# Portable roadside sensor system for vehicle classification, counting, speed measurement

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Abstract: The paper focuses on the enhanced automated system consist of a portable roadside sensor system for vehicle counting, classification, and speed measurement. The sensor system consists of wireless automated system that do not require to be in the roadway but it can be implemented by connecting sensor nodes at roadside —the devices are placed next to the roadway and hence it can measure the speed as well as count number of vehicles in absence of manual interference and also can measure the traffic of adjacent lane. This algorithm and image processing system based on controller model with the help of sensors make the system more robust to the errors with accurate results and fully automation of the system helps to classify larger vehicles which are driving in the nonadjacent lane as well as in the same lane so that we can easily identify the traffic in lanes and can take perfect measures for that. The proposed system can make this traffic solving in more simplicity as well as the application of toll can also be extended on this using speed measurement and counting of vehicles. Signal processing algorithms based on an analysis of the vehicle indents it becomes easy to clarify between the type of vehicle whether it is light or heavy vehicle.

Vehicle classification is done based on the physical parameters and an estimate of the average magnetic heights of the vehicle considering all dimensional parameters of the vehicle. Vehicle length is estimated from the product of occupancy and space and estimated speed is calculated with the help of IR sensors along the roadside. Data analysis is presented from a large number of vehicles on a regular busy urban road and can also be applicable for toll applications and smart city projects.

Keywords: Magnetic sensors, portable traffic sensor, road-side traffic sensor, vehicle classification, vehicle detection, vehicle speed measurement, Toll application with fee classification.

## INTRODUCTION

This paper describes a portable sensing system that can be placed adjacent to a road and can be used for vehicle counting, vehicle classification, and vehicle speed measurements and also the application of it can be extended to Toll application for fee calculation and analysis of raw data can be done using captured information. The proposed system can make these traffic measurements reliably for traffic in the lane adjacent to the sensors. The developed automated sensing system is compact, portable, wireless, and inexpensive and serves for daily transportation system and helps in traffic control and Toll fee calculation.



### Fig:1General overview

Image processing using Matlab or any other Softwares for a vehicular system is a widespread technology used by many transportation agencies in smart cities for vehicle detection and measurement of traffic flow rates and speed measurements so that manually occurring accidents they can also be reduced with the help of SMS system. Single inductive loops, by themselves, do not measure individual vehicle speed hence here we are using IR sensors so that we can get know calculation in terms of distance and time and finally the speed of the vehicle. Vehicle classification into predefined classes such as Heavy vehicle and light ehicle:- cars, trucks, and tractor trailers typically requires measuring the size or length of a vehicle and/or counting the number of axles of the vehicle and also the vehicles can be classified on its GVM parameter. If the vehicle is below 5 Tonne it is termed as Light vehicle and if it is more than 5Tonnes then it is heavy vehicle. A vehicle classification model based on feature extraction from piecewise slope rate values in single-loop signature data is pursued in and classified vehicles into 15 classes as well as using RFID we are detecting vehicle information for future use. However, the accuracy rate is not 100% and can vary from 40% to 100%, depending on the amount of fluctuations in data present in the sensor readings and the class of vehicle under consideration.

Vehicle detection and classification based on feature ex-traction, sampling of image using various softwares from camera systems

have been developed by many researchers [2], [3]. The research [3]which is presented is totally model-based and fuzzy-logic and it approaches to improve the reliability an efficiency of such systems. An evaluation of three commercial camera-based vehicle detection systems is presented in [4] under adverse weather conditions of snow, fog, and rain. The results therein it shows that the performance of such systems deteriorates under adverse weather conditions, particularly under snow conditions in both daytime and nighttime clarification of the predefined results is too less.

Magnetic sensors and anisotropic magneto-resistive (AMR) sensors have also been evaluated for vehicle classification by some research groups and this system is also successfully operating in different domains [5]. The main limitation of these works is their inability to distinguish between sedans versus sport utility vehicles (SUVs), pickups, and vans as these all are light vehicles so identification is too difficult. Mostly, these two classes are combined, or poor classification rates are obtained when these are considered as individual classes. Furthermore, the magnetic sensors that have been evaluated are based on devices that were directly embedded in the roadway lanes and also the extension is with capturing the image in database and comparing the two samples.

Unlike inductive loops and magnetic sensors that have been evaluated, the sensing system proposed in this paper does not require devices to be embedded in the roadway. Instead, it utilizes sensors that are placed on the side of the road, and hence, there is no need to stop the traffic for their installation and also the camera is used so as to capture samples of vehicle so that vehicle class can be easily identified . In addition, the sensor system used is very compact and wireless and can provide very high accuracies in vehicle detection, speed measurement, and classification. Here RF ID's are also used with each individual vehicle separately so that the data can be managed in appropriately when and where required.

# 2. Literature Survey

Portable roadside sensors for Vehicle counting, Classification, and Speed Measurement" Saber Taghvaeeyan and Rajesh Rajamani focused on the development of a portable roadside magnetic sensor system for vehicle counting, classification, and speed measurement. A low-cost image processing algorithm in the field of traffic-information acquisition, one pervasive solution is to use wireless sensor networks (WSNs) to realize vehicle classification and counting, the wireless sensors can be connected at different nodes and then later they can be connected to a server which can control II the nodes that are working at output nodes. By adopting heterogeneous sensors in a WSN at base station and server station, we can explore the potential of using complementary physical information to perform more complicated sensing computation efficiently.

Sensor fusion based vacant parking slot detection and tracking Jae Kyu Suhr, Ho Gi Jung, This paper focuses on automated detection of a vacant parking slot detection and tracking system that fuses the sensors of an AVM system and an ultrasonic sensor-based automatic parking system. This paper presentes t 1) parking slot markings can be successfully detected and tracked by fusing two off-the-shelf parking aid systems without any manual interference, 2) parking slot markings can be reliably detected in AVM image sequences processing by combining sequential detection results, 3) occupancy of parking slot can be efficiently classified by treating each parking slot region as a occupancy grid so that it becomes easy to identify the space to park the vehicle at appropriate place.

"Prediction of short term traffic variables Using Intelligent Swarm based Neural network" B. Abdulhai, H. Porwal, and W. Recker, In this paper they have provided traffic flow forecasting information for traffic management in order to reduce traffic congestion and increase the mobility of transportation. The paper also presents an innovative algorithm using integrated particle swarm optimization with the help of artificial neural networks to develop short-term traffic flow predictors.

🔶 : GPS Sensor	<b>67</b> → <b>6</b> 3
AMR Sensors	Measured Distance

Fig 2: Sensor configuration for data collection.

As per the figure 2, the sensors1 and 3 are perfectly aligned with the side of the road and a vehicle passes precisely parallel to the sensors. Therefore, the signal readings of sensors 1 and 3 should be exactly identical, except for a delay that is used for speed estimation. If we assume that the sensors are not perfectly aligned. There are two methods for speed estimation:-1.Conventional and 2.Cross-correlation method

While comparing the conventional and cross-sectional method, the error range has been reduced from 12% to only 3.5%. Considering the errors of the proposed method an offset is observed which means that the estimated speed is overestimating the actual speed. This happens because of improper alignment of the sensed.

# **3. SYSTEM MODEL**

### **Proposed Research Work**

### 1. Signal strength and sensing system:-

A vision-based traffic analysis system it consists of many components such as the image can be captured using camera real-time basis and on those picture components segmentation, shadow removal, feature extraction and tracking processes are carried out. In order to count the vehicles and classify vehicles, there is a module to detect and separate individual vehicles for each foreground segment. The RFID sensors will sense the vehicle, store its information and later after speed measurement at toll the particular vehicle needs to pay toll fee as well as the fine if applicable. This module could be conducted after feature extraction or tracking. IR Sensors are placed a particular distance from each other at road side the vehicle passes b one sensor to other that is detected and hence by using time and distance formula calculation we can find out the exc speed of the vehicle.

### 2. Vehicle detection and counting system:-

The recorded signals at the nodes from the sensors placed adjacent to the road are more uniform compared to the case that the sensors are on the road. This behavior makes the detection more reliable, because large oscillations in the signals can cause errors due to the double detection of a single vehicle and the same vehicle passing by at the same time in same lane cannot be properly detected hence proper measures are been taken by using segmentation of the vehicle. IR sensor detects the vehicle and the combination of two IR sensor helps in determining the distance and time ratio i.e speed. The counting of vehicles are done by RFID's and simultaneously it also saves the information of each vehicle in database.

# 3. Robustness to traffic on the non-adjacent lane :-

While measuring traffic parameters on the lane adjacent to the sensors, the signals from vehicles that are passing by the non-adjacent lane (the lane next to the closest lane to the sensors) are also recorded. Analyzing the data, it was observed that passenger sedans, SUVs, and pickups that travel in the nonadjacent lane typically do not create errors in the sensing system signals. However, larger vehicles (e.g., trucks and buses) that pass in the nonadjacent lane may create large enough signals to cause false detections and affect the accuracy of the system because of their physical parameters that varies from light to heavy vehicle. The false detections can significantly increase the detection error and hence causing faults at next stages.

### 4. Speed estimation:-

Speed estimation of a passing vehicle is required to measure the length in terms of distance, which is used for vehicle classification. Speed estimation also has other applications; for example, it has been used by researchers to estimate the distance and time so as to know the. speed of vehicle and will help in calculation of toll fee. Transportation agencies use estimated speed information for setting speed limits and timing traffic signals. There are some proposed methods in the literature for speed measurement, to measure individual vehicle speed, two longitudinally spaced sensors are required, here we are using. The two IR sensors conventional method for estimating speed with two magnetic sensors is based on the detection times of the two sensors. If the detection times for sensors "A" and "B" are *TA*, *ON*, *TA*, *OFF*, *TB*, *ON*, and *TB*, *OFF*, an estimate of the speed can be calculated as:-



# 5. Vehicle classification:-

Vehicle classification is useful in a number of applications, including roadway maintenance and management, roadway design, emissions evaluation, multimode traffic model development, traffic control, traffic signal design, and toll application systems development. For example, the distribution of passing vehicles on a road is used in the estimation of pavement life cycle using sensor nodes .There are different vehicle classification methods proposed in the literature based proposals like physical parameters, GVM values, axle based, etc. In general, the main drawbacks of using inductive loops are the high cost, the long installation process, and the intrusive nature of sensor installation. The load cells also helps in vehicle classification based on weight parameter.

The classification method proposed is based on using the magnetic length and an estimate of the average vertical height of the passing vehicles. Vehicles are classified into the following four classes:-

\*Class 1:Sedans

\*Class 2:SUV'S,Pickups,and vans,

\*Class 3: Buses, Two-and Three-axle trucks.

\*Class 4: Articulated buses and four to six axle trucks.

The magnetic lengths of vehicles in classes 3&4 are clearly distinguishable from those of vehicles in classes 1&2.As a result, by using only this single feature, it is possible to classify these two classes perfectly.

## 4. Block diagram and Experimental results:-



The above shown block diagram shows interconnection of all included modules. Matlab software is used so as to do image processing of vehicles and understand the type of vehicle whether it is heavy or light vehicle according to physical parameters. LCD helps in showing the practical results of the system (speed, vehicle type, band will show the count of vehicle). IR sensor module helps in knowing speed of vehicle passing by and RFID module is used for application of toll as future expansion of same project.

# Conclusion

The Vehicle detection and parameter measurements in this system are useful for vehicle classification and counting. From the above, a portable and low-cost sensing system based on magnetic sensors system is more suitable than others. This proposed system adjacent to road can be used for various parameter measurements. These measurements are enabled using three separated modules RF module, IR module, embedded hardware controller. The magnetic sensors are more versatile for all types of weather conditions and hence this system is totally real time. So, this proposed system results in automation in Tollbooths, management in traffic area and highways.

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