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Automatic Pedestrian Safety in Automobiles through Microcontroller and RF Technology

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Abstract

One of the government's top priorities for creating a safe driving environment is pedestrian safety. To guarantee safety in all respects, many safety measures have been put into place by the government and adopted by the populace. The main goal of this study is to indirectly lower the number of accidents by eliminating their core causes. Careless driving and excessive speeding are the main causes of accidents. This document ensures that a car is designed to travel at a specific pace in each area, keeping it within safe speed limit. This lessens the impact of accidents, including material and human loss. This is accomplished by using the proper microcontroller, RF transmitter, and receiver through a comparison process. The car equipped with a receiver, receives the data signal from the traffic sign board, compares it to the output, and adjusts the speed of the vehicle to a safe level. By doing this, the car is always forced to go at the designated speed, and driving behaviour is altered, reducing the likelihood of accidents. This offers a supplementary safety precaution that focuses on eliminating the primary sources of mishaps.

Keywords: Speed Sensor, RF Transmitter Receiver, IR sensor

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1. Introduction

Even though everyone has crossed the street at some point in their lives, pedestrian injuries and fatalities remain prevalent. There is always a significant risk of getting hurt in an accident. In 2021, more than 60,000 pedestrians were injured nationwide, marking a 13% rise in pedestrian fatalities from 2020, totaling 7,388 deaths. Since automobile incidents are the primary cause of commuter fatalities and injuries, pedestrian safety is a serious problem[7-10]. The safety performance function (SPF) is one method developed through road safety research to combat traffic crashes. However, further research is necessary to improve the SPF for pedestrians, focusing on the methodological framework and data input. The safety system proposed here acts as an alert to keep drivers vigilant and serves as a preventative measure against carelessness [1-4].

2. Existing and Proposed System

A. Existing System

There are numerous modes and varieties of safety systems available today. Car applications mostly fall into two categories: driver assistance and pedestrian safety. In the past, pedestrians were detected by sensors in the automobile and infrastructure, which would either inform the driver or use automated braking to prevent collisions [11]. Beyond these, there are not many other safety systems. These include a few automation applications and various automakers' preventive collision procedures [5,6].

B. Proposed System

The system ensures that the drivers obey the rules and regulations, thereby indirectly reducing the likelihood of accidents. It provides a permanent solution by ensuring the safety mechanism is activated at all times. Our aim is to transmit the speed limit within a particular range through the RF transmitters. The speed limit value is sent from the transmitter to the vehicle, ensuring it travels at a safe speed in the corresponding region. This is achieved using a microcontroller and necessary sensors.

3. Block Diagram

A. Block Diagram of Proposed System

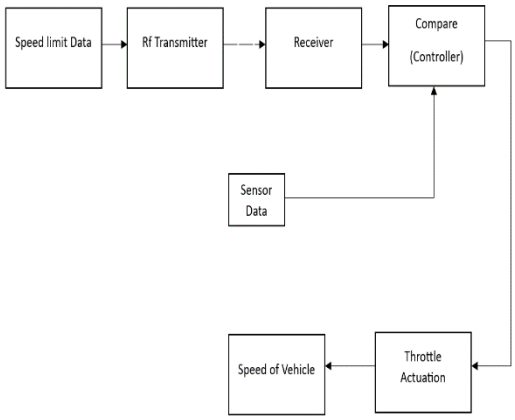

Figure 3.1. Block Diagram for Data Acquisition

The block diagram in Figure 3.1 illustrates how the function is carried out in the proposed safety system. The system aims to provide safety by almost eradicating one root cause of accidents. This is a contribution towards the betterment of society and an attempt to save lives. The software modules in this proposed system handle data collection and transmission.

B. Description of the Components

a. Speed Sensor

The type of position sensor used to measure rotational speed is the speed sensor. They can be found in many kinds of motorsport and commercial vehicles. A speed sensor is an essential component of onboard systems, just like many other devices. They function by supplying a voltage measurement that corresponds to the speed at which the magnet rotates. They are used in situations where contact-free speed measurement in hard-to-reach locations is necessary. Different speed sensors employ various technologies, such as location sensing based on the Hall effect or magnetic fields.

b. RF Transmitter and Receiver

An RF module operates using radio frequency. The spectrum of frequencies in question spans from 30 kHz to 300 GHz. In this RF system, digital data is represented as changes in the amplitude of the carrier wave. Amplitude Shift Keying (ASK) is the type of modulation used here.

c. IR Sensor

An electrical device that emits light to detect objects in its vicinity is known as an infrared sensor. In addition to motion, an infrared sensor can also detect an object's heat. All objects emit some form of infrared heat radiation, which can be detected by an infrared sensor even though it is invisible to the human eye. Infrared radiation falls within the lower end of the electromagnetic spectrum, making it invisible to human vision. It lies between microwaves and visible wavelengths. The infrared wavelength range is divided into three regions: near infrared, ranging from 0.75 to 3 μm; mid-infrared, ranging from 3 to 6 μm; and far infrared, which exceeds 6 μm.

C. Software Implementation

a. Proteus

Proteus Design Suite

Proteus is an application for circuit simulation and virtual system modelling. It streamlines the co-simulation of entire microcontroller-based designs by integrating animated components, microprocessor models, and mixed-mode SPICE circuit simulation. Moreover, Proteus is capable of accurately replicating the interaction between software running on a microcontroller and any connected analog or digital electronics. It faithfully emulates various peripherals such as timers, interrupts, input/output ports, USARTs, and others, which are commonly found in supported CPUs. This software is widely employed by electronic design experts and technicians to generate electronic prints and schematics for printed circuit board (PCB) manufacturing, as well as for rapid prototyping in research and development endeavors. Furthermore, Proteus is extensively utilized in educational institutions worldwide for teaching embedded design, electronics, and PCB layout. Its suite of tools also enables users to virtually model Internet of Things (IoT) projects with precision and ease.

b. Arduino IDE

Writing and uploading code to Arduino boards is accomplished using the open-source Arduino IDE software. The IDE program is compatible with various operating systems, including Linux, Mac OS X, and Windows, and supports the programming languages C and C++. In this context, IDE stands for Integrated Development Environment. 'Sketching' is a common term used to refer to programs or code written in the Arduino IDE. To upload the sketch created in the Arduino IDE software, the Arduino board and Genuino must be connected to the IDE. The sketch is saved with a '.ino' extension.

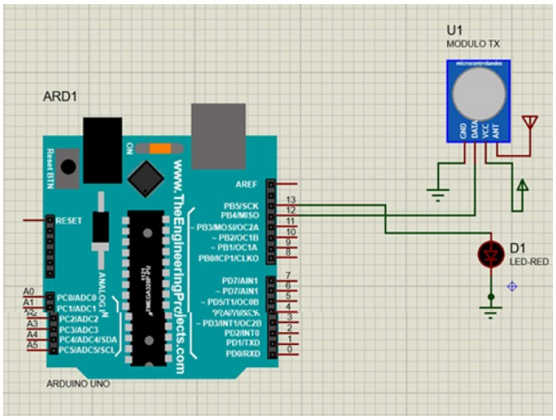

Figure 3.2. Transmission Circuitry Simulation

The simulation software used for this project is Proteus Design Suite. The main objective of the simulation is to examine whether the exact same circuit can be implemented in hardware format. It is found to be achievable.

For the virtual terminal to function, the programme source code includes the library <virtual.wire>. Like a serial monitor, a virtual terminal is a display device. It is employed to display the program's output. The Arduino IDE's source code has been independently compiled and error-checked. Following the error-free code's execution, the INO file is transformed into a build file. At this point, the microcontroller that the proteus programme uses is fitted with this build file.

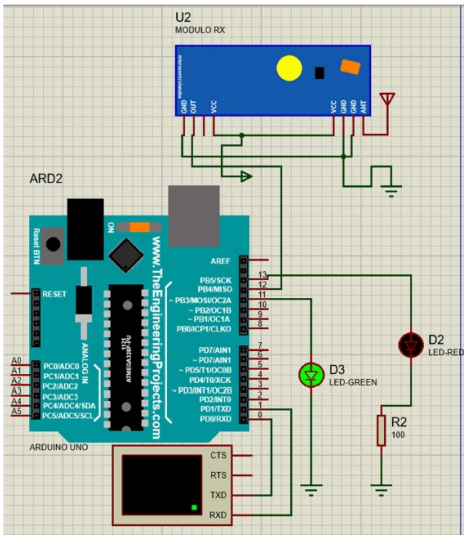

Figure 3.3. Reception and Indication Simulation Circuitry

The vehicle's movement cannot be realized because it is a simulation. Therefore, the LED-based indication mechanism is implemented in place of a physical vehicle. The transmission part is depicted in Figure 4.1, while the reception part is shown in Figure 4.2. The D1 LED in Figure 4.1 indicates successful signal relay. The process flow is as follows: The controller inputs the transmitted data into the program after it is received by the receiver. Once again, due to the simulation, the real-time speed of the vehicle cannot be determined. Therefore, a random function is used to generate the vehicle speed randomly between 0 and 100 kmph. In this context, if the random value is less than the transmitted value, the green LED lights up, and the virtual terminal indicates that the speed is safe. Conversely, if the random value is higher than the transmitted value, the red LED lights up, and the virtual terminal indicates overspeed.

4. Result Analysis

a. Developed Safety System

An IR sensor was installed in a cardboard sign board to identify whether an automobile was within a given range. To provide the speed limit information to the vehicle control unit, an RF transmitter is interfaced with the Arduino UNO R3 in addition to an IR sensor. The code initiates upon the vehicle's detection upon passing the sign board. The vehicle's speed is recorded and contrasted with the value that was transmitted. The power supply of the motor that powers the car is switched in order to lower the speed of the vehicle if the condition is

not met, that is, if the speed of the vehicle exceeds the indicated speed limit. It is permitted to stay in its own state as long as the speed stays within the specified range. The code ceases to run and returns to its initial state as soon as the car leaves the range.

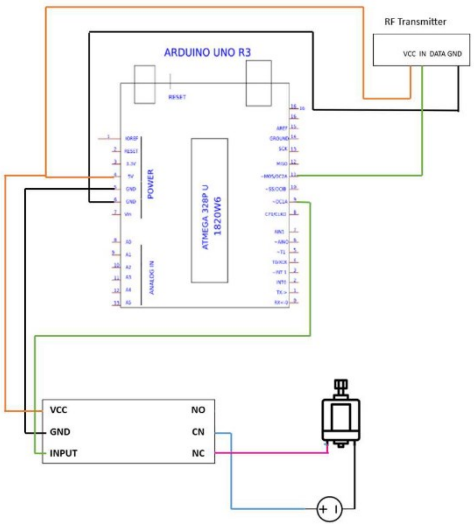

Figure 4.1. Control Circuitry for Car (Vehicle in the Case of Real Life)

5. Conclusion

a. Summary

The simulation-based prototype serves as a tiny version of the real-time application. An IR sensor is used to identify vehicles driving within range of the created prototype, which is based on simulation. An RF transmitter and receiver operating at 433 MHz are used to transmit and receive the detection confirmation data signal. A relay is utilized to regulate the vehicle, much like a simulation component that moves the car within a safe range. This is a conceptual explanation of how the safety system that was built works. Based on simulation, this is utilized to constrain the vehicle to avoid moving faster than the previously stated pace. Consequently, this project can be used in real-time applications where the vehicle's speed needs to be kept within the established safe range. This project can be used to lessen the accident's initial cause or core cause. This project can be used in real-time applications and public mediums such as automobiles and sign boards.

b. Future Enhancement

This prototype can be implemented widely by mandating that this technology be installed in all cars and traffic sign boards to fully realize the project's potential for efficiency. Further application of this in traffic discipline is possible. The traffic authority uses a speed gun or vehicle monitoring in high-traffic zones to levy fines for exceeding the posted speed limit. These approaches have limitations. When several cars are moving quickly together, a speed gun cannot be used. Few automobiles tend to hide their license plates, defying the norm, thus vehicle monitoring cannot always be totally dependable and effective. This designed prototype can be installed in all vehicles to enable effective vehicle monitoring and the appropriate application of speeding fines, thereby supporting the government's efforts to create a safe driving environment.

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