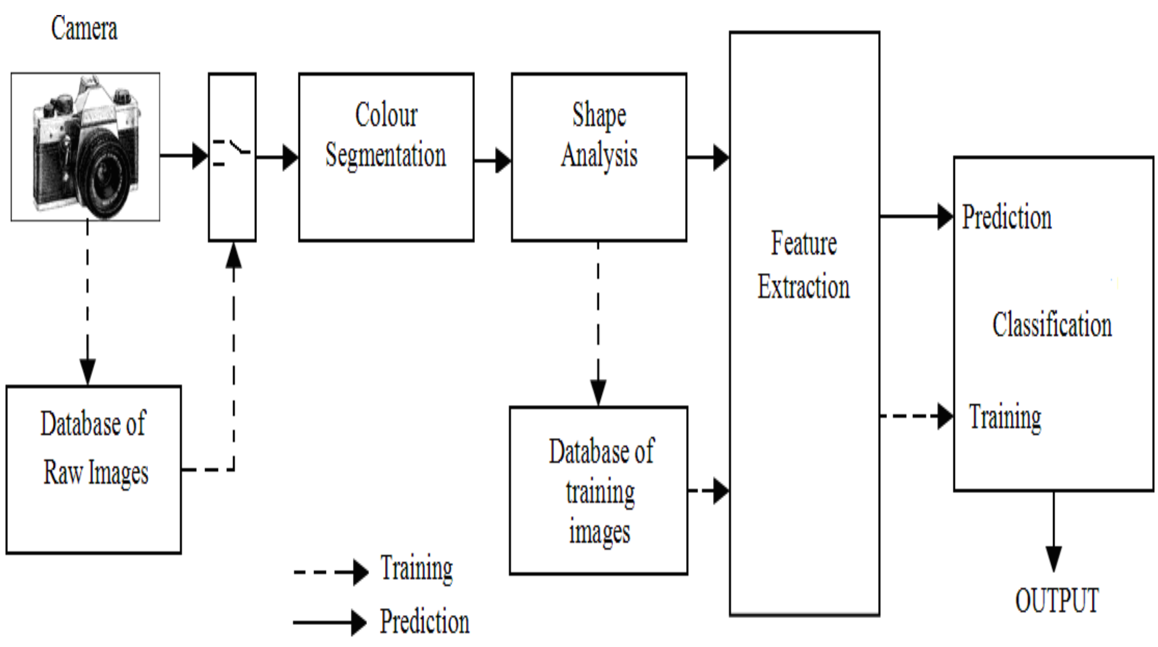

Figure 5: A block diagram of the RSRS.

a. The Camera:

A good digital camera which gives clear and sharp still images with differentsizes is necessary. No special equipment is needed for this purpose. Images collected by this camera are used in later stages to develop and validate the colour segmentation algorithm, the recognition stage, and to build the classification system.

b. Colour Segmentation:

Colour segmentation is an important step to eliminate all background objects and unimportant information in the image. It generates a binary image containing the road signs and any other objects similar to the colour of the road sign. This step reduces the amount of calculation needed in the following steps as it radically reduces the number of probable objects. A colour segmentation algorithm should be robust enough to workin a wide spectrum of environmental conditions and be able to generate binary images even when traffic sign colours are attenuated.

c. Shape Analysis:

The main task of this module includes cleaning the binary image from noise and small objects, applying connected components labelling algorithm, and recognising the traffic sign. This module normalises the recognised traffic sign so that it becomes invariant to the in-plane transformations. This means that the resultant sign has a fixedsize and it is located in a standard position where its centre of gravity is located in the centre of the image. This module works in two modes; the training and the prediction mode. In the training mode it is invoked to create or update the training imagedatabase. In the prediction mode it prepares every object in the binary image to be in standard format and ready for feature extraction.

d. Raw Image Database

This database is simply a collection of traffic scenes gathered by the camera. Images in this database are categorised according to the type of the sign, condition of the sign such as occluded, damaged, or faded, weather conditions, light geometry, and defects in the images such as blurring. The database represents the main source of images from which another database called the "training database" is built. The number of images in this database should be extensive enough to cover the large variety of traffic signs which are used for training the system. In addition to this, the number of images containing the same type of sign should be vast to provide a good number of examples for training. An Access database program manages the images and the information about them so that selecting images with certain characteristics isstraightforward.

e. Training Database

The training database consists of binary images of a normalised size such as36x36 pixels. The database is created and updated in the training mode in such a way that binary images of the desired traffic signs are selected from a set of images. This database is used either directly or by extracting some features to train and validate the classifier. In the prediction mode, the database is invoked to train the classifier before any classification task takes place.

f. Feature Extraction:

This module contains algorithms which are used to extract features from either thetraining images in the training database or images directly from the shape analysis unit. It allows the classifier to be trained by either binary images or by features. Among the features which can be used are geometric moments, Zernike moments, Legendre moments, Orthogonal Fourier-Mellin Moments and Binary Haar features.

5.2 User Interface

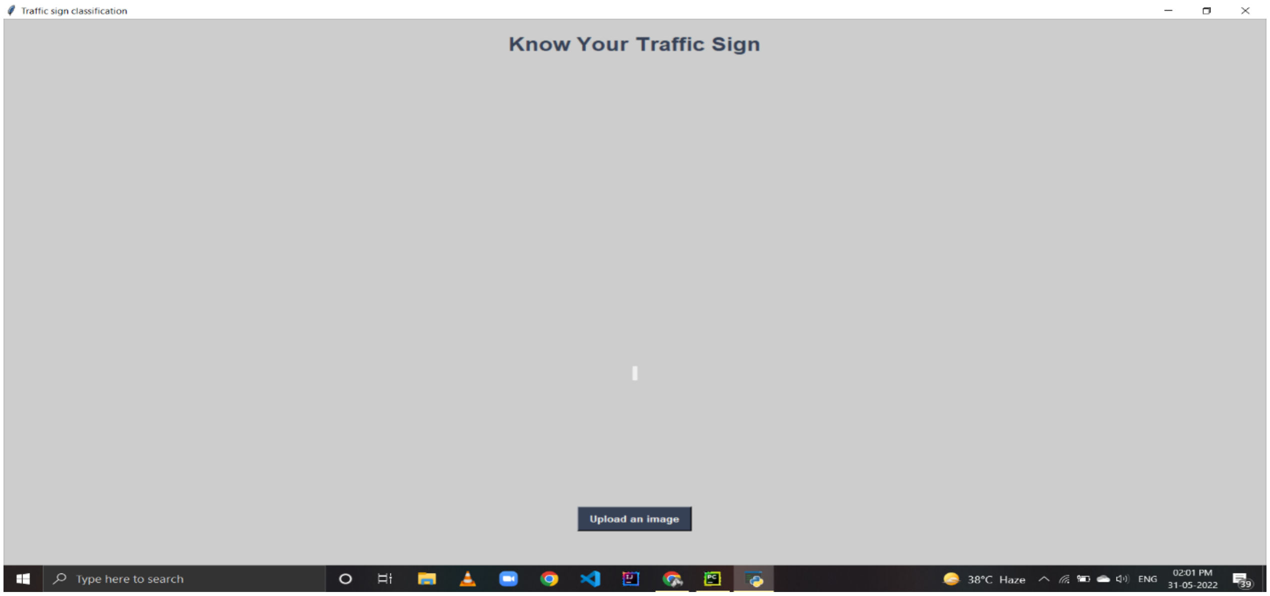

Figure 6: User Interface with upload image option

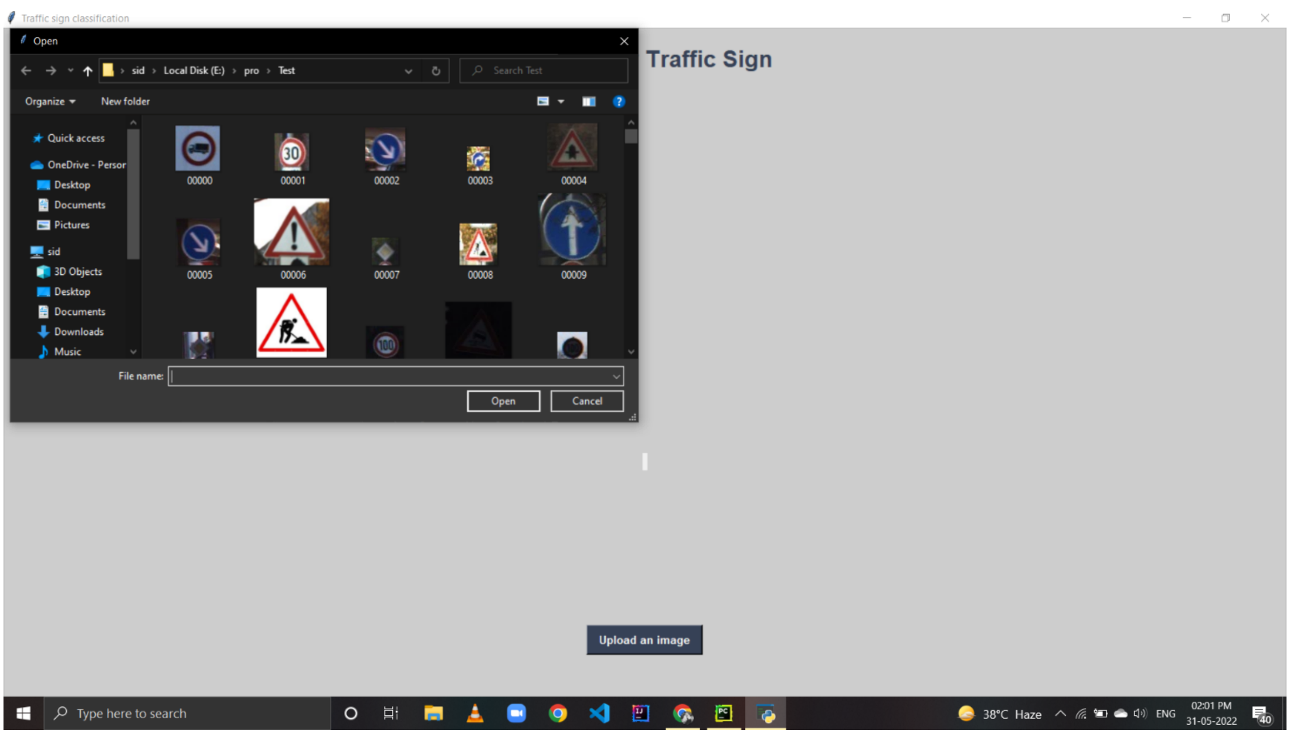

Figure 7 : select Image

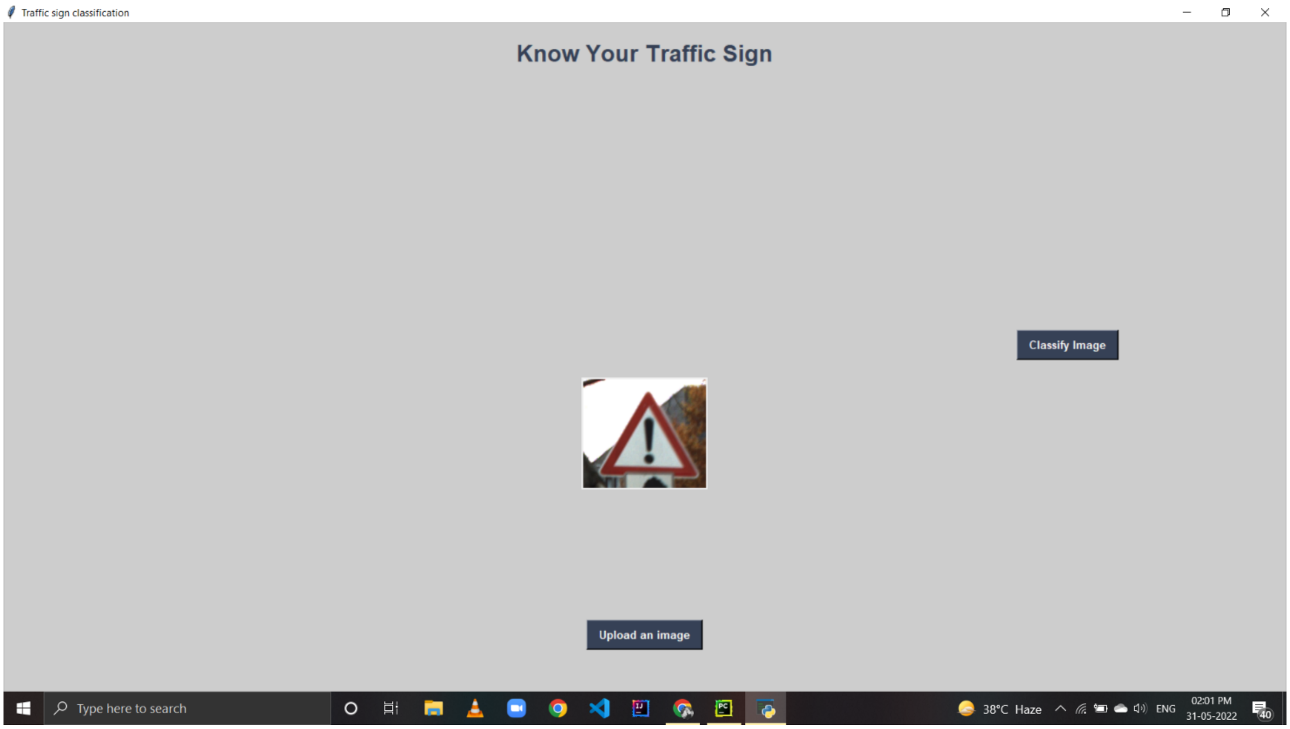

Figure 8: Image selected

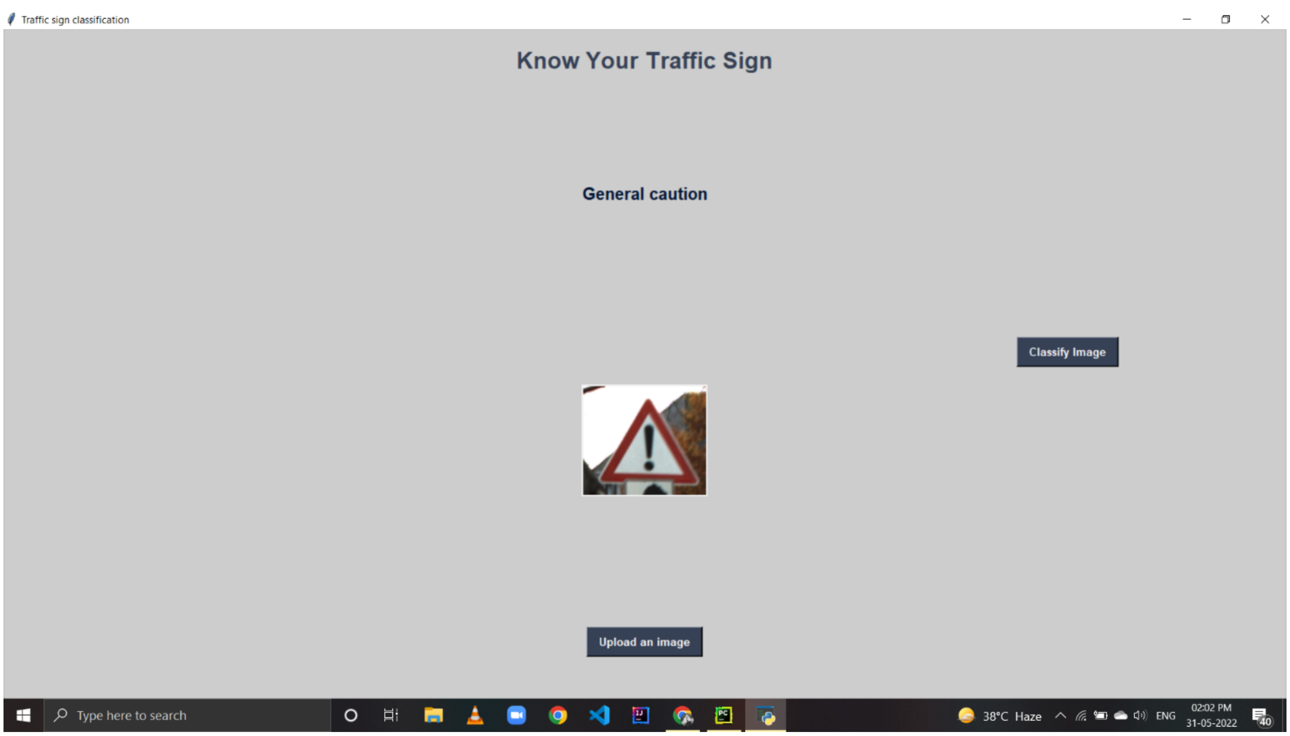

Figure 9 : Result

CHAPTER - 6

TESTING

During this research, images were collected for the development and verification of the algorithms used for traffic sign recognition. A total of 3415 images were collected in Sweden and 330 images in other countries. These images comprise one of the biggest databases of traffic signs in Europe [104]. All images collected in Sweden were taken from the same position in the vehicle, but different vehicles were used depending on availability. All still images were taken manually when traffic signs were seen by the camera operator. They were collected in different light conditions, in different weather conditions and in different road conditions including different speeds. For all images and without any exception, the camera was set to 640x480 pixels; Extra Fine JPG format and Continuous drive which allows a sequence of images to be taken at different distances between the vehicle and the sign.

Figure 10: Minolta DiMAGE 7Hi.

Images in this database are classified into 30 categories depending on weather conditions, type of the sign, sign condition, image condition and light geometry. Table 5.2 presents these categories together with the number of images in each category. Some of the images can be classified into different categories depending on the condition of the image.

Furthermore, this database includes additional traffic sign images taken from different places around the globe. Most of them are collected in Europe but some of them are taken in Canada, the USA, Singapore and Japan. These images are taken using different cameras depending on availability. Some of them are taken by a pedestrian and they can be of different sizes and different resolutions. One of the objectives of collecting images from different countries is to study the differences and compare the colors and pictogram shapes used by these countries. Another objective is to test the compatibility of the algorithms developed in the research.

Category	Number of Images	Category	Number of Images
Bad light geometry	77	SL-5	2
Blurred images	290	SL-10	5
Closed to all Vehicles	62	SL-15	3
Faded signs	158	SL-20	21
Fog	27	SL-30	94
Highlight	40	SL-50	196
Information Signs	508	SL-70	326
No Entry sign	125	SL-90	351
No Parking sign	92	SL-110	81
No Standing	93	Snowfall	80
Noisy images	48	Stop sign	120
Occluded signs	96	Sunny	922
Physically Damaged	61	Sunrise and Sunset	489

Prohibitory signs	227	Warning signs	443
Rain	122	Yield sign	157

Table 3: Raw images database comprises different categories.

A Microsoft Access application was developed to manage these images and associated information. It consists mainly of two tables: the pictures table and the signs table. In the pictures table, each record consists of the picture's name, date, weather condition under which the picture was taken, defects in the picture, light geometry, and time of day. The signs table contains all the signs gathered during the development stage of this research. As any picture may contain one or more sign depending on the nature of the sign, each record in this table is set to consist of the following fields: type of the sign, x and y coordinates of the center of the sign, rim colour, interior colour, sign shape, sign condition, and picture ID which represents the picture in which the sign is found. Other tables are created to prevent typing mistakes in the pictures and signs table. Such tables are called phrase tables and they contain all the phrases used in this database.

CHAPTER -7

CONCLUSION

The problem of traffic sign recognition for the purpose of road sign inventory has been approached by using colour and shape information of the traffic signs. A new set of algorithms, which has been developed and evaluated in a wide range of conditions, is exhibiting a good and robust performance.

The success of the proposed system opens new frontiers for further research in the future. Automation of road sign inventory is becoming a necessity for road authoritiesand such a system will be in use in the very near future.

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