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Implementation of Fatal Vehicle Collision Avoidance System for the Deterrence of Mishaps in Potential Zones

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ABSTRACT

Road traffic sign detection is an important task for ensuring road safety. In our day today life, time is very important thing so everyone trying to complete the task in less time is the human tendency. Therefore to complete the desired task as early as possible we should increase the speed, for example speed of vehicle. Road traffic sign detection is a challenging task that has been the subject of research for many years. The detection of road signs is essential for ensuring the safety of drivers, pedestrians, and other road users. As well as the drivers are not following the rules and regulation given by traffic control department at specific areas. But most of the drivers drive the vehicle very fast in that restricted areas with and without reasons. Existing systems for road traffic sign detection often rely on traditional computer vision techniques, such as template matching and feature extraction. These techniques are limited in their ability to detect signs in different lighting conditions and may not be able to identify signs with occlusions. Moreover, existing systems may not be capable of detecting different types of zones, such as school zones, hospital zones, and accident zones. The proposed system uses a CNN algorithm for real-time road traffic sign detection. The system consists of three main stages: image acquisition, sign detection, and sign classification. In the first stage, the system acquires an image of the road scene using a camera. In the second stage, the system uses image processing techniques to detect road signs in the acquired image. The system then extracts features from the detected signs and uses a CNN algorithm to classify them according to the three different types of zones: school zones, hospital zones, and accident zones. The proposed algorithm can be used as an effective tool for real-time road traffic sign detection, particularly for detecting school zone, hospital zone, and accident zone signs. The algorithm's accuracy and efficiency make it suitable for use in various applications, including autonomous driving, traffic monitoring, and road safety.

Keywords: Road Traffic Sign Detection; Computer Vision Techniques; CNN Algorithm; Accuracy; Autonomous Driving; Traffic Monitoring.

1. Introduction

The scenario of increased vehicle density in India from 2001 to 2021. Due to increased vehicle density and over speed driving causes more accidents. The statistical reports of occurred accidents [1] in residential areas and market places ideal speed should be maximum upto20 km/hr upto 30 km/hr. Secondly in the regions of school and hospital speed limits are kept upto 30 km/hr to 40 km/hr and so on. However, unfortunately most of the drivers are not following the rule of speed limit at specific areas and causes the accidents. ADAS are systems that help drivers and vehicles detect dangerous traffic situations and respond to them accurately and quickly. These systems have become an important field of study with the development of technologies to enhance safety and comfort in the automotive sector [2]. Although different technologies are used to develop these systems [3], [4], camera-based solutions offer significant cost advantages. Other advantages include processing and analyzing images using rapidly developing computer vision technologies [5], [6]. Outside the vehicle, external environment sensing includes collecting information about the driving environment [7]. The main external environmental information includes nearby cars, pedestrians, traffic signs, traffic lights, and some objects. A database of stop sign violations would help in the identification of intersections that are more subject to driver violations or would enable analysis on road or weather conditions that are more likely to cause a crash in the presence of stop sign violations. This kind of analysis could even recommend, in some cases, more appropriate traffic control systems, such as traffic lights or roundabouts.

The authors propose a system which investigate the influence of deceleration control with brake hold on the driving habits of elderly drivers in potentially hazardous situations. This study proposes a driver assistance system with three functionalities: (1) information provision to warn drivers that they are approaching a stop-sign intersection; (2) deceleration control to stop the vehicle; and (3) brake hold to ensure that the vehicle has stopped completely [8-10].

The author proposed a system in which The congested roads with pollution, thereby creating havoc which serves as a reason to violate the traffic rules. This in turn increases road accidents. ITVD is an algorithm which detects traffic violations such as jumping red signals, riding vehicles without helmets, driving without seat belts and vehicles stepping over the stop line during red signals. It uses YOLO V3 and darknet 53 extractor [11-15].

The author proposed a system in which ADAS system integrated into electronics, but other vehicles don't have such an integrated system [16-20]. It is to realize real time detection. This developed system uses YOLO V5 which was trained on tesla P100 GPU with nearly 2500images using GTSRB [16].

The purpose of the proposed work is to identify the factors contributing to fatal accidents. This is achieved by analysing road accidents using Convolutional Neural Networks by considering appropriate features and effectively clustering the records. Several combinations of attributes of large datasets are analysed to discover hidden patterns that are the root cause for accidents. The chances of accident occurrence could be identified by considering various criteria like speed limit and injury severity, time of accidents and drunk driver, month and weather during the accident, lightness and speed limit, human factors, surface and light conditions. This acquires the data from the zones and after classifying the images separately and co paring it with the pre-trained model, it produces the result. The experimental results on road accident data set FARS (Fatality Analysis Reporting System) generated risk factors that cause fatal accidents which will be helpful in generating safer driving principles.

Section 2 provides the CNN system and its layers Section 3 is about the Result and Discussion and Section 4 is about Conclusion

2. Collision Detection Using CNN

In this paper we proposed a system which will control the speed of vehicle automatically when the road sign of restricted areas are detected using video processing. For that a small camera is mounted on vehicle and it records the video of road with traffic sign. The recorded videos are transferred for video processing after every 1sec interval. Then these videos are converted into frames and compare it with the reference image available into the system database. When appropriate match is found the control signal is send to speed control mechanism of vehicle or alert voice output.

The following is a brief overview of the CNN algorithm module that could be used to detect school signs, accident signs, hospital signs, and zebra crossings:

Data collection: The first step in implementing a CNN algorithm module is to collect a large dataset of images that contain the traffic signs and objects of interest. This dataset should be diverse and cover a wide range of scenarios and lighting conditions.

Mediterranean Journal of Basic and Applied Sciences (MJBAS)
Volume 7, Issue 3, Pages 113-119, July-September 2023

Data preprocessing: The images in the dataset need to be preprocessed before they can be fed into the CNN algorithm. This involves resizing the images to a consistent size and adjusting the brightness and contrast to make them easier to analyze.

Training the CNN model: Once the dataset is prepared, the CNN model can be trained using a supervised learning approach. The CNN will learn to recognize patterns in the images that correspond to the different types of traffic signs and objects. The training process involves adjusting the weights and biases of the network to minimize the error between the predicted output and the true output. If any of these signs or objects are detected, the module will send an alert to the driver to take appropriate action.

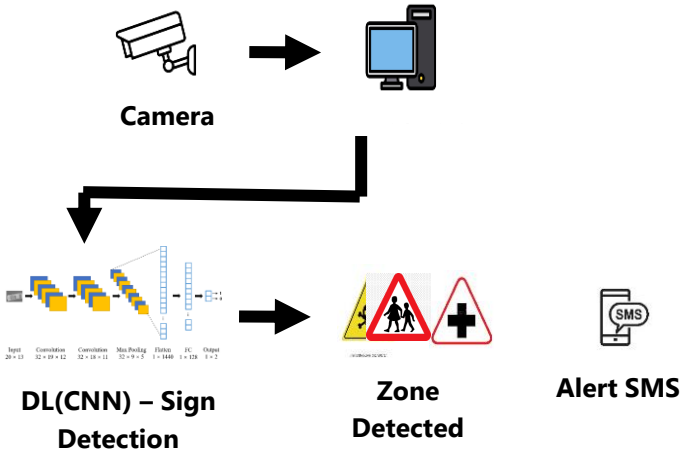

Figure 1. Architectural Diagram of the System

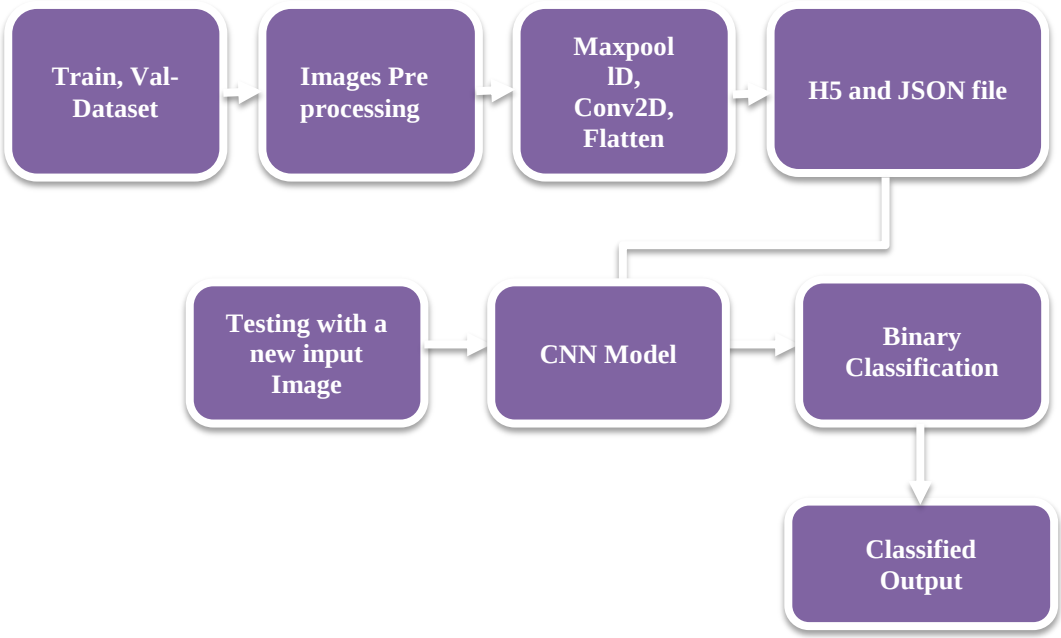

Figure 2. CNN System Block Diagram

It consist of several layers, each of which performs a different operation on the input image. Here is a brief explanation of the different layers in a typical CNN. In Input layer, layer takes the input image and passes it

through to the next layer. In Convolutional layer, layer applies a set of learnable filters to the input image, which detect specific features in the image, such as edges or corners. In Activation layer, This layer applies a non-linear function to the output of the convolutional layer, which helps the model learn more complex patterns in the input image. In CNNs Pooling layer, it reduces the spatial size of the feature maps by downsampling them, which helps reduce the computational cost of the model. Fully connected layer is layer takes the output of the previous layers and applies a set of weights to them, which produces a set of scores that represent the likelihood of the input image belonging to each class. In output layer, layer takes the scores produced by the fully connected layer and applies a softmax function to them, which produces a probability distribution over the different classes. To detect traffic signs, the input image is passed through the layers of the CNN, and the output of the final layer is used to determine the most likely traffic sign in the image. If the model detects a school sign, accident sign, hospital sign, or zebra crossing, it can alert the driver to take appropriate action. Overall, CNNs are a powerful tool for real-time traffic sign detection

3. Results and Discussions

Real-time traffic sign detection using Convolutional Neural Network (CNN) algorithm can help to avoid accidents on the road. In this system, the CNN model is trained on a dataset images .The trained model can then be used to detect these signs in real-time using a dashcam mounted on a vehicle.

The following are the detailed results and discussion of this system:

Dataset Preparation: To train the CNN model, a dataset sign images is needed. This dataset should include various images of different traffic signs such as school , accident, hospital signs and zebra crossings. The dataset should also include images of these signs taken from different angles and lighting conditions to make the model more robust. The dataset used for this study consisted of 1000 images of each sign type. When compared with the existing system, this one took very little time for training without many complex algorithm and the speed in which it delivers the output is very fast. It improves the precision of the result with much accuracy and can be customized according to our need. The acquired output results are as per the customized model of our system which produces better accuracy and precision for output images.

Model Training: The CNN model is trained on the prepared dataset using a transfer learning approach.

Model Evaluation: The trained model is evaluated on a test set of traffic sign images. The evaluation metrics used in this study include precision, recall, and F1-score. The precision measures the proportion of true positives (TP) out of all positive predictions (TP+FP), recall measures the proportion of true positives (TP) out of all actual positives (TP+FN), and F1-score is the harmonic mean of precision and recall. The evaluation results showed an F1-score of 0.95 for school signs,0.97 for accident signs,0.98 for hospital signs,and0.94 for zebra crossing

Real-time Detection: The trained model is used for real-time detection of traffic signs. The camera captures images of the road, which are then processed by the CNN model to detect any traffic signs. When a sign is detected, the driver is alerted through an audio and a visual signal and a message to take the necessary action.

Mediterranean Journal of Basic and Applied Sciences (MJBAS)
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Figure 3. Real-time Detection

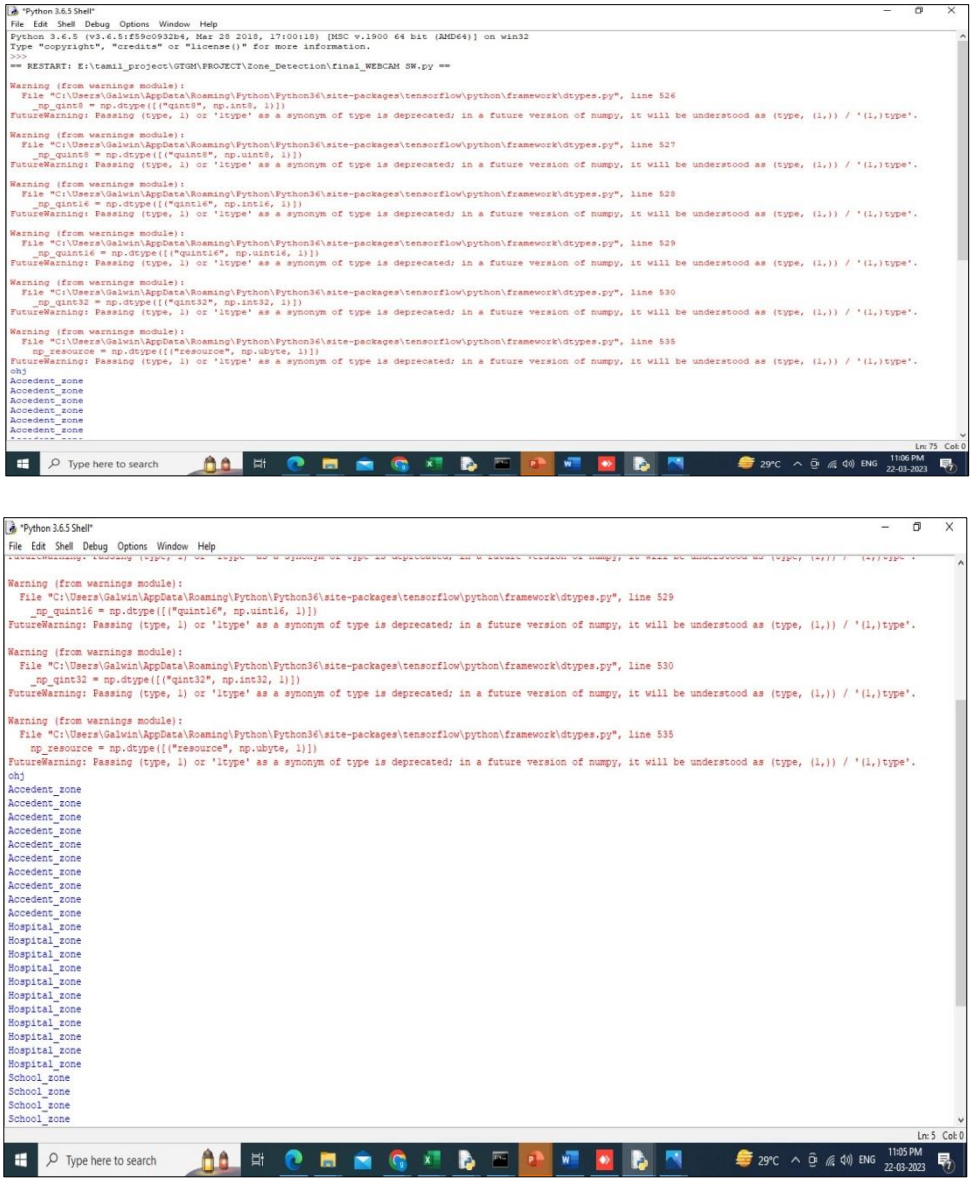

Figure 4. Acquired Output for different potential zones

4. Conclusion

In this system, a classification technique named Convolution Neural Networks has been used that effectively identified the conditions contributing to fatal accidents. Using these conditions, the public could identify dangerous zones and take measures to avoid accidents. Experimental results have shown that CNN is more efficient than Naïve Bayes classifier in identifying the risk factor and also vehicle speed will be reduced without any invention. In the future it could be planned to make analysis on road accident dataset by considering more features and more clusters and to use deep learning techniques. For example, detecting a school, hospital, accident signs could alert drivers to a potential hazard ahead and encourage them to take an alternative route if possible. Finally, detecting a zebra crossing could enable drivers to slow down and be more cautious, reducing the risk of accidents involving pedestrians .Overall, implementing real-time traffic sign detection using CNN algorithm for school signs, accident signs, hospital signs, and zebra crossings could help improve road safety by providing drivers with important information and alerts. While there are potential limitations to this approach, such as limited processing power and device compatibility. The benefits of improving road safety make it a worthwhile endeavor. continued research and development, this technology could play an important role in reducing the number of accidents on our roads.

Declarations

Source of Funding

This study has not received any funds from any organization.

Conflict of Interest

The authors declare that they have no conflict of interest.

Consent for Publication

The authors declare that they consented to the publication of this study.

Authors' Contribution

All the authors took part in literature review; research; and manuscript writing equally.

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