A Smart Transportation Design System for Restricted Areas with Vehicle Automation Technologies using Raspberry Pi B and Open CV Python – An Experimental Approach

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Abstract. With the advent of shallow and automation technologies, the intelligent transportation system has become a horizon in energizing and transforming human lives. It gains attraction among various communities due to its reduced workforce and efficient automation. In recent decades, digital advancements stood witnessed as the novel technology in performing the traffic control regime. However, factors such as over speed, natural disasters, and human distractions making the traffic system more puzzling. Hence to address the challenges, the proposed system propounds the novel way of traffic control by taking the vehicle over-speed as the intended factor. It performs automatic control of vehicle speed to avoid accidents and to accomplish safe driving in restricted areas. In this system, Raspberry Pi B microcontroller is utilized to embrace the detection of traffic signals. Additionally, the ultrasonic sensor is equipped for measuring the distance of the vehicles ahead to it in order to avoid collisions. Moreover, the R-pi camera module is employed for the detection of traffic signals and signboards. The real-world images are processed using Open CV python for object and traffic sign detection. Typically, it performs some intelligent classification of the images acquired from the camera module. Furthermore, the speed control of the vehicle is facilitated by the deployment of DC motors connected to the engine. Thus, the proposed system is designed to achieve the speed control and automation of the vehicle as per the warning signals. Here, python has used for programming the microcontroller. Also, step by step analysis of the system is carried out, and the experimental results are shown to visualize the function of the proposed self-automated vehicle.

1. Introduction
Due to the rapid urbanization and growing number of vehicles, road accidents now endangering the country and leads to loss of human lives. The factors like over speed, driver distractions, traffic intensity, and natural calamities are becoming the primary concern in the transportation systems. Nowadays the road and traffic control systems are widespread in making the communities more alert in following the driving rules. Also, the safety mechanisms such as automatic speed control [1], collision warning system [2], and novel driver assistance systems came into existence for intelligent driving and safer travel. Moreover, due to the advent of sensors and IoT technologies [3], the automation of vehicles becomes more pervasive, and intelligent Transportation has been ascertained. In recent decades, the smart vehicles gained attraction among various communities and paves way for an improvement of economic viability of the technology.

Intelligent travel is now becoming multimodal due to the enhanced forms of transportation in which the travellers seamlessly connected across every means of travel. Indeed, Intelligent Transportation Systems (ITS) [4] becomes an attention snatcher by its firm and remarkable benefits such as navigation support, effective communication, traffic management, and users’ entertainment; thereby, it becomes an extension of peoples’ digital lifestyle. In many advanced applications, smart city and transportation systems are connected as depicted in Figure 1. Additionally, the technological
progression in transportation systems helps proponents across the world with the applications such as electronic toll collection, license plate detection, traveller information systems, intelligent parking systems, automatic speed control, railway track crossing public safety, and tracking mechanisms. As beneficial, it promotes substantial changes in various sectors such as government, tourism, trade, and logistics. In this context, Intelligent Transport Systems (ITS) is likely to be fascinating by adopting some modern technologies, which include automation, ubiquitous sensing, and robust tracking systems. Many learning algorithms facilitate the intelligent transport systems to a greater extent by employs supervised models for vehicle movement prediction, expert systems for damage mitigation by pavement monitoring, and deep learning systems for traffic signal automation. At the same time, the primary goals of Intelligent Transport Systems are to mitigate transportation bottlenecks by ensuring better decision making and to maintaining the sustainability of available resources.

Due to the rapid proliferation of the IoT and automation capabilities, HCI (Human Computer Interaction) offers diversified advancements in transports for instance: a) Informing nearby fuel or recharging stations offers lowest prices b) vehicle passenger monitoring to adapt seating navigation and entertainment preferences c) vehicle drift and collision monitoring to respond in case of potential dangers d) Congestion detecting and notifying when heavy traffic detected and e) Enabling automated intelligent real-time decisions to optimize safe travel. In this proposed system the experimental approach is carried out using R-Pi and Open CV python [5] to facilitate the intelligent travel. The automation technologies utilize the existing communication technologies like ZigBee and Bluetooth [6] for connecting the sensors to the cloud. The proposed system is modelled using Raspberry Pi B microcontroller [7-10] to integrate all the vehicle functions. For capturing the real-world images, R-Pi camera module is used. It assists the vehicle in navigating with the help of traffic signal and sign board images. Moreover, ultrasonic sensor is used to find the distance of the vehicle ahead to it. It automates the vehicle according to the intended distance either to stop or run to avoid the chaos. DC motors are equipped to carry out the speed control of the proposed venture. Python programming is used to control the entire set up and Open CV is used to model the images of the R-Pi. The reference database is fetched into the memory of R-Pi which consists of the trained set of traffic images. Hence a finest automation system is proposed in this work to navigate and automate the vehicles during cautionary

Fig. 1 Coupling of vehicles and smart city
incidents. The prototype model is designed in order to show the miniature version of the self-automated car associated with the above said functions. Also, the communication technologies such as Bluetooth and Wireless LAN equip the short and long-distance communication.

2. Literature Survey
In this section, various existing approaches for vehicle automation and speed control is discussed. CH. Madhuri Devi et.al [11] designed traffic sign detection and sign board recognition in which segmentation algorithms are used. This utilizes Raspberry pi B and ARM processors for controlling various processors. Also, it employs fabricated sensors and cameras to alert the drivers for further actions need to be taken. The primary goal of the suggested system is mainly to navigate the vehicles according to the sign boards detected. Followed by [11], P. A. Shinde and Y. B. Mane proposed a vehicle monitoring and tracking using GSM and GPS technologies [12]. It alerts the driver if he chosen a wrong path via mobile devices. Also, the system utilizes the gas leakage sensor and temperature sensor for vehicle’s safety. Consecutively in [13], fuzzy-PID control based smart vehicle is designed for smart way of parking in urban areas. MA Khan et.al [14] has suggested a design to detect and warn the user during the impediments such as object detection, overspeed and traffic warning signals. It is efficiently programmed for sending the over-speed vehicle information to the authorities for further action. To carry out the functions, an authorized threshold speed value was set. If the vehicle crosses the limit it sends the relevant information to the intended centres. In addition, Digital Image Processing technologies used for immediate license plate detection of the over-speed vehicles. Thus, the system propounded a novel framework for vehicle detection accompanied with associated images.

3. Proposed System

3.1. System design
The block diagram of the proposed system is depicted in figure 2. The proposed system consists of a Raspberry Pi which acts as the central part of the self-automated vehicle. It consists of a power supply for the microcontroller and the connected devices to run the system. It connected to the rectifier to convert the incoming AC power supply to the DC values. Further, it connects with the regulator to reduce the abundant power supply to limit the range that the raspberry module can resist. To convert the high voltage to the low voltage input the regulator is used. Then LCD display is meant for viewing the functions of the system. Camera module V2 is connected to the GPIO pin to capture the traffic signs and objects. The Bluetooth module of specification BLE 4.0 is used to connect wirelessly with the controller. Furthermore, to detect the objects and to automate the vehicle automatically, the ultrasonic sensor of specification HC-SR04 is equipped. In order to automate the vehicle function, Motor driver IC l293d is connected to the microcontroller. Significantly, the traffic board signal images and stop boards are fetched in the internal memory for further processing.
3.2 An automated vehicle-speed control with OpenCV python and Raspberry Pi B

OpenCV (Computer Vision) is a library package intended for objects and image detection of real-time images. The proposed system uses the OpenCV for processing the traffic signals and sign boards. The images that are acquired from the camera module are then fed into masking and contour techniques for detecting the sign boards and red signals of the traffic ecosystem. Python 3 IDLE is used for programming the microcontroller.

The main objective of the proposed system is to detect the sign boards and stop boards located in the road sides. It is designed to further automate the vehicle accordingly. More often, the red signal system is recognized as the rectangle that lies between the topmost and least bound extremities of the red signals as shown in figure 3. In this system, the fixed area is determined by rectangle formed by the red light and the geometric shape is given as input to the GPIO pin. Normally it is used to control the vehicle by automating the motors as programmed. In order to detect the stop boards, the proposed system uses the cascade classifier[17-20]. This classifier normally processes the XML files in the training data which contains various sizes of the board. It classifies the normal images and warning signs effectively. If found the intended image, it sends the warning signal to the Pi board and further sends the control signal to the 1293d.

In this system, the motor driver IC 1293d is equipped for the efficient control of the DC motors. More specifically, one driver IC can be able to operate a couple of motors. So, the proposed system uses one 1293d for process of control in which the input of the GPIO is connected to the driver IC and the output pin is unite to the motor IC. Also, the system automates the speed of the left wheels and right wheels to slow down when sign boards are detected. To accomplish the task, GPIO pin (2,3) is meant for left wheel control and GPIO pin (9,10) is for the right wheel.
3.3 Experimental Results

In this proposed system, VNC viewer is linked to the Raspberry Pi for viewing the vehicle status. It normally connects to the R-Pi using the IP address (Figure 4).

After getting authenticated, vehicle status can be viewed in Raspberry Pi B window. Various status of the vehicle is processed by python and shown in IDLE. For instance, the below figure shows the distance measure of the vehicle ahead to it.

Figure 6 shows the road side symbol contains the information of speed lowering. The data with the corresponding label is fetched from the training data set after gets processed by the classifiers.
The prototype of the proposed system is shown in figure 7.

4. Conclusion
The proposed system provides a novel framework for automatic speed control of the vehicle using Raspberry Pi B. Moreover, it establishes a safer transportation system that facilitates both pedestrians and vehicle users. Open CV and python programming used for automate the vehicle according to the warning and sign boards. Furthermore, ultrasonic sensors efficiently detect the objects and lowering the speed of the vehicles if obstacles found. To view the working of the propounded system, VNC viewer is connected to the microcontroller. The prototype model is designed and tested for various conditions. Thus, the proposed system offers efficient vehicle automation and speed control in restricted areas to avoid accidents.

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