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Research Article

System Development and Assessment For Road Vehicles Speed Detection Using GSM

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ABSTRACT

In metro cities, cars are not allowed to exceed the displayed speed limit. However, many drivers still choose to speed, which is a major contributing factor to accidents. To address this issue, an easy-to-use road speed check system has been implemented to automatically detect traffic crashes in smart cities. This system uses a photovoltaic (PV) input power supply source, which captures the light emitted by the sun on solar panels and converts it into energy. In addition, the system utilizes an IR sensor to measure the speed of vehicles by detecting their distance and time. The infrared sensor detects a car in front of it, allowing for the calculation of time. A proximity sensor is also used to detect the speed of vehicles, regardless of their material configuration. The ESP8266 interface camera is used to capture live images in traffic, which are then transmitted to a specific IP address. Furthermore, the GSM Communication Device allows for the transmission of vehicle speed information through digital cellular communications, such as GSM (Global System for Mobile Communications). The output of this system accurately reflects real-world traffic data and has been tested through a comparison examination of individual speed measurements

1. INTRODUCTION

Currently, one of the most common traffic violations is speeding. Speeding is often the result of impatient and reckless driving. It is important to develop and implement a system that can automatically detect and report instances of speeding to traffic control authorities in a timely manner, especially considering the increasing number of accidents. Speed limits are posted on roads based on traffic volume and vehicle size, but some drivers still exceed these limits. Manual or semi-automatic systems have been replaced by automated systems due to advancements in technology[1-3]. A vehicle speed detection system accurately measures a vehicle's speed and can determine if it exceeds the posted limit in real time. The purpose of this effort is to design and create a new GSM based smart car over speeding detector that will warn users when a vehicle exceeds the speed limit. With so many incidents occurring on the roads every day, sophisticated car over speed detectors are vital to human life. This paper provides an overview of a smart car over speed detector and focuses on how GSM technologies may be used to improve the over speed detector's functioning.

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An additional study highlights the advantages of the speeding detector as well as how it operates technically. For this reason, the suggested analysis will open researchers' eyes to new study directions and give researchers and academics fresh perspectives on this topic. This system has various applications, including in power, private road safety departments, and public road safety employers. The main reason for enforcing speed limits is to save lives. Road safety is a major concern for governments worldwide. Implementing new traffic enforcement measures is necessary to address this issue and reduce the number of fatalities from traffic accidents. In this respect, effort is being done to develop a security driving application for automobiles using newly emerging GSM oriented technology, which is used to provide a more practical solution. The relationship between uniquely identifiable integrated computer equipment inside the current infrastructure is referred to as the Internet of Things, or GSM. Besides M2M (Machine to Machine Interactions), the Internet of Things GSM offers advanced connection between systems, services, and devices across a variety of domains and applications. Embedded appliances, such as smart items, are integrated into all automation systems. A prototype for vehicle speed detection warns the user when a vehicle violates the speed limit. This prototype's special feature is that, in addition to detecting over speed, it also broadcasts the location of the vehicle—which is tracked by GPS to the rescue team so that they may act quickly to save the victim.

1.1 Objective

1. To prevent accidents in school and hospital zones where speed limits are in place, it is important to have surveillance cameras continuously monitoring the area.
2. These cameras should be positioned at the top or on both sides of the road. However, it is important to note that improving the speed measurement of moving objects may have a negative impact on the backdrop modeling.
3. This is necessary in order to ensure the safety of walkers crossing the road, as they may be at risk from high-speed vehicles.

2. LITERATURE SURVEY

The system is powered by a junction point that utilizes solar power, with two main components: the vehicle part and the intersection. An infrared delay technique is used to sense traffic intensity and adjust signal timing accordingly. However, in emergency situations such as when an ambulance or fire department is called, it is important for the necessary vehicle to have a remote control unit that can override the signal timing and provide an immediate green light in the appropriate direction [1]. In order to create a smart city, challenges such as updating lighting systems, reducing power consumption, and minimizing expenses must be addressed. One solution is to use GSM technology and an ESP8266 microcontroller to develop an intelligent lighting system that operates autonomously based on estimated human traffic.

The computer vision product YOLOR is utilized to analyze images captured by a camera and calculate human traffic volume, which serves as a control signal for the lighting system to efficiently use energy [2]. Unlike traditional traffic systems that operate on a fixed schedule and are often inefficient, this proposed method utilizes computer vision and analysis algorithms to determine the speed of vehicles and predict if they will be able to cross the stop line before the green light turns red. Another camera, positioned a specific distance from the stop line, is used to detect vehicles that may not make it through the intersection in time and adjust the signal accordingly [3].

To maximize the power output of a solar panel, it is recommended to use a cuk converter to adjust the output to the desired level before connecting it to a load suitable for low-power systems such as traffic signals, outdoor lights, and camera surveillance systems. This converter offers the advantage of high efficiency compared to other converters and reduced switching losses due to its digital controller. The regulating process is based on output voltage feedback, resulting in a nearly zero error signal [4]. To fully utilize a self-sufficient VANET infrastructure, various methods and algorithms have been proposed to facilitate its implementation. The current effort aims to improve the networking, computing, and storage performance of the Green VANET by incorporating the concept of self-powered fog computing into the network design.

The green fog layer consists of three elements: wireless solar routers (WSRs), a self-powered edge server, and a newly developed device that combines a solar-powered Road Side Unit (RSU) with a smart camera (SC) to enhance road traffic sensing [5]. The system's main components include a photovoltaic power production subsystem, a tunnel environmental monitoring component, an intelligent lighting control subsystem, and a notice and alert subsystem. It is built around the STM32 microcontroller and powered by the photovoltaic power generation subsystem. The environmental monitoring and intelligent lighting control subsystems adjust the intensity and shade temperature of the lights in the tunnel to counteract the black and white whole effect. The notice and alarm and environmental surveillance subsystems provide tunnel control evaluation, fire alarm functions, and environmental parameter monitoring [6].

The situation at the intersection of traffic lights is becoming increasingly problematic, especially during emergencies. Emergency vehicles face difficulties navigating through the multiple crossings when there is heavy traffic congestion. This unsafe condition could potentially lead to accidents. To address this issue, emergency vehicles such as ambulances have the ability to activate traffic signals, automatically changing them from red to green and allowing them to pass through [7]. A cutting-edge solution to this problem is the traffic density-based IoT-based traffic signal system, which utilizes connected devices and real-time data analytics. This technology dynamically adjusts traffic signal timings based on the traffic density at each intersection [8], aiming to alleviate traffic congestion. Additionally, the system has the capability to capture images of traffic law violators. An interesting feature of this system is the use of servo motors to rotate the camera, reducing the cost of using multiple cameras [9].

The battery can be damaged if it is immediately charged due to the unstable voltage produced by solar energy. To maintain a stable voltage, the power is first sent to the controller and then stored in the battery. The MPPT algorithm is used to increase the output power and achieve maximum energy conversion, resulting in the highest possible power output. This algorithm can also determine the number of parallel interleaving modules, adjust the output power of streetlights, and simulate the output power curve of solar panels based on current conditions [10].

An automotive density measurement instrument uses laser and light-dependent resistor (LDR) technology to measure the density of passing cars. This device calculates the maximum number of cars that can pass in a given amount of time. The master unit (ESP32) receives a signal from the LDR indicating excessive congestion if it detects a significant volume of traffic. Similarly, the master unit is also notified if the LDR detects a regular flow with fewer vehicles. The master unit then analyzes the data to check the state of traffic. When a vehicle is detected by the LDR and laser, the matching green LED will illuminate [11].

AI-based car recognition plays a crucial role in improving traffic control. By analyzing data collected from a network of smart cameras, we have observed significant enhancements in incident management, congestion detection, and traffic flow analysis. The use of AI-powered systems allows for unparalleled accuracy in vehicle classification, anomaly detection, and adaptive signal management [12]. As smart cities continue to develop, the concept of using the Internet of Things to automatically control street lights is gaining popularity. This system utilizes wireless communication technology and sensors to automate streetlight operation. The sensors, such as motion or light sensors, are installed on the streetlights and are responsible for adjusting the intensity of the lights. For example, if there are no cars or people in the area, the system will dim the lights to conserve energy. On the other hand, if activity is detected, the lights will become brighter [13 -15].

Smart cities can create efficient transportation systems and advanced public services with the help of IoT and cloud computing. By utilizing large amounts of data stored in the cloud and conducting real-time analysis, the device controller can employ a traffic management algorithm to configure the Wi-Fi module and gather data from traffic signals. A recent study suggests a real-time traffic control approach that integrates data analytics with the Internet of Things (IoT). The suggested system will predict the possibility of heavy traffic at crossing number 14 by analyzing sensor data and sending it to a cloud server [16 -18].

3. MATERIALS

Due to the increasing number of accidents caused by over-speeding cars, it is necessary to have a technology that can identify and notify authorities about these vehicles. Our proposed assignment aims to detect and promptly notify relevant authorities about vehicles that exceed the speed limit and method of block diagram shown in figure 1.

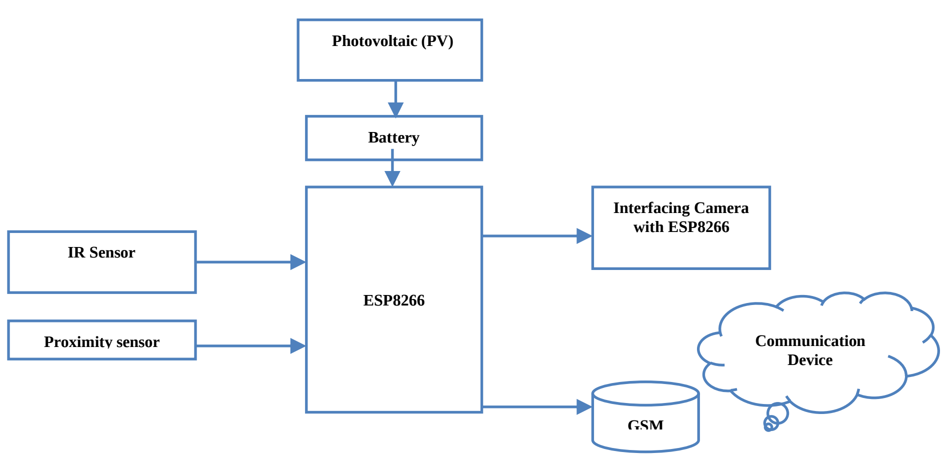

Fig. 1. Stated block layout

Photovoltaic (PV) input power supply electricity by converting sunlight energy given as input source and they are two types of energy created by the sun for human use: electricity and heat. The IR sensor works by having an infrared transmitter that constantly produces light, while the infrared receiver continuously looks for reflected light. If a moving vehicle is in front of the light and reflects it back, the sensor will detect it. Real-time speed detection of a moving vehicle is possible through a motion detection system. Proximity sensors are designed to deliver a high-speed response, which is the time it takes for the sensor to detect a moving object and activate its output. This response is crucial for accurately detecting the speed of a vehicle. This technology uses frame detection and visual processing to determine a vehicle's speed. The GSM communication device information must be transmitted continuously, for example: "alert speed: 50 km/hr" and "alert speed: 60 km/hr". These alerts are then sent to a specific person. This model can be used in real-time traffic if the results from the model and the human technique are almost identical with a reasonable margin of error. Additionally, it reduces the amount of moving vehicle and time required to classify, count, and monitor speeding vehicles.

4. METHOD

4.1 Photovoltaic (PV)

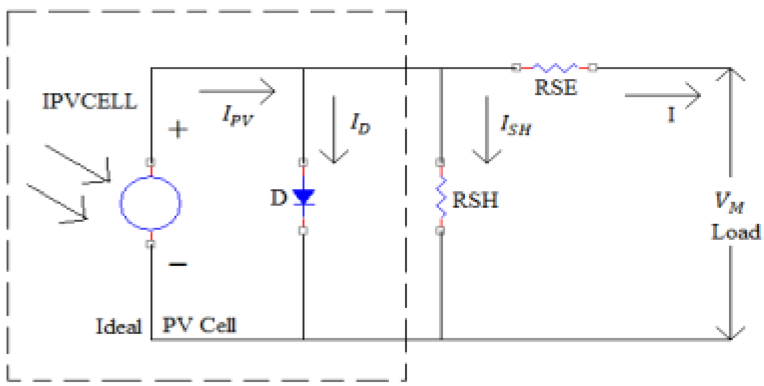

Fig. 2 Photovoltaic (PV)

Figure 2 shows the circuit of PV cells, also known as solar panels, which are components of photovoltaic (PV) panels that use solar radiation to generate electricity. These cells are connected to form a module and are typically composed of a semiconductor, such as silicon. A typical rooftop solar panel contains 30 modules. When sunlight is absorbed by the semiconductor in solar panels, it releases electrons, which are the fundamental elements of electricity, from their position and allows them to pass through the semiconductor. The electron-hole pairs in the photon from the external radiation cause the diode's neutrality to be broken. If a second current route is present, the electrons traveling through the P-side will go towards the N-side, ultimately producing a DC current. The amount of electromotive force produced is directly proportional to the intensity of the incident irradiation

4.2 IR Sensor

Figure 3 shows an infrared sensor that utilizes light to detect movable vehicle in specific surroundings. Apart from movable vehicle in traffic, an infrared sensor can also measure the distance of vehicles in traffic. This is because all objects emit some form of heat radiation in the infrared range, which can be identified by the sensor but is not visible to the human eye. The sensor consists of an IR LED (Light Emitting Diode) as the emitter and an IR photodiode as the detector, which detects IR light of the same wavelength as the IR LED. Unlike passive infrared sensors that emit infrared radiation, these sensors simply measure it.

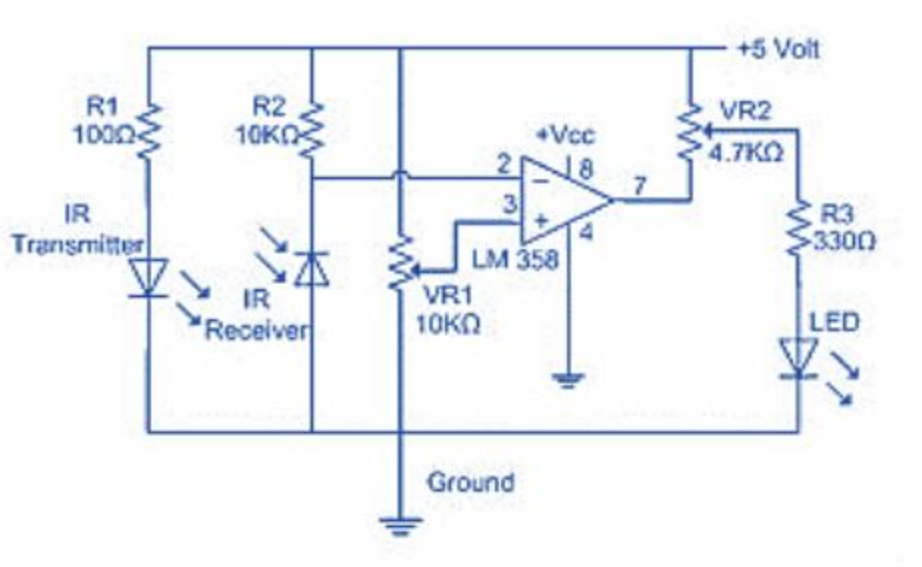

Fig. 3 Circuit diagram of IR sensor

4.3 Proximity Sensor

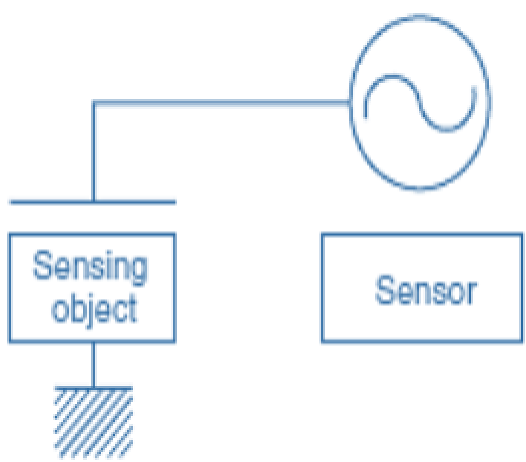

Fig. 4. Working of proximity sensor

When compared to sensors that detect items by making physical touch, such limit switches, proximity sensors are any sensors that do non-contact detection. Proximity sensors generate an electrical signal based on an appearance or departure of an item. This conversion is accomplished by three different types of detection systems: those that use eddy currents, which are forces created by induction of electromagnetic energy in metallic sensing objects, those that look for changes in electrical capacity as they conduct the detecting product, and those that employ magnets and reed switch technology.

4.4 ESP8266 interfacing Camera

The ESP8266 module allows microcontrollers to connect to 2.4 GHz Wi-Fi using IEEE 802.11 BGN. It may be used with ESP-AT firmware to offer Wi-Fi connectivity to various host MCUs, or it can function as a standalone MCU by operating an RTOS-based SDK. These are entire GSM MCU development platforms with modules pre-installed. They are used by developers and manufacturers to generate prototypes during the design stage, before beginning production. Development boards are made by a variety of vendors, and the specs vary across versions.

Fig. 5. ESP8266 with connected Camera

4.5 GSM Module

Figure 6 shows a model of SIM900A is a comprehensive dual-band GSM/GPRS solution that can be incorporated into client applications. It provides GSM/GPRS 900/1800MHz capabilities according to industrial standards for voice, SMS, data, and fax in a tiny shape with low power consumption. SIM900A may be employed in most space-constrained user applications, particularly for designs that are slim and compact. GSM sends a notification to automobiles about speed monitoring.

Fig. 6. Module of GSM Module.

5. RESULT AND DISCUSSION

The protecting software implementation of the accessible speed detection device for automobiles is represented by the speed detection system testing, which is displayed bellow in figure 7. The speed limitation in this work was defined, although it is easily adjustable by a human operator and appropriate for specific road segments.

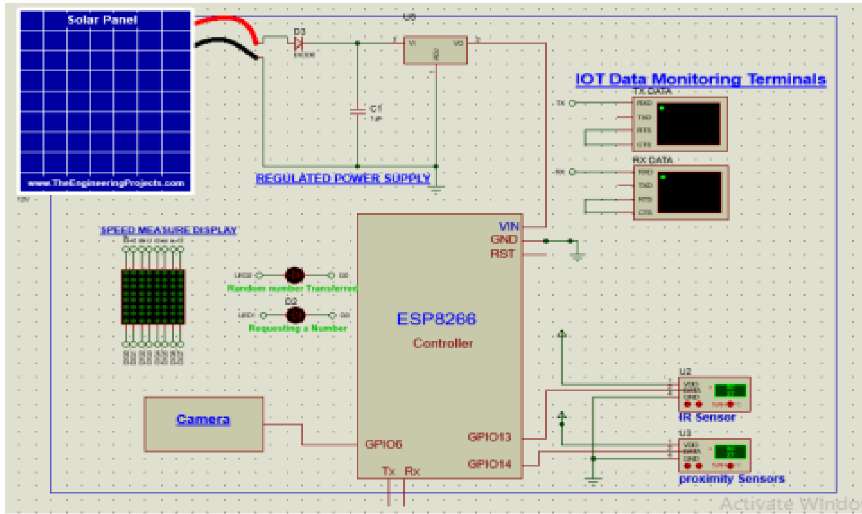

Fig. 7. Simulated output of proposed vehicle speed measurement

Figure 8 shows the output image captured by the ESP8266 interfacing Camera. When calculating speed, time and speed are inversely related. The count begins when the car crosses the first infrared sensor and continues until it crosses the second. The speed is higher when the count is smaller and decreases when the count is higher. The distance technique is used to process the data obtained from the vehicle speeds. This sensor becomes active when the car passes the infrared sensor. A timer is then started and will continue to count until it reaches the second proximity sensor.

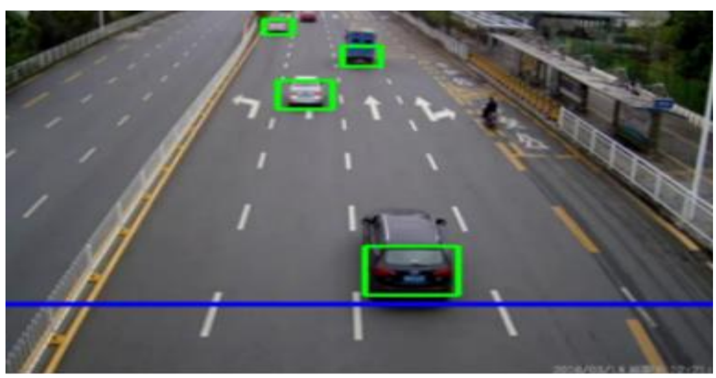

Fig. 8. Vehicle tracking and detection

Fig. 9 GSM output vehicle speed detection

Figure 9 shows the output of the GSM module, which is calculated using the ESP8266 controller. This message is received by the designated person for the specific vehicle.

6. CONCLUSION

The design and development of this unique speed detecting device for road vehicles is crucial for ensuring driver safety and preventing vehicle accidents. In the world of automotive driving, these elements are of utmost importance. The detecting module is able to accurately distinguish between moving automobiles. The suggested system includes two distinct sensors: infrared sensors for detecting vehicle speed and proximity sensors for transmitting this information to the Node MCU controller. The GSM module then transmits the precise speed detection information instantly. Experimental results have shown that the use of sensors is crucial for achieving high accuracy in speed and time calculations. Additionally, the integration of a camera and GSM module into the circuit allows for the detection of vehicles exceeding the maximum speed, with the added capability of capturing an image of the vehicle. In the future, the integration of a GPS module could further enhance the smart vehicle speed system by enabling the transmission of the accident's orientation. This would greatly benefit emergency response teams, allowing them to quickly arrive at the accident scene.

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Conflicts Of Interest

The author declares no conflict of interest in relation to the research presented in the paper.

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