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A CNN- POWERED TRAFFIC SIGN DETECTION AND VOICE ALERTING SOLUTION

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Abstract: Traffic signs that appear on the road are an important part of our lives while driving. They provide basic data to road customers. Traffic sign detection plays a crucial role in intelligent transportation systems to enhance road safety and assist drivers in adhering to traffic regulations. Negligence in viewing and interpreting traffic signboards is a major cause of road accidents. In this project, we propose a system for traffic sign detection using Convolutional Neural Network (CNN). The system leverages the power of deep learning and image processing techniques to accurately detect traffic signs.

I. INTROUDCTION

The detection and interpretation of traffic signs play a critical role in maintaining road safety and preventing accidents. Traffic signs serve as important visual cues that provide essential information to drivers, guiding them on speed limits, road conditions, and other crucial regulations. However, human error in perceiving and comprehending these signs can lead to serious consequences. To address this challenge, we propose a project that focuses on traffic sign detection using Convolutional Neural Network (CNN) technology.Convolutional Neural Networks have revolutionized the field of computer vision by demonstrating exceptional capabilities in image recognition and classification tasks. By leveraging the power of deep learning and CNN algorithms, we aim to develop a system that can accurately detect, classify, and interpret traffic signs.

Problem Statement

The problem addressed by this project is the need for accurate and efficient traffic sign detection. Negligence in viewing and interpreting traffic signboards can lead to road accidents and violations. Traditional methods of traffic sign detection may lack the robustness and accuracy required to handle variations in lighting conditions, weather, and sign designs. Therefore, there is a demand for a reliable system that can accurately detect and classify traffic signs in real-time, providing timely alerts and aiding decision-making for drivers. The project aims to develop a traffic sign detection system using Convolutional Neural Networks (CNN) to address this problem and enhance road safety by ensuring the proper recognition and interpretation of traffic signs.

PRELIMINARY ANALYSIS & INFORMATION GATHERING

The detection and interpretation of traffic signs are fundamental to ensuring road safety and efficient traffic management. Traffic signs provide critical information to drivers, such as speed limits, road hazards, and directions, enabling them to navigate safely and adhere to traffic laws. However, human limitations in perceiving and interpreting these signs, particularly in complex or high-speed driving environments, can lead to accidents and violations. Traditional methods of traffic sign recognition, which rely on human observation and manual monitoring, are often insufficient and prone to errors. This necessitates the development of automated systems that can accurately and consistently recognize traffic signs, thereby supporting safer driving practices and enhancing road safety[1].

In recent years, Convolutional Neural Networks (CNNs) have emerged as a powerful tool in the field of computer vision, demonstrating remarkable success in image recognition and classification tasks. CNNs are particularly well-suited for traffic sign recognition due to their ability to automatically learn and extract relevant features from images. Leveraging deep learning and CNN algorithms, this project aims to create a machine learning model capable of accurately detecting and classifying traffic signs from image data. By training the model on a diverse dataset of traffic sign images, the project seeks to develop a robust and reliable solution that can serve as a foundational technology for future real-time applications in autonomous driving, advanced driver assistance systems, and traffic management.

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II. LITERATURE SURVEY

1. Detection of Traffic Sign Using CNN

https://www.researchgate.net/publication/361142189_Detection_of_Traffic_Sign_Using_CNN
Authors: Simran,Sristi Tandon,Shilpi Khanna,Radhey Shyam
For past more than half of the decade, the detection and recognition of the traffic signs are an active research area. Specially in the field of automation of driving that is critical for driverless driving, as there is drastic increase in road accidents due to ignorance of traffic signs and rules. This is frequently used for recognizing permanent or temporary various road signs which are displayed on the side of every small and long road. A complete recognition system may consist of detection of traffic sign as well as their recognition. The detection of traffic sign as well as their recognition is typically used on portable devices.[11]

2. Traffic sign recognition using convolutional neural networks

https://ieeexplore.ieee.org/document/8238205
Authors: Kaoutar Sefrioui Boujemaa,Ismail Berrada,,Afaf Bouhoute,Karim Boubouh
Traffic sign recognition (TSR) represents an important feature of advanced driver assistance systems, contributing to the safety of the drivers, pedestrians and vehicles as well. Developing TSR systems requires the use of computer vision techniques, which could be considered fundamental in the field of pattern recognition in general. Despite all the previous works and research that has been achieved, traffic sign detection and recognition still remain a very challenging problem, precisely if we want to provide a real time processing solution.[12]

3. Traffic sign classification using CNN and detection using faster-RCNN and YOLOV4

https://www.sciencedirect.com/science/article/pii/S2405844022030808
Author : Njayou Youssouf
Autonomous driving cars are becoming popular everywhere and the need for a robust traffic sign recognition system that ensures safety by recognizing traffic signs accurately and fast is increasing. In this paper, we build a CNN that can classify 43 different traffic signs from the German Traffic Sign Recognition benchmark dataset. The dataset is made up of 39,186 images for training and 12,630 for testing. Our CNN for classification is light and reached an accuracy of 99.20% with only 0.8 M parameters. It is tested also under severe conditions to prove its generalization ability.[13]

4. TRAFFIC SIGN DETECTION USING CONVOLUTION NEURAL NETWORK A NOVEL DEEP LEARNING APPROACH

https://ijcrt.org/papers/IJCRT2005338.pdf
Authors: Bharath Kumar,N. Anupama Rani
The accident rate due to negligence of observing traffic signs and not obeying traffic rules has been increasing drastically. By utilization of synthesized training data, which are created from road traffic sign images allows us to overcome the problems of traffic sign detection databases, which vary for countries and regions. This method is used for the generation of a database which consists of synthesized pictures to detect traffic signs under different view-light conditions. With this data set and a perfect Convolutional Neural Network (CNN), we can develop a data driven, traffic sign recognition and detection system which has high detection accuracy and also has high performance ability in training and recognition processes. This ensures less occurrence of accidents and also helps the driver to concentrate on driving rather than observing each and every traffic sign.[14]

5. CNN Design for Real-Time Traffic Sign Recognition

https://www.sciencedirect.com/science/article/pii/S1877705817341231
Authors: Alexander Shustanov,Pavel Yakimov
Nowadays, more and more object recognition tasks are being solved with Convolutional Neural Networks (CNN). Due to its high recognition rate and fast execution, the convolutional neural networks have enhanced most of computer vision tasks, both existing and new ones. In this article, we propose an implementation of traffic signs recognition algorithm using a convolution neural network. The paper also shows several CNN architectures, which are compared to each other. Training of the neural network is implemented using the TensorFlow library and massively parallel architecture for multithreaded programming CUDA. The entire procedure for traffic sign detection and recognition is executed in real time on a mobile GPU. The experimental results confirmed high efficiency of the developed computer vision system.[15]

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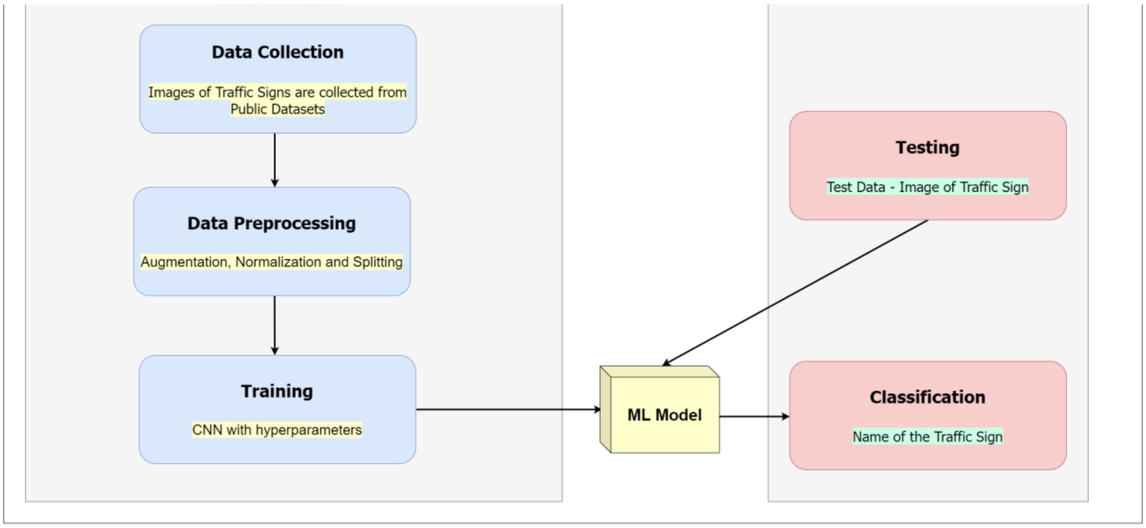
III. METHODOLOGY



1. PROPOSED METHODOLOGY

Convolutional Neural Networks (CNNs) are highly effective for traffic sign detection due to their ability to automatically learn spatial hierarchies of features from images. In this context, a CNN can be trained to identify and classify traffic signs by processing a large labeled dataset of traffic sign images. The process involves several key steps: collecting and preprocessing the data, designing a CNN architecture with layers such as convolutional, activation, pooling, and fully connected layers, and then training the model using these processed images. After training, the model is evaluated for accuracy and fine-tuned as necessary. Once the model achieves satisfactory performance, it can be deployed for real-time traffic sign detection in various applications like autonomous driving.

The CNN architecture typically involves multiple convolutional layers to detect features like edges and shapes, followed by pooling layers to reduce dimensionality and fully connected layers to make the final classification. By leveraging data augmentation techniques, the model can become more robust to variations in traffic sign appearance due to different lighting conditions, angles, and distances. The end result is a highly accurate system capable of recognizing traffic signs in real-world conditions, thereby enhancing the safety and efficiency of automated driving systems.

CNN Algorithm

The CNN algorithm is used to achieve the same and cross validated. The Cross Validation is a technique for evaluating machine learning models by training on subsets of dataset and evaluating on complementary subsets of dataset. In this CNN model, k-fold cross-validation divides the dataset into k parts of equal size, one part is kept for validation and remaining parts are used for training.

CONVOLUTIONAL LAYER

It always comes first. It receives the image (a matrix of pixel values). Assume that the input matrix's reaction starts at the top left of the image. The software then chooses the smaller matrix there, which is referred to as a filter. The filter then generates convolution that moves over the input image. The filter's job is to multiply the original pixel values by its value. All of these multiplications are added together, yielding a single number. The filter moves because it only reads the image in the upper left corner. Additionally, one unit on the right performs a similar operation. A matrix is created after passing the filter through all points, however it is less than the input matrix. From a human standpoint, this operation is comparable to distinguishing visual boundaries and simple colors. However, in order to recognize the fish, the entire network is required. Several convolution layers will be blended with nonlinear and pooling layers in the network. The first layer to extract features from an input image is convolution. Small squares of input data are used in convolution. It's a mathematical procedure with two inputs: an image matrix and a filter or kernel.[4]

- Dimension of an image matrix (h x w x d)
- A filter (fh x fw x d)
- Outputs a dimension (h-fh+1) x(w-fw+1) x1

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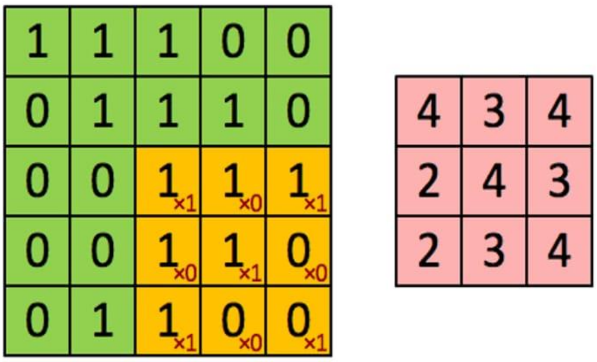
Consider a 5 x 5 whose image pixel values are 0, 1 and filter matrix 3 x 3 as shown in below

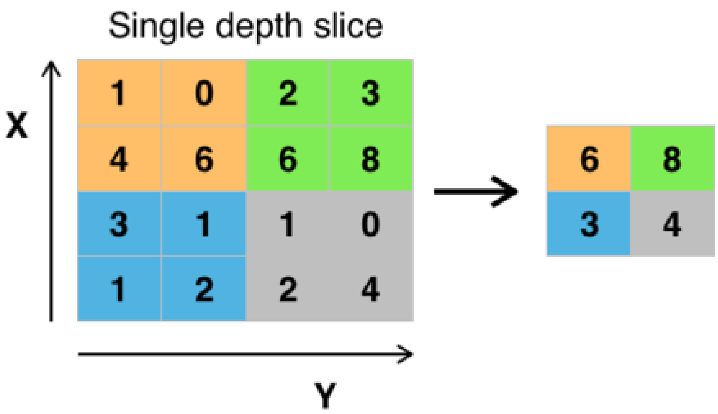
Convolution with a filter example

Then the convolution of 5 x 5 image matrix multiplies with 3 x 3 filter matrix which is called “Feature Map” as output shown in below

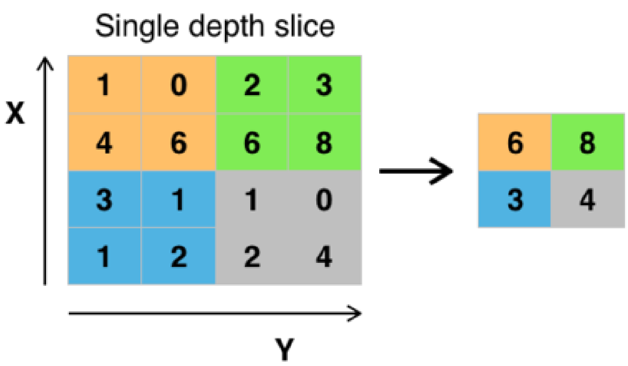


THE NON-LINEAR LAYER:

After each convolution process, it is adder. It features an activation function that provides a nonlinear property; without this trait, a network would be insufficiently intense and unable to simulate the response variable.



It moves in the same direction as the nonlinear layer. It works with the image's width and height, performing a down sampling procedure on them. As a result, the size of the image is lowered. This means that if some features were already recognized during the previous convolution operation, a detailed image is no longer required for further processing and is reduced into smaller images.



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FULLY CONNECTED LAYER:

It's primary to link an overall linked layer after completing the succession of convolution, non-linear, and pooling layers. This layer receives the convolution network's output data. When a completely connected, layer is attached to the network's end, it produces an N-dimensional vector, where Ni is the number of classes from which the model chooses the needed class.

CNN MODEL

- The TensorFlow framework and the OpenCV library were used to create this CNN model, which is widely utilized in real-time applications.
- This concept can also be used to create a full-fledged software that scans everyone entering a public meeting.

LAYERS IN CNN MODEL

1. Conv2D Layer
2. MaxPooling2D Layer
3. Flatten () Layer
4. Dropout Layer
5. Dense Layer

1. Convo2D Layer:

It has 100 filters and the activation function used is the 'ReLu'. The ReLu function stands for Rectified Linear Unit which will output the input directly if it is positive, otherwise it will output zero.

2. MaxPooling2D:

It is used with pool size or filter size of 2*2.

3. Flatten () Layer:

It is used to flatten all the layers into a single 1D layer.

4. Dropout Layer:

It is used to prevent the model from overfitting.

5. Dense Layer:

The activation function here is SoftMax which will output a vector with two probability distribution values.

IV. CONCLUSION

In conclusion, the project focuses on the development of a traffic sign detection system using Convolutional Neural Networks (CNN). The CNN-based approach offers numerous advantages, including high accuracy, robustness to variations, scalability, real-time performance, adaptability, and integration potential. By leveraging the power of deep learning, the proposed system can accurately detect and classify traffic signs, contributing to enhanced road safety and traffic management.

The successful implementation of this project paves the way for the deployment of advanced driver assistance systems, autonomous vehicles, and intelligent transportation systems that rely on accurate and efficient traffic sign detection. Overall, this project represents a significant step towards improving road safety and traffic flow through the effective use of CNN-based traffic sign detection technology.

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