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Implementation of e-toll using ML

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Abstract: In this, we will discuss how traffic problems can be reduced by implementing an automatic toll collection system. This system is based on image processing and image classification. It helps in maintaining the transparency of the toll collection system. The aim is to make a digital toll collection system that will be less time-consuming and automated monitoring and control of vehicle entry-exit on a highway using machine learning techniques. At the entrance of the toll, the gate camera captures an image of the vehicle and from the image, it creates a bounding box with probability estimates of the feature classes as output. We present a review of state-of-the-art traffic monitoring systems focusing on the major functionality of vehicle classification. The result is the use of machine learning for effectively detecting vehicles in electronic tolling systems in real-time.

Keywords: e-toll, ml for vehicle classification

1. INTRODUCTION

Electronic toll collection (ETC) is a wireless system that collects tolls automatically for vehicles utilizing toll highways, HOV lanes, toll bridges, and toll tunnels. It is a more efficient alternative to toll booths, which require vehicles to stop and drivers to manually pay the toll via cash or a card.

Vehicles that use the system are usually equipped with an automated radio transponder device. The radio transponder reads the RFID tags on vehicles passing via roadside toll scanners and sends the information back to the database. The toll fees are charged to the user through an electronic payment mechanism.

A big benefit is that a driver does not have to wait for long periods, which reduces traffic delays. Electronic tolling is less expensive than a manned toll booth, saving the government and private road owners money on transaction expenses. FASTag, for example, is an electronic toll collecting system administered by the National Highway Authority of India in India (NHAI). Toll payments are made directly from the savings account linked to the owners' account to the toll owners using Radio Frequency Identification (RFID) technology.

RFID tags are attached to the vehicle's windscreen and allow drivers to go past toll plazas without having to stop for transactions. Vehicle categorization systems can play a key role in the development of intelligent transportation systems, such as automated highway toll collection, perception in self-driving vehicles, and traffic flow control systems, with the exponential production of automobiles around the world.

Another method could be the implementation of ETC with the help of Machine learning. People can readily recognize and examine the objects in the image. Man's visual system is quick and precise, and it can handle difficult tasks like recognizing many objects and spotting barriers with rational thought. However, in computer vision, object recognition is one of the most difficult problems to solve since we must not only classify various images but also precisely identify the location of objects in each image. Object detection is the name for this flow mechanism.

Handcrafted extraction methods are used to get visual features from the input visual frame in the first step of a computer vision-based classification system. Machine learning classifiers are then trained on the retrieved features to perform classification on group-based data in the second stage.

2. EXPERIMENTAL METHODS OR METHODOLOGY

As shown in figure 1, for training data Supervised learning is used, where the different classes of vehicles like cars, buses, and trucks are being classified based on their training data. The training data is annotated on the makesense.ai website where the images correspond with bounding boxes. The images are augmented using roboflow, the images are preprocessed. The preprocessed images are given as input for the training model. The weights are extracted using the

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Yolo classifier. The results of the trained model will be obtained. The weights are used to classify and supervise vehicles in toll booths.

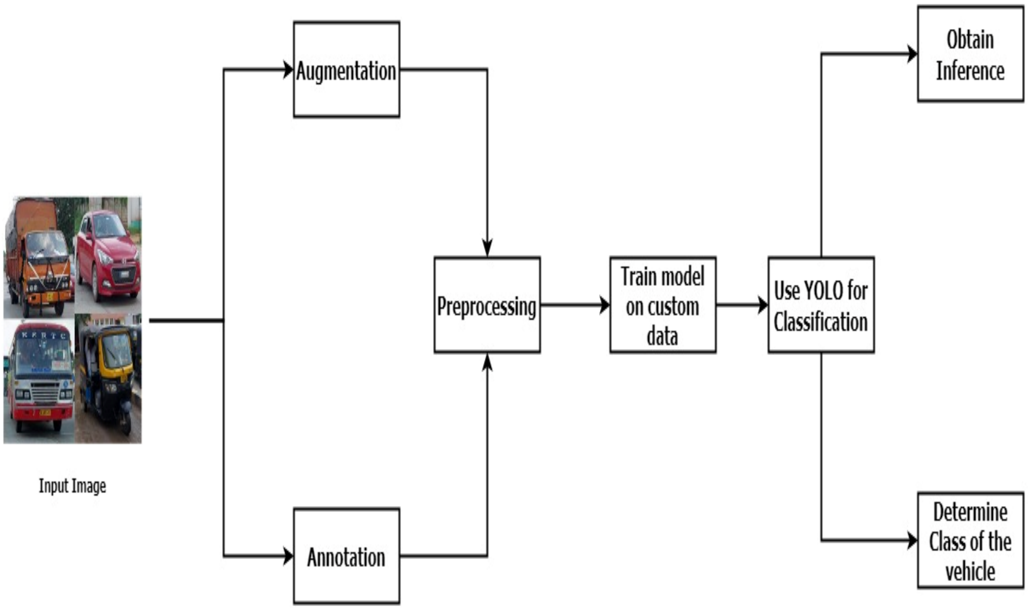

Figure 1: **Workflow of image classification**

3. LITERATURE SURVEY

- A deep learning-based classification system by Muhammad Atif Butt et.al, [1] suggested that addresses the shortcomings of existing approaches. The obtained data is utilized to train and validate the performance of five state-of-the-art CNNs like AlexNet, Inceptionv3, GoogleNet, VGG, and ResNet. By extending the effort to construct a fine-grained categorization system, future studies have to be done.
- Deepaloke Chattopadhyay et.al, [2] developed a model that tries to uncover more cost-effective techniques for detecting vehicles on toll infrastructure placement. The model contained and validated the applicability of machine learning techniques for real-time vehicle recognition (Tiny YOLOv3 and YOLOv3). The focus of future work will be on expanding the range of vehicle classifications.
- Detection and classification of the type of vehicle for the ETC system using YOLOv3[3] were carried out by conducting extensive experiments that were used to validate the suggested model. Network resolution in the configuration file was raised during the pre-training stage to increase precision.
- A system was devised by Mithya V et.al, [4] in which a webcam captures the image of a car passing through a tollgate, which is then interfaced with a Raspberry Pi. The barrier will remain closed if the appropriate amount is not deducted correctly. Otherwise, the barrier will open, allowing the vehicle to exit the tollbooth.
- The Raspberry Pi system was employed by T.Madan Mohan et.al, [5] with the goal of making a less time-consuming toll collection and also monitoring and controlling the vehicles entering the highways. Extended use of the technology could include spotting stealing vehicles and reporting them to the nearest station. The method for detecting and locating cars by V. Vijayaraghavan et.al., [6] designed a convolution neural network that was built from the ground up to classify and detect objects using CNN. The results of the experiment showed that the proposed approach can improve detection accuracy. Future research will concentrate on using noise as a pre-processing step.
- Mohammad O. Faruque et.al, [7] worked on research that aimed to classify vehicles in videos, which has a wide range of applications in intelligent transportation and smart cities. Three training data sets are manually prepared from two videos to train the Faster R-CNN and the YOLO. The performance of generalization (one of the deep learning's drawbacks) is explored.
- A Comparison of the K Means, K Means++, and Artificial Neural Networks (ANN) methods were made by Mrs. Sujatha D Badiger and colleagues [8] for vehicle categorization. Among the other algorithms tested, CNN was found to have the highest accuracy. To make the forecast, several data fusion feature extraction strategies from different sensors were not examined.
- Sumathi S M et.al, [9] created an Automatic Toll Tax system to help manage traffic congestion. When the car passes through the toll gate, the RFID reader will automatically deduct the toll tax from the user's account.

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- A cutting-edge traffic monitoring system was reviewed by MYOUNGGYU WON[10]. It was mostly concerned with vehicle classification. Because the system overlooks other performance indicators, further study will concentrate on the cost of maintenance and installation, the capacity to categorize overlapped cars, and the system's long-term viability.
- Selim S. Sarikana et.al, [11] built a system that classifies vehicles solely in their designated lanes using image processing and machine learning techniques Time warping was used to compensate for traffic speed fluctuations. Motorcycles and cars can be differentiated using this way. Different types of vehicles will be detected in future research.
- Using an Embedded Linux development kit, Mr.Abhijeet Suryatali et.al, [12] created a system. Vehicles are classified as light or heavy depending on the amount of space they take up. The variance threshold between foreground and background was an important element to consider. The planned system was implemented using the Embedded Linux platform, which proved to be quite useful.
- Dr. Khali Persad et.al, [13] produced vehicle identification/registration system suggestions. The benefits and costs of ETC were discussed, as well as the current deployment of ETC in the United States. Sensors, video-tolling systems, and RF transponder systems were discussed as mature ETC technologies. They concluded that mileage-based tolling would be the way to go in the future.

An extensive literature survey covering numerous research issues, techniques, and hardware design, related to e-toll has been carried out and we found that still there is a scope for improvement in the implementation of the e-toll system. A variety of research challenges and prospective research areas were also presented. Hence, we are proposing a methodology with certain improvements in the previously accomplished work.

CONCLUSION

The proposed automated vehicle classification system will provide an e-toll to discriminate between different vehicle kinds using machine learning. An evaluation of traffic monitoring systems will be provided with a focus on vehicle key functions and expanding the range of vehicle classifications. We expect a wealth of information on practically all vehicle classification schemes that have been established in the past. Academia, industry, and government organizations will be able to use these resources to make decisions in the coming decade. The existing methods lack in the classification of vehicles and our proposed work intends to provide proper vehicle classification solutions for traffic monitoring applications. Software-based approaches, notwithstanding their benefits, have some disadvantages. Video processing is constrained by processing time, and ambient lighting has an impact on total performance.

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