Bangladeshi Road Sign Detection Using Deep Learning Technique for Driver Assistance system

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A Capstone project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering

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Declaration

We, **Ashraful Reza Tanjil, Md. Fahim Mohammad Adud Bhuiyan, Md. Ashraful Hasan and Sherajum Monira Noha** hereby, declare that the work presented in this capstone project report is the outcome of the investigation performed by us under the supervision of **Musharrat Khan**, Senior Lecturer, Department of Computer Science and Engineering, East West University. We also declare that no part of this project has been submitted elsewhere for the award of any degree or diploma, except for publication.

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Letter of Acceptance

The capstone project report entitled "Bangladeshi Road Sign Detection Using Deep Learning Technique for Driver Assistance System" submitted by **Ashraful Reza Tanjil, Md. Fahim Mohammad Wadud Bhuiyan, Md. Ashraful Hasan and Sherajum Monira Noha** to the Department of Computer Science and Engineering, East West University, Dhaka, Bangladesh, is accepted for partial fulfillment of the requirement for the degree of Bachelor of Science in Computer Science and Engineering on 23 /05/2023.

Board of Examiners

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Abstract

With the country's densely populated cities and often chaotic traffic conditions, accurate and efficient detection of road signs is crucial to ensure that drivers are well-informed about speed limits, warnings, and directional guidance. Implementing advanced road sign detection technology can help reduce accidents, improve traffic flow, and contribute to a safer and more organized road network, ultimately benefiting the lives and well-being of all road users in Bangladesh. This research was performed to develop an application to detect road signs from a sufficient distance. The VGG-16 model and several image processing algorithms are used to examine whether the performance of the model changes with different weather and lighting conditions. The proposed application was also used to explore integration strategies for road sign detection with other driver assistance systems and evaluated the proposed road sign detection method's performance across diverse traffic sign types and under varying lighting conditions to ensure its effectiveness in real-world scenarios. For the recognition phase, several pre-trained models have been trained and evaluated. The dataset was produced using field-taken pictures. Then, compared the results of these models to determine the suitable technique for development. Accuracy is a vital parameter in road sign identification for a driver assistance system in Bangladesh. Still, there are many other factors to consider in a complete evaluation. With an impressive 97.60% accuracy, GoogLeNet demonstrates its ability to correctly classify Bangladeshi traffic signs. Complex features can be captured with ease thanks to conception modules. ResNet-50's impressively high accuracy (98.33%) may be traced back to its use of depth and skip connections for capturing features at several scales. AlexNet's high accuracy of 84.01% suggests it could be pretty effective. With an impressive 99.52% precision, VGG-16 is a top contender. Overall, the most promising road sign detection efforts are being led by VGG-16.

Acknowledgments

As it is true for everyone, We have also arrived at this point of achieving a goal in our life through various interactions with and help from other people. However, written words are often elusive and harbor diverse interpretations even in one's mother language. Therefore, We would not like to make efforts to find the best words to express our thankfulness other than simply listing those people who have contributed to this capstone project itself in an essential way. This work was carried out in the Department of Computer Science and Engineering at East West University, Bangladesh.

First of all, We would like to express our deepest gratitude to the almighty for His blessings on us. Next, our special thanks go to our supervisor, Musharrat Khan, who gave us this opportunity, initiated us into the field of Deep Learning, and without whom this work would not have been possible. Her encouragement, visionaries, and thoughtful comments and suggestions, unforgettable support at every stage of our B.Sc. study were simply appreciating and essential. Her ability to muddle us enough to finally answer our own question correctly is something valuable that we have learned and we would try to emulate if ever we get the opportunity.

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There are numerous other people too who have shown us their constant support and friendship in various ways, directly or indirectly related to our academic life. We will remember them in our hearts and hope to find a more appropriate place to acknowledge them in the future.

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October 2023

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Chapter 1

Introduction

1.1 Background

Traffic signs are carefully designed with distinct colors and shapes to ensure easy recognition by drivers. These signs serve various purposes and are positioned strategically along the road. Autonomous systems also rely on these color and shape characteristics to recognize traffic signs. They can contain text or images to convey their meaning and use standardized fonts and sizes. In Bangladesh, traffic signs are categorized as WARNING, REGULATORY, and INFORMATORY based on color and shape. Additionally, Automatic Driver Assistance Systems (ADAS) assist drivers by performing tasks like braking and steering to enhance vehicle safety. They utilize sensors like cameras and radar to detect the environment. This project aims to develop a traffic sign recognition system, building upon existing research in this field. Fig.1 shows different kinds of traffic signs.

fig.1. Different kinds of traffic signs

1.1.1 History of Traffic Sign

With the installation of the first electric traffic signal in 1914, the globe witnessed a huge advancement in traffic management. In Cleveland, Ohio, on August 5, this momentous occasion happened at the intersection of Euclid Avenue and East 105th Street. Electric traffic signals provided a methodical means to manage and control vehicular movement at junctions, which represented a significant improvement in traffic management and road safety. This development paved the way for contemporary traffic management systems, which are now an essential component of urban transportation infrastructure all over the world, aiding in accident avoidance and ensuring the smooth flow of traffic.

1.1.2 Types of Traffic Signs

Different shapes correspond to specific categories of road signs:

- Vertical rectangles denote regulatory signs. Fig.2 shows One way traffic.

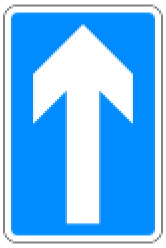

Fig.2

- Horizontal rectangles represent guide signs. Fig.3 shows Bus stop.

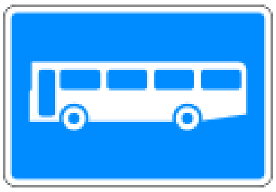

Fig.3

- Triangle-shaped signs indicate warnings. Fig.4 shows Railway level crossing with gate or barrier

Fig.4

- Octagonal signs are associated with Stop and Giveway signs. Fig.5 shows Stop and Giveway.

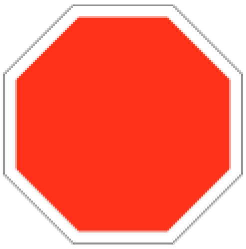

Fig.5

- Circular Regulatory sign. Fig.6 shows No Rickshaws.

Fig.6

- Horizontal rectangles additional signs. Fig.7 shows Disability.

Fig.7

1.1.3 Production of Traffic Signs

To ensure that traffic signs effectively notify vehicles and pedestrians of crucial information, a precise and meticulous technique is used in their construction. Here is a summary of the procedures involved in creating traffic signs.

Design: Create sign layout with messages and specs.

Material: Choose durable materials like aluminum or reflective sheets.

Fabrication: Machines shape materials into sign forms.

Printing: Apply graphics and text, especially reflective for visibility.

Coating: Add protective layers for durability.

Assembly: Combine components if needed.

Quality Control: Ensure accuracy, alignment, and durability.

Packaging: Protect signs for transportation.

Distribution: Send to agencies, contractors, or suppliers.

Installation: Follow guidelines for proper placement and visibility.

1.1.4 Traffic Sign Management

In order to maintain safe and effective roadways, traffic sign management include designing, installing, maintaining, and regulating road signs. Planning sign layouts, appropriate positioning, routine maintenance, regulatory compliance, inventory management, and integrating technology for real-time information are all part of it. The effectiveness of transportation systems is eventually increased through improved road safety, accident reduction, congestion relief, and clear instructions for drivers and pedestrians.

1.1.5 Traffic Sign in Other Countries

Traffic signs vary significantly from one country to another due to differences in language, road regulations, and cultural nuances. Here are some interesting examples of traffic signs from various countries:

Japan: Japanese road signs are known for their simplicity and clarity. A unique sign is the blue-and-white "Shingō" sign, indicating that a road leads to the famous Shingō village, where it is believed Jesus Christ's tomb is located.

Germany: Germany uses circular blue signs with white symbols to indicate mandatory instructions, such as speed limits. The iconic "Autobahn" sign signifies a stretch of high-speed, no-speed-limit highway.

Australia: Australia's road signs often feature iconic wildlife symbols. The kangaroo and koala crossing signs are easily recognizable. They also have signs warning about "road trains," long convoys of linked trucks found in the Outback.

Switzerland: Swiss road signs are notable for their multilingual approach, as Switzerland has four official languages. Road signs often include text in German, French, Italian, and Romansh.

India: Indian road signs can be a visual feast, with colorful illustrations. For example, the "Elephant Crossing" sign warns drivers of potential encounters with elephants in certain regions.

United Kingdom: The UK uses a mix of rectangular and circular signs with various colors. The "Zebra Crossing" sign, featuring black and white stripes, is one of the most iconic pedestrian crossing signs.

South Africa: South African road signs often include warnings about wildlife crossings, such as signs for "Kudu Crossing" or "Warthog Crossing," reflecting the country's diverse wildlife.

Norway: Norway has distinctive road signs featuring black symbols on yellow triangles, including a sign depicting a troll, which is a playful nod to Norwegian folklore.

China: China's road signs use a combination of Chinese characters and international symbols. The "No Honking" sign with a hand covering an ear is one example.

Canada: In Canada, bilingual signs are common, with both English and French text. Wildlife warning signs featuring moose or bears are prevalent in rural areas.

These examples highlight the diversity of traffic signs around the world, each designed to convey essential information to road users while reflecting the unique characteristics and cultures of their respective countries. Understanding these signs is crucial for safe and responsible driving when traveling internationally.

1.1.6 Traffic Sign in Bangladesh

The traffic sign system in Bangladesh follows international conventions and standards, but it also includes some unique signs that cater to the specific needs and challenges of the country's road network. Here is an overview of traffic signs in Bangladesh:

Regulatory Signs:

Stop Sign (থামা): Red sign, means stop. Fig. 08 shows Stop Sign.

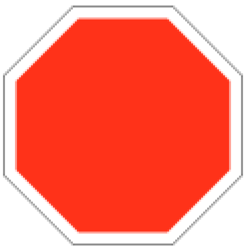

Fig. 08

Giveway Sign (রাস্তাদিন): Red triangle, means give way. Fig. 09 shows Giveway Sign.

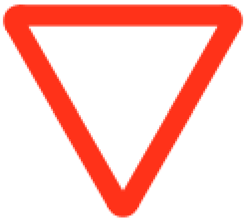

Fig. 09

No Entry Sign (সব ধরনের গাড়ি প্রবেশ নিষেধ): Circular sign with a white bar, means do not enter. Fig. 10 shows No Entry Sign.

Fig. 10

Warning Signs:

School Sign (সামনে স্কুল): Red Triangle, indicates a school zone. Fig. 11 shows School Sign.

Fig. 11

Pedestrian crossing ahead sign(সামনে পথচারী পারাপার): provide advance notice of areas of high pedestrian activity. Fig. 12 shows Pedestrian crossing ahead Sign.

Fig. 12

Narrow bridge ahead (সামনে সরু সেতু আছে): The driver is approaching a bridge that is more narrow than the road they are currently on. Fig. 13 shows Narrow bridge ahead Sign.

Fig. 13

Indication Signs:

Parking place (পার্কিংয়ের জন্য নির্ধারিত স্থান): Directs motorists to parking facilities. Fig. 14 shows Parking place Sign.

Fig. 14

Hospital Signs (হাসপাতাল): Direct motorists that are in need of immediate emergency medical attention from the state highway to the nearest emergency medical facility. Fig. 15 shows Hospital Sign.

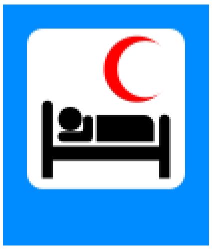

Fig. 15

Bus stop (বাস থামার স্থান): Identifying where transit buses stops to pick up and discharge passengers. Fig. 16 shows Bus stop Sign.

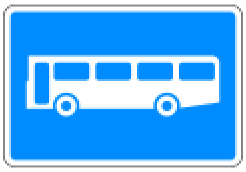

Fig. 16

Additional Signs:

Disabilities(হুইলচেয়ার): The wheelchair symbol should only be used to indicate access for individuals with limited mobility, including wheelchair users. Fig. 17 shows Disabilities Sign.

Fig. 17

Truck (ট্রাক): Alert drivers of large motor vehicles approaching. Fig. 18 shows Truck Sign.

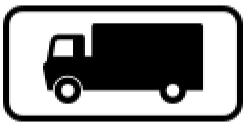

Fig. 18

Unique Bangladesh-Specific Signs:

No rickshaws (রিকশা চলাচল নিষেধ): Indicates no rickshaw is allowed in the designated area. Fig 19. shows No rickshaws Sign.

Fig. 19

No handcarts (ঠেলাগাড়ি চলাচল নিষেধ): There should no movement of handcarts in the designated area. Fig 20. shows No handcarts Sign.

Fig. 20

Knowing and obeying these signs is essential for safe and smooth driving in Bangladesh. Traffic authorities enforce these signs to ensure road safety.

1.1.7 Accident

Accidents caused by road sign problems, such as poor visibility, inaccurate information, and inconsistent signage, are a global concern, including in Bangladesh. Factors contributing to these accidents include damaged signs, theft, language barriers, and technology reliance. To address these issues and enhance road safety, countries should focus on regular maintenance, driver education, standardization, technology integration, and enforcement of traffic regulations related to road signs. Preventing accidents related to road signs requires proactive measures and public awareness.

1.2 Problem Statement and Analysis

A road sign detection method for the driver assistance system will be developed keeping the following questions in mind:

1. Can the system detect road signs from a sufficient distance?
2. Does the performance of the model change with different weather and lighting conditions?
3. How can road sign detection be integrated with other driver assistance systems to improve overall system performance and road safety?
4. How well does the proposed method perform on different types of traffic signs and under different lighting conditions?

Traffic signs are complex as they have different shapes, colors, and meanings so it's very tough to detect traffic signs properly. Wrong detection or hidden traffic sign is the main cause of road accidents. Problems can happen with the image quality that was captured for processing or the quality of the traffic sign that was in the frame. However, the problem arises as the condition of the sign itself, which may be old, or damaged from weather or accidents on the roadside, as is the case for the majority of signs in Dhaka city. The image quality may be preprocessed and enhanced later through computational processes, regardless of lighting issues or angle of perception. According to a report from the World Health Organization (WHO) published in 2021, traffic accidents caused the deaths of 1.3 million people every year and 93% of those causalities occurred in low and middle-income countries. Road accidents can be controlled efficiently with the proper detection of traffic signs. Thus lots of lives can be saved as well as time and cost of after-accident consequences.

1.3 Project Objectives

We will create a dataset by taking pictures of different road signs. Then for pre-processing the pictures, we will apply RGB to Grayscale. After that, we will train different pre-trained CNN models using the training data set. Based on the test results using the test data set, the best model will be selected. Finally, we will develop an app that will give Bangla text and audio alerts describing the detected road sign.

1.4 Project Contribution

The project's results will help enhance road safety, reduce road accident. In Bangladesh, road infrastructure is challenging to navigate, now a days. This project will help to provide instructions and warnings to drivers, reducing the risk of accidents and improving overall traffic flow. Throughout this project we created a strong data set of traffic signs of Dhaka city roads. The data set will be valuable for any further work related to traffic sign. After running VGG-16 model we got accuracy of 99.52% which is the highest among our references. This perfectly working algorithmic model gives a special contribution in this research sector. As a result, the combination of effective road signs and advanced driver assistance systems will enhance road safety, reduce accidents, and improve the efficiency of transportation in Bangladesh.

1.5 Project Outlines

In this project, different kinds of traffic sign are determined using machine learning and image processing techniques. To achieve this, a literature study has been carried out by looking at recent, relevant publications. The limitations of previous techniques for locating and classifying traffic signs have been identified. The data set is about traffic sign photos. Deep learning algorithm was used to detect the type of traffic sign after pre-processing the dataset. Additionally, some post-processing methods were employed to reduce the False positive rate. The ability to predict had been evaluated using a few criteria after deep learning algorithms were run to determine the most accurate predictive model. The experiments' results are then compared and evaluated. The model with the highest accuracy is chosen for future use. To accurately predict and categorize the desired things, the base model has finally been integrated. Lastly an app has been developed that will give Bangla text and audio alerts describing the detected road sign.

Chapter 2

Related Works

2.1 Survey of the State-of-the-Art

The authors of [1] developed a deep learning-based method for recognizing Indian road traffic signs. They introduced RMR-CNN, a modified version of Mask R-CNN, enhanced in terms of architecture, data augmentation, and parameter refinement. This approach effectively extracted features from Indian traffic sign photos using deep convolutional neural networks (CNNs). Their methodology performed well under various conditions, including scale, orientation, and illumination changes. The authors tested their method using the Indian Traffic Sign Dataset (ITSD) and demonstrated superior performance compared to other state-of-the-art techniques. They achieved high accuracy and a low false alarm rate, with precision, recall, and F measures for RMR-CNN reaching 97.08%, 96.75%, and 96.87%, respectively.

The work in [2] is on an intelligent transport system. The project works with different traffic sign conditions. There are 4 kinds of signs. Warning Signs, Compulsory Signs, Regulatory signs, and Informatory signs. The proposed approach of the project was first to train the data set and then work with the testing stage. At the training stage, the RGB color-based threshold will help to analyze the shape and then extract the features. These features will be saved in the database. From this classification of traffic signs will be done and test data will be categorized at that classification and a better result will be found. Normalized RGB color space is used for RGB-Based color thresholding. Shape Analysis is used in this project to clean the binary image from noise and small objects and apply connected components labeling algorithms to identify the traffic sign. This project uses HOG (Histogram of Oriented Gradients) to recognize pedestrians. KNN (K-Nearest Neighbor) algorithm is used to find the closest object sets similar to each other. The proposed project for traffic sign recognition attains a classification accuracy of 63%.

A traffic recognition system based on a CNN-based classifier and a YOLOv3-based detector is proposed in [3]. For the detector and classifier's training and evaluation, a PC equipped with an Nvidia GTX 1060 GPU and 6GB GPU RAM was employed. GTSDB and GTSRB databases were tested by the authors. The GTSRB dataset consists of more than 50000 traffic sign images of 43 classes with sizes ranging from 15×15 pixels to 222×193 pixels. The GTSDB dataset consists of 600 training images and 300 test images of 1360×800 pixels from urban, rural, and highway locations under various weather and lighting conditions. Positive detection is defined as Intersection over Union (IoU) > 0.5 between the ground truth box and the predicted bounding box. Utilizing the GTSDB test set, the detector's performance is compared against an R-CNN traffic sign detector implementation. On the GTSDB test set, the suggested YOLOv3-based detector demonstrated great accuracy of 92.2% and a frame rate performance of almost 10 frames per second. The GTSRB test set, which contains 12630 photos, was used to evaluate the CNN-based customs traffic sign classifier. A model trained without the addition of new data might attain a 96.46% accuracy. Accuracy has increased with data augmentation to 99.6%.

The project [4] used an Artificial Neural Network algorithm to recognize traffic signs which they called the CNN module. This study proposes a CNN TS-Module module for traffic sign recognition. Several trials on the traffic signs dataset show that the module's CNN is more suited for traffic sign identification than the classic CNN, because the typical convolution is done through a single layer. The 3*3 convolution kernel conducts feature extraction, which has the problem of producing an excessive number of parameters. The gradient diminishes as the network deepens, resulting in poor network performance. The TS-Module module CNN employs many sets of convolutions in its implementation. A 3*3 convolution kernel is created by connecting a 1*3 convolution kernel and a 3*1 convolution kernel via a 1*1 convolution kernel. The experience field effectively deepens and broadens the network, while multi-channel convolution can not only extract a variety of information but also considerably lower the parameters, increasing the network's practicality. CNN also mentions the residuals. This module is 87% or more accurate than the GTSRB data set.

The paper [5] presents a method for recognizing traffic signs in real time using efficient convolutional neural networks (CNNs). The authors propose a new CNN architecture that is optimized for real-time traffic sign recognition, as well as a new dataset for training and testing the CNNs. The authors proposed Faster R-CNN and MobileNets are combined and modified to make the detection process more efficient. A pretty good detection result of unique traffic signs is reported for the first time on the GTSDB database. An easy approach based on color and shape information for the localization refinement of small traffic signs is proposed, improving the detection quality and the classification accuracy of typical traffic signs. The traffic Sign Recognition (TSR) method used computer vision and machine learning methods. For the recognition of traffic signs, the benchmark dataset GTSRB is used. In Network Architecture they have used CNN architectures such as CNNs, VGGNets, ResNets, DenseNets, and LeNet-5. For Network Regularization they have used data argumentation, dropout, parameter norm penalty, and early stopping. Then they optimize the network by using the training of CNNs, etc. Their proposed system has traffic sign detection (Faster R-CNN), base convolutional layers, Region Proposal Network (RPN), RoI Pooling Layer, Classifier, and Loss Functions. Convolutional neural networks have achieved state-of-the-art traffic sign classification.

The paper in [6] describes a novel dataset and algorithm for recognizing traffic signs using artificial neural networks. The authors collected a dataset of traffic sign images and used it to train and evaluate an artificial neural network for the task of traffic sign recognition. In this paper, they were starting their methodology by combining data sets GTSRB and TSRD by merging those data sets together. After merging two datasets they resized all of the cropped images to 32 x 32 pixels for preprocessing TSRD and GTSRB and they inspected all the 101 classes of the new dataset manually. They followed the rule of thumb by taking 80% for training, 10% for validation, and 10% for testing. Thirdly they did data augmentation by increasing the number of observations. For data augmentation, they have done such as translation, rotation, noising, color, intensity jittering, and blurring. Following the application of the aforementioned data augmentation strategies, feature extraction from images used a novel classification algorithm. In their paper, they used Hybrid-ANN Classification Models for their data set. As they had many predictions that's why they used Hybrid-ANN Decision Model. In their proposal they performed two sets of experiments to further validate their results such as experiments on the GTSRB dataset and experiments on the Dataset Created. The HOG feature extraction algorithm with a cell size of 4 x 4 obtained the best accuracy around 80% and for experiment -2. Their novel dataset achieved an 87% 1st classification accuracy while a 95% was obtained for 2nd classification accuracy.

A method for recognizing and classifying traffic signals is developed in [7] using You Only Look Once (YOLOv2), Faster Region Convolutional Neural Network (RCNN), Single Shot Detector (SSD). The authors constructed these three designs in the TensorFlow environment using the Anaconda 5.1.0 Windows platform and measured the performance using the mAP (mean average precision) and FPS (frames per second) benchmarks. The effectiveness of object detectors and classifiers is assessed using mAP. The German Traffic Sign dataset, which contains several traffic signs with distortions such as sunshine reflections, wind effects, barricades, and occlusions, was used to evaluate their methods. In this methodology, 530 photos are utilized as the verification objective while 7832 images are used to train SSD, faster RCNN, and YOLOv2. These pictures were categorized by the authors into five categories: pedestrian crossing, no entrance, speed restriction, stop sign, and turn ahead. Using their mAP and FPS, SSD, Faster RCNN, and YOLOv2 are contrasted and evaluated. Their overall average mAP's are 68.35, 74.68, and 77.89 for the five classes. In terms of overall accuracy performances, YOLOv2 is faster and more accurate than both Faster RCNN and SSD, but SSD is less accurate than Faster RCNN and SSD.

A method for recognizing traffic signals is developed in [8] using a convolutional neural network (CNN) and the "max pooling" technique. The authors propose a model approach to distinguishing traffic signs that combines the color and shape of the traffic signs. The suggested technique employs a CNN with a max pooling layer to extract features from the color and shape. In contrast to earlier techniques, which often used CNN as a feature extractor and multilayer perceptron (MLP) as a classifier, they proposed max pooling positions (MPPs) as a potent discriminative feature to predict category labels. The desirable traits of little inter-class variance and big intra-class variance are demonstrated by MPPs through extensive studies. Utilizing the max pooling layer, the most important characteristics from the CNN are selected, and the features are then used to recognize traffic signs. The German Traffic Sign Recognition Benchmark (GTSRB) dataset is used by the authors to compare their suggested strategy against a number of state-of-the-art methods for traffic sign recognition and show that it outperforms them. Their accuracy rate is 98.86%.

The authors in [9] propose a system that uses a combination of image processing and machine learning techniques to detect and translate road signs in the Bengali language in real time. The authors use several image-processing techniques for road sign detection, such as color-based thresholding, morphological operations, and edge detection. These techniques are used to extract the region of the image that contains the road sign and to remove any unnecessary background information. For road sign recognition, the authors use a convolutional neural network (CNN), a type of deep learning algorithm commonly used for image classification tasks. The CNN is trained on a dataset of road sign images and their corresponding labels. The authors use a machine translation model for road sign translation to translate the recognized text from English to Bengali. Machine translation models use neural networks to learn the relationship between two languages and generate translations.

The paper in [10] presents a model for detecting and recognizing traffic signs using a combination of Support Vector Machine (SVM) and Histogram of Oriented Gradient (HOG) feature descriptors. Pictures of traffic signs are collected from streets of Bangladesh are categorized based on the type of traffic sign and stored on a data set. This data is used to train the classifier model. SVM (support vector machine) is made using the OpenCV library of python, it classifies the data using the HOG (Histogram of Oriented Gradients) property. If the result is 96% correct it will be taken into consideration. Their proposed approach is the identification of the traffic sign by playing a video and extracting frames. Match them with pre-processed frames, generation of SVM Classifier Model using Hog, Detection, and recognition of traffic signs from video input, after all of those have been done detection and recognition of traffic signs from video input by using Similarity Measurement algorithm. For implementation, they used a dataset of Bangladeshi traffic signs with 1000 images of 6 different classes, each class containing approximately 170 images to train the model. The project was implemented with the help of JetBrains PyCharm, OpenCV, and Numpy. Final results were precision 100%, recall 95.83%, accuracy 96.15%.

The project in [11] converts images from RGB to the YCbCr color model to extract candidate regions and to avoid the illumination sensitivity of color. The second part allows procedures for detecting ROI by using color segmentation in YCbCr color space. In YCbCr color space, any color is represented by the values of its intensity. Noises are eliminated using a morphological closing operation to recover the gaps smaller than 5 consecutive pixels. Eight connected components concept is used for labeling. After that geometrical features such as the area and aspect ratio of each region are extracted. Distance to Borders (DtBs) vector is a robust method for rotated and scaled objects to recognize the shape. To calculate the DtBs they have calculated the Euclidean distance between the bounding box (BB) and perimeter position of the RSs. A BB has 4 sides so the DtBs will generate 4 vectors For every time the vector is calculated. The detected RS is resized as 30X30 blobs that represent 900 pixels by ANN (Artificial Neural Network). These are normalized into 60 outputs by averaging each column and row intensity values. Then these 60 values are feed into the neural network. To recognize the content of road signs, ANN is used with three layers. The first layer consists of 60 inputs as the input layer. So, there are 3 layers Input, Output, and Hidden layer. The frame size of the image is resized as 448X336 pixels. Celeron Dual Core CPU 2.10GHz processor computer with 4GB ram has been used to execute the program to classify the BRS. The program has been developed under the MATLAB environment. Considering the above conditions, the successful road sign detection and recognition rate is about 94.87% and 92.79%.

2.2 Summary

Researchers and projects have developed various methods for traffic sign recognition and detection, tailored of different contexts and datasets. These approaches include deep learning-based methods like RMR-CNN for Indian road signs, achieving high accuracy. An intelligent transport system addressed various traffic sign conditions, achieving 63% accuracy. YOLOv3 and CNN-based systems showed real-time performance with a mAP of 92.2%. Enhanced CNN modules and optimized architectures led to state-of-the-arts results in real-time recognition. A novel dataset and algorithm achieved an 87% accuracy rate, while YOLOv2 outperformed other detection methods. SVM and HOG combined for an accuracy rate of 98.86%. Real-time Bengali road sign recognition utilized image processing and machine translation. Color and shape analysis with SVM and HOG achieved high precision and accuracy. Lastly, a method using max pooling in the YCbCr color space showed successful detection and recognition rates. These approaches collectively advance traffic sign recognition with a focus on accuracy and adaptability to diverse conditions. Table 1 shows reference paper comparison.

Paper Title with reference	**Method**	**Accuracy**
Traffic-Sign Recognition for an Intelligent Vehicle/Driver Assistant System using HOG [1]	Histogram of Oriented Gradients (HOG) k-Nearest Neighbors (k-NN)	63% accuracy using KNN
Traffic Sign Recognition with a small convolutional neural network [2]	(CNN) Convolutional Neural Network (Tra-Net, MyNet)	GTSRB- Tra-Net 97.35%, GTSRB – MyNet - 97.4% BTSD -Tra-Net 96.4%, BTSD - MyNet 98.1%
Real-Time Traffic Sign Recognition Based on Efficient CNNS in the Wild [3]	CNNs, VGGNets, ResNets and DenseNets Support Vector Machines (SVM)	Undefined
Recognition of Traffic Signs with Artificial Neural Networks: A Novel Dataset and Algorithm [4]	Artificial Neural Networks (ANNs), Support Vector Machines(SVMs) and Convolutional Neural Networks (CNNs),	87% top-1 classification accuracy and 95% for top-2 classification accuracy (HOG)

	Histogram of Oriented Gradients (HOG)	
Traffic Sign Recognition with Convolutional Neural Network Based on Max Pooling Positions [5]	Convolutional Neural Network (CNN) Multi-Layer Perception (MLP)	96.95% based on CNN - MLP scheme.
Indian traffic sign detection and recognition using deep learning [6]	Mask R-CNN Refined Mask R-CNN Faster R-CNN	97.08% of Precision and 96.75% of Recall (RMR-CNN model)
Traffic Sign Recognition and Classification Using YOLOv2, Faster RCNN and SSD [7]	SVM, PCA, HOG SSD Faster RCNN and YOLOv2	SSD 68.35%, Faster RCNN 74.68% and YOLOv2 77.89% (based on mAp)
Real-Time Traffic Sign Recognition Using YOLOv3 based Detector [8]	Faster R-CNN and YOLOv2, YOLOv3	84.5% mAP(Faster R-CNN), 92.2% mAP(YOLOv3)
Bangladeshi Road Sign Recognition Based on DtBs Vector and Artificial Neural Network [9]	Distance to Borders (DtBs) vector YCbCr color model SVM	92.79% (YCbCr)
Road Sign Detection and Translation in Bangla Using Image Processing and Machine Learning [10]	Support Vector Machines (SVM)	90%
Traffic Sign Detection and Recognition Model Using Support Vector Machine and Histogram of Oriented Gradient [11]	SVM, HOG YCbCr color space HSV space DtBs vector	96.15% (HOG)

Table 1. Reference paper comparison.

Chapter 3

Materials and Methods

3.1 Materials

This project contains a traffic sign detection system which can detect traffic sign with camera and automatically gives Bangla voice. To develop this traffic sign detection system we have collected datasets and trained multiple deep learning models like VGG-16 and others to get the proper output about the traffic sign. Among all the models we have used we chosen the best one to detect the traffic sign, and which will automatically give Bangla voice.

Collecting the data is challenging and we collect our dataset from our environments, roadsides and many more places. We also collect the dirty and clean also shaded traffic sign to get the better result for our project.

After collecting and finalizing the data we trained our data in various models like VGG-16, ResNet-50 and Yolo. We used jupyter, TensorFlow python libraries to develop our models. After running the program, it can say which traffic sign it is and after creating the app it can give Bangla voice properly.

3.1.1 Data Collection

An exciting and impactful area of research and innovation lies in the application of machine learning models for traffic sign detection from images. Researchers and practitioners in this domain require access to representative datasets to advance the development of effective machine learning systems. However, datasets for traffic sign detection specially in Dhaka city is limited. Our review of existing literature reveals a noticeable absence of standardized datasets, encompassing factors like dataset size, noise levels, and class distribution, for images of various traffic signs. Thus, we consider it crucial to create and publicly release such a dataset to stimulate research in machine learning-based traffic sign detection.

When predicting the labels of instances in a dataset using a machine learning model, it is essential for instances belonging to different classes within the dataset to exhibit distinct characteristics. These distinguishing traits enable the model to effectively differentiate a mong inter-class feature vectors during the prediction phase. In this section, we analyze t he distinctive traits within each of the 21 classes of traffic sign found in our dataset: 'ইউ টার্ন', 'ইউটার্ন নেওয়া নিষেধ', 'একদিকে চলাচল', 'ওভারটেকিং নিষেধ','ট্র্যাক প্রবেশ নিষেধ', 'ডানদিকে মোড় নেওয়া নিষেধ', 'থামানো নিষেধ', 'পার্কিং', 'পার্কিং নিষেধ' , 'প্রবেশ নিষেধ', 'বামদিকে মোড় নেওয়া নিষেধ', 'বাস স্ট্যান্ড', 'মসজিদ', 'রিকশা চলাচল নিষেধ', 'সামনে ডানদিকে আচমকা মোড় আছে', 'সামনে পথচারী পারাপার', 'সামনে বামদিকে পার্শ্ব রাস্তা আছে', 'সামনে স্কুল', 'হর্ন বাজানো নিষেধ', 'হাসপাতাল ', 'হুইলচেয়ার'

3.1.2 Dataset Sampling

The dataset has been sampled into three sections which are train, test, and validation. A simple random sampling has been used to split the dataset. For gathering data this technique is much more reliable than any others. From the dataset 70% of the images in the training set, 20% in the testing set, and 10% in the validation set.

3.1.3 Dataset Pre-Processing

The dataset should be preprocessed because the photos in a dataset were not all the same size. To train a model, this is a crucial step. We wouldn't achieve greater accuracy if we used the pre-processed version of this dataset. We clicked RGB images for our dataset, and cropped it manually. Hence, we converted them to gray scale using Matlab. Then we resize all photos to the same 600*600-pixel size using python in Jupyter Notebook. We also applied auto orientation in those images. Because auto oriented pictures standardize the pixel ordering, and the gray scale will merge color channels to make the model faster and insensitive to subject color. We were also serious about vertical and horizontal flip as it can make the traffic sign different. After resizing, the image size gets small. As a result, images turn into smaller file size. This small size images are easy for faster training. Fig. 19 shows the proposed methodology.

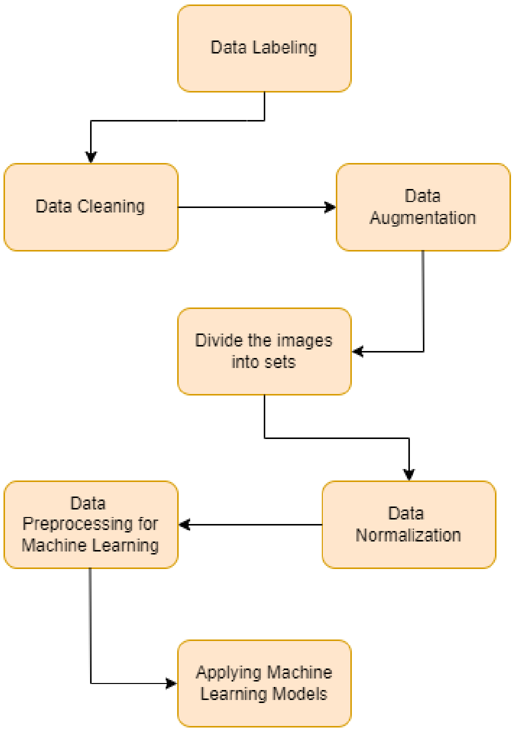

Fig.19 Proposed Methodology

3.1.4 Data Augmentation

Data augmentation is a different preprocessing step that is applied to the training dataset to enhance the model's performance and increase prediction accuracy. After applying data augmentation, the total number of training instances is 5880 and for validation and testing are 840 and 1680 respectively. Firstly, we flipped the images. We added horizontal flips to help our model be insensitive to subject orientation. After that to get the camera-oriented image we added rotation, and it rotates clockwise and counterclockwise. Then images have been cropped 0% to 20% for adding variability to it.

3.1.5 Research Environment and Devices

Modern technologies must be needed for our whole project. The specifications are given below:

Hardware Specification:

To run the programs smoothly we need some good specifications which will consume less time and give the result as soon as possible.

PC configuration:

1. Intel Core i5 with 6^{th} generation gaming mother board
2. 16 GB RAM
3. GeForce GTX1660 Super with 6 GB of VRAM
4. 256GB M2 SSD and connected to 1 TB (HDD).

Software Specification:

Software specifications are essentially the features or programs that were employed to create our project. Our choice of programming language is Python. We used the "Jupyter Notebook" ANACONDA.NAVIGATOR Python IDE to create our models.

3.2 Method

Firstly, we must collect images from various sources as our data to work with. Image data produced by scanning a surface with an optical or electronic device. Common examples include scanned documents, remotely sensed data, and aerial photographs. Auxiliary picture data is stored in other graphic image formats such as TIFF, GIF, PCX, etc. There is a high chance of getting some fluctuating data or images. So, we must enhance them in the next step, namely data enhancement. Digital pictures are modified during the process of image enhancement to provide outcomes that are more suited for display or additional image analysis. To make it simpler, eliminate noise, sharpen, or brighten a picture. After enhancing data, we have to resize all images into same pixel because it will be more convenient for the application if we do so and we are nominating this step as image shaping. We resized an image to make it bigger or smaller without having to remove any content. Fig. 20 shows the work flow.

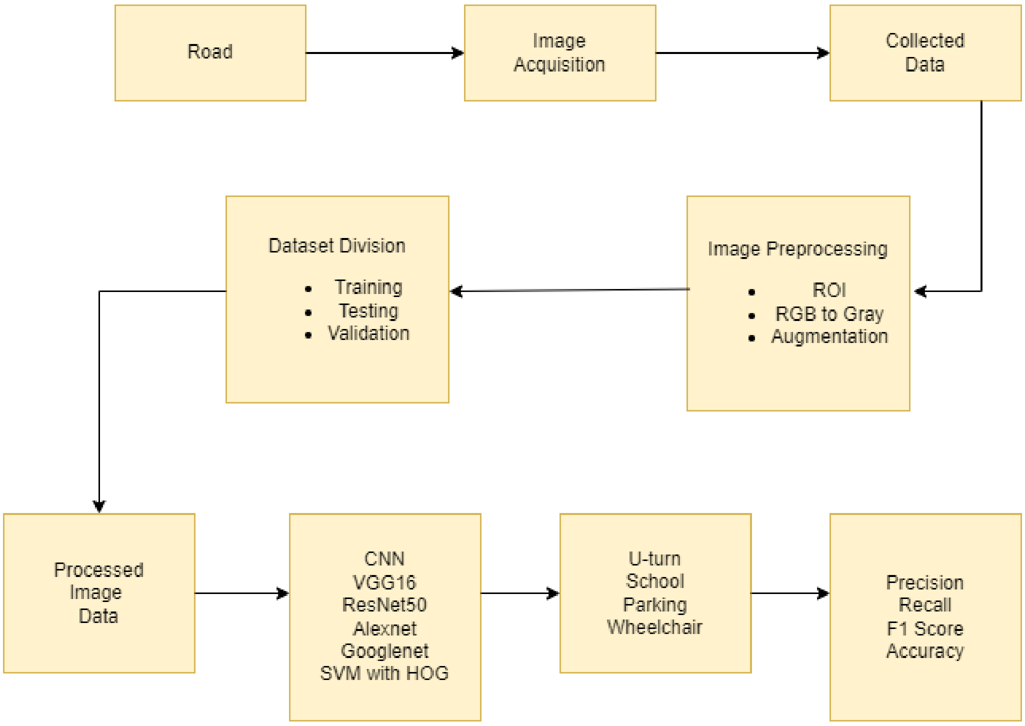

Fig. 20 Workflow

The image's dimensions are changed when it is resized, which often has an impact on the file size and image quality. Reducing the size of huge pictures to make them easier to email or share online is the most popular justification for shrinking photos. After that, we must classify the data according to different data types. Data categorization is the process of categorizing data so that it is easy to find, sort, and store for later use. It is simple to locate and retrieve crucial data thanks to a well-planned data classification system. We shall store them in the cloud for better safety. Thereafter, we must separate the data into two types of datasets. One is the training dataset, and the other is the validation dataset. The distinction between test data and training data is obvious. We will train our model on the training dataset and test the model on the validation dataset, as well as verify if the dataset is properly working or not. After all those steps, we must choose our model, and finally, we will develop our application. Application development is the process of developing a computer program or a collection of applications to carry out the many activities needed by a business.

3.2.1 Proposed model

We worked with 4 models, which are discussed below.

3.2.1.1 VGG-16 model

The deep convolutional neural network VGG-16, which is a member of the Visual Geometry Group's family of models, is renowned for its simple yet effective architecture. Its "16" label accurately matches the number of layers, which are 13 convolutional layers and 3 fully linked layers. VGG-16, which was first created for large-scale picture categorization, excelled in the ImageNet competition, demonstrating its adaptability for a variety of computer vision tasks. Although more recent designs have appeared, the VGG-16 is still a useful starting point, especially for tasks where deep learning applications place a high value on simplicity, interpretability, or transfer learning.

3.2.1.2 AlexNet Model

As a result of its outstanding performance in the 2012 ImageNet competition, where it significantly lowered error rates, AlexNet is recognized as a foundational milestone in deep learning and computer vision. The idea of deep convolutional neural networks, which include stacked convolutional and max-pooling layers, was introduced. Its accomplishment demonstrated the potency of deep learning, influenced the parallel processing of data using GPUs, and sparked a significant interest in transfer learning. Beyond picture classification, AlexNet's influence fosters the creation of cutting-edge neural network architectures and applications in a variety of fields, serving as a key driver for the advancement of deep learning.

3.2.1.3 ResNet-50 Model

ResNet-50 is a ResNet-family deep convolutional neural network. It is made for picture classification. ResNet-50's depth (50 layers), remaining connections (skip connections) that alleviate the vanishing gradient problem, and picture recognition performance are its main strengths. ResNet-50 and other ResNet variations have helped construct incredibly deep neural networks that can train hundreds-layer models with good convergence. This architecture underpins deep feature extraction-based computer vision applications like image classification, object recognition, and picture segmentation.

3.2.1.4 GoogleNet Model

GoogleNet, alternatively referred to as Inception, is a widely employed convolutional neural network architecture utilized for the purposes of image classification and object recognition. Its effectiveness stems from several key factors, including its efficient design, incorporation of inception modules to enhance feature extraction, ability to mitigate overfitting, adaptability to diverse computer vision tasks, and its notable contributions to the progression of deep learning research. Efficient and precise picture analysis is of great value in this context.

3.3 Working Process

App working process is described below.

3.3.1 Mobile Application

To use this application firstly new user needs to sign in and register users need to sign up. To detect images application user has to capture or upload an image.

3.3.2 Sign Up

To sign up for the application, the user has to provide a full name, E-mail, and password (entering two times a second time, re-enter the password to match the password with the first password). According to the Django database security, the password must be eight characters long, such as uppercase, unique personality, number, etc., and upload or capture their image. After all these steps are followed, this information will send to the Django database, and data will be stored there for further process. In the fig. 21 shows the registration process.

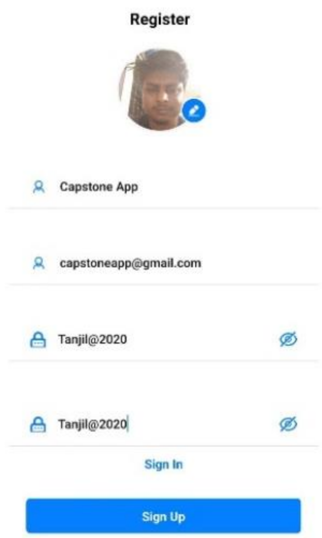

Fig. 21

3.3.3 Sign in

Users can sign in after completing the registration process by providing their registered email and password. When this information is provided here, phrase the sign-in button. All information will be cross-validated with the database information. The user can sign in to their account if all are correct or filled. Otherwise, they will get an error message. Fig. 22 shows the sign-up process and user profile.

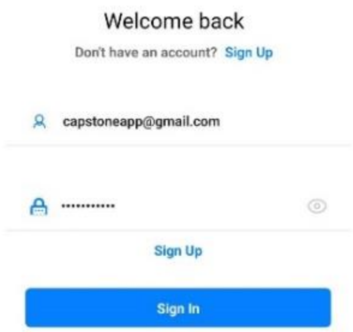

Fig. 22 Sign in

3.3.4 Browsing Photo

To detect the sign user has two options, they can upload an image by browsing the phone gallery or Google Drive and capturing an image from the street. Fig. 23 shows the interface of browsing photos.

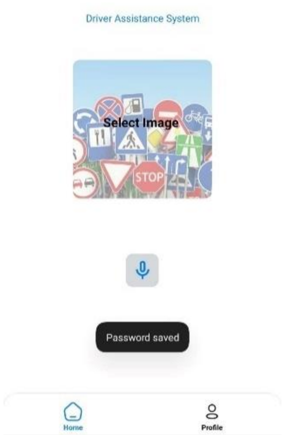

Fig. 23 Browsing photo

3.3.5 Detecting Traffic Sign

After giving the image, it will be sent to the Django database; it has to be resized according to the training image size 224*224 pixel. Then, convert the image to the RGB and numpy array. For normalizing the pixel values, there will be a divided image array with the value 255 and an added batch dimension with the image array. Finally, it will be sent to predict the traffic sign's class name from the best weight saved.

3.3.6 Bangla Voice and Text

When the traffic sign class name is predicted, our app will show the Bangla tax according to the class name which is stored in the database, and by phrasing the speaker logo, the user can also hear the Bangla voice. We used Google Voice for a good user experience for the Bangla voice. Fig. 24 shows the Bangla text and voice.

Fig. 24

Chapter 4

Results and Discussion

4.1 Obtained Results

To do traffic sign detection, we used GoogLeNet, ResNet-50, AlexNet and VGG-16. K-fold is used to divide the dataset. The average accuracy is 94.86%.

4.1.1 GoogLeNet:

The GoogLeNet model exhibits a notable level of accuracy, precisely 97.60%, showcasing its proficiency in accurately categorizing traffic signs from Bangladesh. Nevertheless, the only consideration of correctness fails to comprehensively understand the situation. The power of GoogLeNet resides in its capacity to effectively capture intricate details present in road signs. The architectural design incorporates inception modules, which facilitate the optimal utilization of computational resources.

4.1.2 ResNet-50:

ResNet-50 has exceptional accuracy relative to other models, indicating robust performance in the classification of road signs. The model attains a level of accuracy of 98.33%. ResNet-50 is renowned for its substantial depth and incorporation of skip connections, which facilitate the model's ability to proficiently capture characteristics across several scales. This characteristic is likely a contributing factor to its elevated level of accuracy.

4.1.3 AlexNet:

The AlexNet model exhibits a comparatively lower level of accuracy, as evidenced by its 84.01% accuracy rate. This suggests that it may encounter difficulties when applied to specific road sign identification tasks. Despite its lesser accuracy than other models, AlexNet may demonstrate exceptional performance in certain areas, particularly in computing efficiency.

4.1.4 VGG-16:

The VGG-16 model has remarkable accuracy, rendering it a highly viable option for road sign detection. The accuracy rate is 99.52%. The VGG-16 architecture, characterized by its deep layers and consistent structure, exhibits potential efficacy in capturing a diverse array of road sign features.

4.2 Performance Evaluation

In summary, the accuracy findings presented provide a favorable initial stage for detecting road signs in Bangladesh, with VGG-16 and ResNet-50 emerging as the leading approaches. Table 2 shows the comparison of accuracy of the models implemented.

Model	Accuracy
GoogLeNet	97.60%
ResNet-50	98.33%
AlexNet	84.01%
VGG-16	99.52%

Table 2: Comparison of all model Accuracy

4.3 Discussion

Accuracy is a vital parameter in road sign identification for a driver assistance system in Bangladesh. Still, there are many other factors to consider in a complete evaluation. With an impressive 97.60% accuracy, GoogLeNet demonstrates its ability to correctly classify Bangladeshi traffic signs. Complex features can be captured with ease thanks to conception modules. ResNet-50's impressively high accuracy (98.33%) may be traced back to its use of depth and skip connections for capturing features at several scales. AlexNet's high accuracy of 84.01% suggests it could be pretty effective. With an impressive 99.52% precision, VGG-16 is a top contender. Overall, the most promising road sign detection efforts are being led by VGG-16 and ResNet-50.

Chapter 5

Conclusion

5.1 Social and Environmental Impact

Bangladeshi Road Sign Detection Using Deep Learning Techniques for Driver Assistance Systems has a lot of potential for improving the environment and society. These systems reduce accidents, traffic sign violations, over-speeding, pollution, and traffic congestion by effectively detecting traffic signs and Bangla voice. As a result, carbon emissions are decreased, resources are conserved, and harm to humans and wildlife is avoided. By giving current and relevant information, accurate traffic sign detection can lessen the cognitive pressure on drivers and possibly increase their concentration while driving. To eliminate missing or erroneous detections that might result in safety issues, the solution is created and tested to assure high reliability and robustness. The system's overall safety depends heavily on the precision and dependability of the road sign detection sensors, such as cameras.

5.2 Summary

We thoroughly improved our approach through extensive testing with GoogLeNet, ResNet-50, VGG-16, and AlexNet models, and ultimately picked VGG-16 for its remarkable real-time detection capabilities, notably in detecting the 20 different traffic signs. This cutting-edge model makes quick and accurate recognition possible, resulting in effective traffic sign detection. A further example of our dedication is the Bangla voice which helps the driver to drive and hear at the same time. It responds to traffic sign detection and gives audio just in time.

5.3 Limitations and Future Works

Traffic sign detection in our country is not cost-effective. Sometimes, the management process causes more problems. Due to the growing population, the low rate of traffic signs is seen in major cities. New construction buildings are made by removing traffic signs.

Moreover, most of the traffic signs are highly damaged. Most of the time traffic is managed in Dhaka city by traffic police as a result the importance of traffic signs is getting lesser. The important limitation is all traffic signs cannot be detected as Government is introducing new signs regularly.

While the results of our Bangladeshi Road Sign Detection Using Deep Learning Technique for Driver Assistance System, which incorporates VGG-16 for real-time detection, there are several drawbacks that need to be considered. First off all, even though VGG-16 has enhanced object identification accuracy, many ambient factors such as illumination and object occlusions can still have an impact. Furthermore, because the system relies on a camera, bad picture quality can cause improper result, also detecting traffic sign which is damaged or badly shaped may be difficult. Additionally, the technological features might not adequately address social behaviors, necessitating the deployment of a comprehensive behavioral change strategy in addition to the technological one. Further optimization of the current configuration might be necessary to address newly introduced traffic signs. We are working to improve and expand our dataset. If more images were used at the time of training the data set could show better results but it was not possible as the pc was not highly configured.

This work is done in basis of 1 traffic signs still picture, and its detection. In future we want to work on developing an app which will detect traffic sign from live video.

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Appendix-A

Mapping of Course and Program Outcome

CSE400-A

Program Outcomes:

PO1 (Engineering Knowledge): We have chosen a project that can be resolved using the engineering knowledge we gained through our studies of computer science and engineering. Additionally, it includes both the fields of software engineering and data science. The project is chosen by considering the current traffic jam issues and addressing them with previously collected and newly acquired knowledge. We have applied our understanding of programming languages, concepts of image processing, AI, deep learning, robotics, and many other areas. Along with applying our earlier engineering knowledge, we also gathered new information from various outside sources for the project. We used our models to find better accuracy and solutions by comparing our findings to those of earlier models.

PO4 (Investigation): The prerequisite for starting a new research/project is reading many papers, as it is not possible to present something new in the field of research without being aware of the previous works. To achieve the objectives of our project, we have studied numerous research papers that were related to it and published in reputable conferences and journals to gain a better understanding of the procedures, apparatus, and software. The goal of this research was to locate pertinent papers. We have investigated.

the necessary laws, security measures, hardware, and tools.

CO	Details	Knowledge Profile (K)	Engineering problem (EP)
CO1	As part of the capstone project, combine previously learned information with new knowledge to identify a complex engineering problem in real life.	(i) Background [**K1, K2, K3**] • We have discussed different types of traffic signs related to our project. **K1** is addressed. • We tried to detect traffic sign with other data as a demo test. **K2** is addressed. • A deep learning-based traffic sign detection model will be developed. **K3** is addressed.	(i) Background [**EP1**] • The background study has given us in-depth knowledge for the proposed work. **EP1** is addressed. (ii)Related works. [**EP2, EP6**] • We have searched for traffic sign detection works around the internet, and we have seen some conflicts; however, there are no such works in our country. Thus, we choose the modern techniques of detecting traffic sign type. **EP2** is addressed. • Knowledge about traffic sign is needed in addition to deep learning approaches. We have talked with our supervisor regarding the work and knowledge.

CO2	Investigate several problem areas, specify the issues, and create the capstone project's goals.	(i) Related Works [**K8**] • We have done different types of inquiries on traffic sign detection. In addition, we have tried to understand the deep learning techniques and approaches that are used across the world. **K8** is addressed.	(i) Related Works [**EP1**] • The inquiries have given us in-depth knowledge of the proposed work. **EP1** is addressed. (ii) Objectives [**EP2, EP6, EP7**] • We will train and test different types of models and choose the best one to work with. **EP2** is addressed. • Domain knowledge of traffic sing and types is needed for this work. **P6** is addressed. • We will work on the backend of this system as well as the front-end and application development is also included in this. **EP7** is addressed. (ii) Planned Methodology [**EP3, EP4**] • Detecting traffic sign types and giving Bangla text. **EP3** is addressed. • The issues regarding our project can be solved by using images. So, **EP4** is addressed.

CSE400-B

Program Outcomes:

PO2 (Problem Analysis): Traffic greatly hampers our time and life, especially in Bangladesh. It is a major problem nowadays. As a result, we have examined the issue and identified its key components to resolve it. We looked at previous research papers on the topic and tried to draw inspiration from various methods to address the issue. We identified both strengths and weaknesses in the relevant literature to build a solution to this problem.

PO3 (Design/Development of Solutions): We have primarily created and developed a solution for a problem related to traffic sign detection. The current solution may have limitations. As a result, we have also thought about other possible solutions to the issue. The public's health and safety won't be negatively impacted by the solution we've developed. To develop the solution, cultural, social, and environmental issues were considered.

PO5 (Modern Tool Usage): We've had meetings with our honorable supervisor, and under his guidance, we learned how to use some IT tools to identify a problem's solution. We have also done independent tool experiments. To develop the solution, we used cutting-edge IT tools like Python, VS Code, Google Colab, Flask, TensorFlow, and the Raspberry Pi. For the development process, we also used web-based tools like Google Collaboratory.

PO6 (The Engineer and Society): For the benefit of our society and the recycling industries, the project was chosen to reduce environmental pollution, problems, and crimes associated with them. There are no negative impacts of this project or its development on culture or society. In the development and use of this project, social and legal issues have also been considered.

CO	Details	Knowledge Profile (K)	Engineering problem (EP)
CO 3	Analyze different aspects of the goals in developing a resolution for the capstone project.	(i)Problem Analysis [K1, K2, K3, K4] • We gave a lot of attention to Bangladesh's overall traffic sign system as well as studied the overall system to identify the problems and solution regarding it. **K1** is addressed. • To work with different traffic signs, we have taken images and processed them through various image processing techniques. In this case, mathematics is the main structure. **K2** is addressed. • Throughout this project, we are applying extensive knowledge of machine learning, deep learning technology and artificial intelligence to create different models to detect the traffic sign type. **K3** is addressed. • The security measures will be added in future using the help of deep learning and machine learning to get the best outcome. This phase will happen only if there is any preferable scope. **K4** is addressed.	(i)Problem Analysis [EP1, EP2, EP6, EP7] • We have studied about the problems in Bangladesh which are created from misuses of recycling technologies. The most common thing we found is that the lack of knowledge about recyclable materials lead the products to produce black smoke which is a dangerous threat for the environment.**EP1** is addressed. • Some published works utilized an organized format, while others just made use of the built-in feature. **EP2** is addressed. • We researched the technologies we already must classify traffic sign and set our goal which must be unique comparing to others in Bangladesh.**EP6** is addressed. • To clarify which material is non-recyclable or if it is recyclable then which one should be producing black smoke is a challenging issue in our project. **EP7** is addressed.
CO 4	Develop and create solutions for the capstone project that consider issues with public health and safety, culture,	(i)Design and Implementation[K5] • To acquire technical knowledge, design strategies, and pertinent tools and resources to	(i)Design and Implementation [EP1, EP2, EP4, EP5, EP6, EP7] • A fundamentals-based, first-principles analytical approach is possible after acquiring in-depth engineering knowledge at the level of **K3, K4**, **K5**,

	society, and the environment.	create components, models, or processes that meet requirements, we examined YouTube videos, online courses, and our academic course. After examining several strategies, including CNN, sequential model and ResNet50 model, we created our product in a way that will be incredibly beneficial to the environment. Data pre-processing, data augmentation, statistical analysis of the two types of datasets, deployment of machine learning models, and lastly detection and prediction make up our method for identifying and detecting the traffic sign. **K5** is addressed.	**K6**, or **K8**. We use our technique for identifying different traffic signs. **EP1** is addressed. • We applied various kinds of deep learning and machine learning models as well as we did the pre-processing which were replicating over the engineering design of us. **EP2** is addressed. • We can recognize the issues which we are encountering such as the glass and plastic detection while they both look the same. **EP4** is addressed. • To ensure that outside concerns are handled by professional engineering standards and best practices, we concentrated on making our system understandable and maintaining the code standard. so that the user may easily obtain recognition and detection. **EP5** is addressed. • While revising the similar papers that are like us, we got some properties and requirements that are similar to us. So that we have deducted those properties and are working with the ones that are unique and do not have that many similarities. **EP6** is addressed. • In image detection, we are free to work on complex issues with several constituent parts or smaller issues, such as tackling numerous traffic sign detection & recognition issues concurrently. Moreover, we try to integrate it into our system. **EP7** is addressed.

CO 5	Determine which current engineering and IT technologies to use while designing and developing the capstone project.	Materials and Devices [**K6**] • We had to research various ML and DL algorithms to use them as a form of detection and prediction. Other deep learning and machine learning techniques, such as Convolutional Neural Networks (CNN), the sequential model or the ResNet50 are also used. We use the most recent tools and features to carry out these operations and analyses. We are using high speed computers with GPU systems since we must deal with different image data. We use the Python programming language combined with the Google Colab package to implement the algorithms. We put a lot of effort into delegating tasks equally throughout the staff. **K6** is addressed.	Materials and Devices [**EP1, EP2, EP4, EP5**] • A fundamentals-based, first-principles analytical approach is possible after acquiring in-depth engineering knowledge at the level of **K3, K4**, **K5**, **K6**, or **K8**. We use our technique for identifying different traffic signs. **EP1** is addressed. • We applied various kinds of deep learning and machine learning models, as well as we did the pre-processing which were replicating ourover the engineering design of us. **EP2** is addressed. • We can recognize the issues that we are encountering, such as glass and plastic detection, even though they both look the same. **EP4** is addressed. • To ensure that outside concerns are handled by professional engineering standards and best practices, we concentrated on making our system understandable and maintaining the code standard. so that the user may easily obtain recognition and detection. **EP5** is addressed.
CO 6	Assess and address societal, health, safety, legal, and cultural aspects related to the implementation of the capstone project, considering the relevant professional and engineering practices and solutions.	Social and Environmental Impact of Engineering [**K7**] • In our project, we did not employ any illegal phrases or software. Our system has no negative consequences for social or environmental engineering. We incorporated new and sustainable technologies into our	Social and Environmental Impact of Engineering [**EP2, EP5, EP6**] • In our traffic sign detection project, we applied a range of deep learning models and did the pre-processing that conflicted with our engineering design. EP2 is addressed. • We focused on making our system understandable and maintaining the code standard so that outside issues are covered by professional engineering standards and rules of practice So that it

		system's processes. Our system is risk-free, and the information we provide is accurate, trustworthy, and real, with valid references. We ensure that the system is safe and that our execution is adequate for health. In laboratory, test, and experimental processes, the application is safe. K7 is addressed.	would be easy for the user to classify the objects. **EP5** is addressed. • We collected different types of traffic signs to study the system and find some requirements that we didn't see in our reviewed papers. So, we set the objective of our project based on those requirements. **EP6** is addressed.

CSE400-C

Program Outcomes:

PO7 (Environment and Sustainability): In our entire project, no harmful elements or devices were used. There is no negative influence on soil, water, or air. This work hasn't used any harmful materials, and it won't in the future either. Any traffic sign detection organization can use this technology to detect traffic sign. Our project also doesn't require a lot of electricity, so we can say that the project is also sustainable.

PO8 (Ethics): In our project, we were always concerned about ethics. The image dataset was collected from different roads, random places in the environment, etc. Secondly, we captured some images from Hatir Jhil, Dhaka, manually. We preprocessed those images to get the appropriate dataset for this project. All the images in this article were taken for research purposes only.

PO9 (Individual Work and Teamwork): Even though we each contributed to this project, it required teamwork to develop. This project's implementation required solid skills in web programming, deep learning, and digital image processing. Our collective expertise was acquired to complete this project.

P10 (Communication): Offline meetings at the university have been the main form of communication for this project. A Google Meet online meeting was a backup plan for this project. Since everyone involved in the project is close to one another, there was no communication breakdown.

P11 (Project Management and Finance): We were always working on this project under the direction of our supervisor. We used the Work Breakdown Structure (WBS), Earn Value Management (EVM), budget, and Cost Calculation for project management. Each task had a time limit, and we completed them all by that time. This is how we were able to complete our work on schedule. Although we estimated the cost for commercial use, this project had no significant costs. The project's participants self-funded any costs that were necessary.

P12 (Life-Long Learning): We have put the ideas we learned in our previous courses into practice in this project. Throughout the project, we also learned a few additional ideas. Along with these, we also learned some fundamental skills like problem-solving, critical thinking, and communication that will be useful in the future.

CO	**Details**	**Knowledge Profile (K)**	**Engineering Problem (EP)**
CO7	Our capstone project follows the idea that environmental protection should come first when beginning any project. There is no chance of harmful substance release or detrimental environmental impact because our program is computer-based. The camera, PC, and software, along with all other necessary tools	**(i)** Ethical principles and practices [**K7**] • Our project is aimed at addressing a common problem faced by drivers and passengers, which is a big concern now a days. By providing a simple and efficient way to detect traffic sign, our system can help save time and secure travel and simplify the process of identifying traffic sign. Therefore, it has a great	**(i) Societal and environmental context [EP2, EP5, EP6]** • In real time driving , the drivers may not operate the system due to a lack of familiarity with technology. **EP2** is addressed. • We have taken steps to ensure data safety and integrity for users. **EP3** is addressed. • The project has been developed in accordance

	and equipment, do not pose a threat to the environment. It is safe to say that our project will not harm the environment.	impact on society. **K7** is addressed.	with the requirements of the stakeholders. **EP3** is addressed.
CO8	We carefully considered the project's ethical implications as we began preparing it. We used two separate data sets as our project required a lot of traffic sign pictures to train our model. The image dataset was collected from different roads, random places in the environment, etc. Secondly, we captured some images from Hatir Jhil, Dhaka, manually. We preprocessed those images to get the appropriate dataset for this project. All the images in this article were taken for research purposes only.	**(i)** Ethical principles and practices **[K7]** • We have given the importance of ethics and public safety a lot of thought throughout the entire project. We have taken steps to ensure that our project will not have a negative impact on society. **K7** is addressed.	

C09	The development of this project was a collaborative effort, with each team member contributing according to their strengths and abilities. Through effective teamwork, we were able to successfully complete the project. This experience taught us the importance of open communication among team members and the need to consider each other's viewpoints to achieve the desired outcomes.		
CO10	Our capstone project report is comprehensive and includes a detailed analysis of the project's design and implementation. We have provided a thorough description of the specific aspects of our project's design and implementation in the		

	relevant section of the report.		
CO11	Our project was of considerable size and required a significant amount of time to complete. However, we organized our project work effectively and prioritized timely submission as a crucial aspect of the project. Through good teamwork, we were able to adhere to the project schedule and ensure that the project was completed and submitted within the allotted time frame.		
CO12	Our experiment involved the use of new concepts that we had to apply to complete the project successfully. In addition to these new concepts, we also incorporated existing knowledge to develop		

	the final software application. This practical application of knowledge has enabled us to create a solution that helps users detect traffic signs efficiently.		