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Collision Prediction Based on Vehicular Communication System

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Abstract— *Road traffic accidents are one of the leading causes of mortality globally. Reducing the number of traffic-related incidents has become a serious socio-economic and public health problem, given the ever-increasing number of cars on the road. As a result, this paper proposes an intelligent vehicle prediction communication mechanism that alerts drivers to any autos that may be overtaking or bypassing the targeted vehicle. The primary goal of this paper is to leverage modern Internet of Things (IoT) and wireless sensor technologies to predict any potential accident that may occur as a result of car accidents. This paper proposes the Collision Prediction of a Moving Vehicle (CPMV) system. The information acquired by CPMV will alert the driver to divert the vehicle in a reasonable amount of time before any harm occurs. It redirects the inbound object that emitted the Ultrasound signal which was received by the vehicle, to a safe location. The proposed system predicts collision between vehicles through Wi-Fi and Bluetooth, using a set of sensors with a precision of 360 degrees and a distance of collision prediction of one meter and at a speed of 200-300 revolutions per minute. The python programming language was utilized to code the programs that control the vehicle during the implementation of this project. The Raspberry Pi 4 is utilized as the controller to examine the vehicle's spatial data. The test results showed that using this application to deal with an approaching object can be a successful strategy in the three proposed scenarios at different angles and directions.*

Index Terms— *collision prediction, collision avoidance, Internet of Things (IoT), Raspberry Pi, vehicle communication.*

I. INTRODUCTION

In recent years, remarkable developments in network technology have ushered in a new information revolution to rival the industrial revolution. Not just in the economic sector but also our daily lives, the network is now an essential component of social infrastructure [1]. The Internet of things (IoT) is a well-known developing technology that aims to link many gadgets to the Internet. The seamless integration of Radio Frequency Identification, wireless communication, and sensors contributes to IoT devices. Smart features are utilized in conjunction with IoT services platforms to deliver smart services, with controllers and electromechanical systems used to establish interaction between cyberspace and the real world [2].

The Internet of Things (IoT) is a network that links items over the Internet to monitor, control, predict, and logistics the things around us [3]. The Internet of things (IoT) aims to link things at any time, anywhere, with anything and anybody, preferably utilizing any network and any service. Everything, including the administration of life, home, building, cities, energy, transportation, health, and industry, may be handled sensibly with IoT. IoT also provides particular object identification, connection capability, and sensor capabilities [4]. The IoT applications can be shown in *Fig. 1*. One of the IoT applications that may be effectively employed to mitigate the severe effects of crashes is the vehicular communication system. This research attempts to offer a vehicular communication system

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capable of forecasting dangerous objects on a moving car using IoT technology [5]. Vehicle communication is one of the most recent additions to wireless communication systems. Vehicles traveling on highways may be thought of as communication nodes, and they must establish reliable communication linkages to communicate information with surrounding vehicles and road infrastructure. Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication are the two primary types of vehicular communication [6].

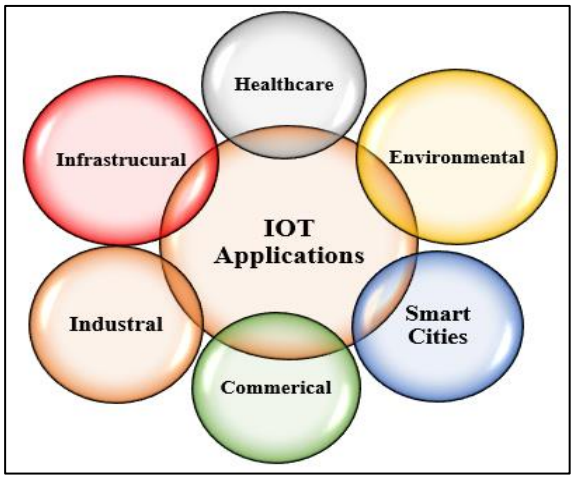

FIG. 1. THE IOT APPLICATIONS DIAGRAM [4].

Consider an attacker who "debases" substantial chunks of the vehicular organization with false data: A single traded-off vehicle can transmit false hazard signals, which are then picked up by all vehicles in both rush-hour jam streams. A modified vehicle that sends out messages disguised as a crisis vehicle in order to trick other motorists into backing up and yielding, or a different type of attacker that transports various collectors and captures messages given by cars. Particularly security reference points that report a vehicle's location in order to follow the position and movements of the vehicle and derive personal information about its driver and passengers [7].

This paper's major goal is to develop a collision prediction system based on vehicular communication technology. The Internet of Things (IoT) relies on Wi-Fi for connectivity, which is the architecture on which this suggested system is built. Wireless sensing using the Internet of Things is used to predict any potential accidents that may occur as a result of unsynchronized automobiles driving in opposite directions on the road. Collision Prediction of Moving Vehicle is the name of the proposed system (CPMV). The information obtained by CPMV will be used to alert the driver, allowing them to divert the engine within a reasonable time period and allowing them to decide before an accident occurs. The redirection is based on the incoming car's ultrasonic pulse being reflected by the other car wherever it is safe and far away from the collision zone.

The CPMV systems required codes are designed in the Python programming language, and the developed software is in charge of the vehicle's hardware control. The Raspberry Pi 4 is used as the controller for analyzing the vehicle's spatial data. The following is the order in which this paper is organized. The vehicle communication system is discussed in section two, and the third part includes a list of related works. The proposed approach of collision prediction employing a vehicular communication system was thoroughly detailed in section four. The fifth section is devoted to explaining the proposed application test results. Finally, in the last section, we highlight the conclusions and recommendations for further study. The car sensor system used in the proposed system is shown in *Fig. 2*.

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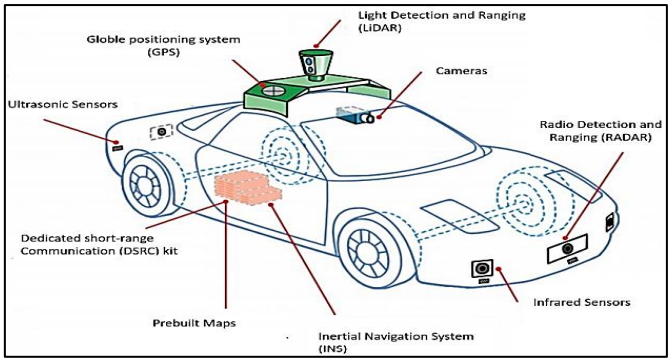

FIG. 2. AN ILLUSTRATION OF A CAR SENSOR SYSTEM.

In 2016, E. Nasr et al. [8] offered an intelligent and trustworthy IoT system solution that informs the PSO headquarters as soon as an accident happens and pinpoints its geographic coordinates on a map. When an accident happens, a shock sensor recognizes it. The sensor signal is then processed by an algorithm, which sends the geographic position, along with other ancillary information, to the PSO headquarters, signaling the occurrence of an accident. This is a promising technology that is intended to help in the time-consuming rescue procedure by notifying the location of an accident, the passengers hurt, and blood types in a matter of seconds, therefore decreasing fatality rates. This system's geographical data might be used as admissible evidence or as an indication of road state and conditions.

In 2018, M. Pal et al. [9] suggested a technique around creating a sensor-based embedded system that can provide helpings to drivers in avoiding any traffic collision to save lives and money. The suggested collision avoidance system has the crucial advantage of being able to forecast the likelihood of a collision and, as a result, advise the driver on remedial procedures to take in real-time to avoid a collision. Furthermore, the suggested system works with any existing car and does not require any additional roadside infrastructure. Furthermore, the suggested collision avoidance system is inexpensive because of the use of low-cost components such as an ultrasonic sensor node, a speed sensor, a GPS module, and a Wi-Fi module.

In 2019, S. Yogarayan et al. [10] offered a low-cost technique for estimating the distance between a vehicle’s front and rear wheels. This research aims to develop a system for estimating the range of vehicles with a low cost of entry. The measurement gadget uses an ultrasonic sensor and a Raspberry Pi to determine the range. Furthermore, the data is saved in real-time in Firebase.

Table I explains the pros and cons of this study and the previous studies as follows:

TABLE I. COMPARISON AMONG THE PROPOSED SYSTEM AND RELATED WORKS

Ref	Pros	Cons
[8]	This approach provides numerous benefits, including reducing injured passenger interaction, providing basic medical information to rescue crews, recognizing specific and accurate accident locations, and simplifying the routing procedure.	This system does not anticipate the occurrence of a collision, but it detects the locations of accidents after the collision. Although this would contribute to reducing accident damage, such as the possibility of reaching the injured and trying to save them, it does not prevent the accident, so there is no possibility of predicting the occurrence of the collision in the system; therefore it reduces the damage caused by collision and does not prevent it.

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[9]	The suggested collision avoidance system's main benefit is that it can predict the likelihood of a collision and, as a result, advise remedial actions for the driver to do in real-time to avoid a collision. Furthermore, the proposed system may be installed on any existing car and does not require any additional roadside infrastructure.	Several key circumstances have not been examined by the collision avoidance system given in this paper, such as how safe it is to overtake the front side car or do a U-turn on a two-lane road.
[10]	The gadget keeps track of the distance between the present car and the vehicle in front of it, ensuring a safe driving distance. It also serves as a warning to drivers, advising them to drive cautiously to avoid harmful situations.	One of the disadvantages of the proposed system is that it is limited to a specific scenario, which is the current vehicle with the vehicle in front or behind. It prevents collisions that occur on a straight line, ignoring the curves, as most accidents occur at intersections.
This work	The proposed system predicts collision between vehicles through Wi-Fi and Bluetooth, using a set of sensors that help in the accuracy of $360^{\circ}$and distance of collision prediction with one meter and at a speed of 200-300 revolutions per minute.	One of the problems that we faced in the proposed system, which we recommend working on in the future, is speed, as the quality of the parts used did not enable us to raise the level of speed because the higher the speed, the less accuracy in identifying the objects that could be expected to collide with it.

II. THE PROPOSED SYSTEM

The suggested method is an automated vehicle collision detection system that anticipates the movement of any approaching object toward a moving vehicle. The upcoming vehicle would communicate to the driving vehicle that it is approaching the last. As a result, the moving vehicle will be rerouted. The proposed system architecture is shown in *Fig. 3*.

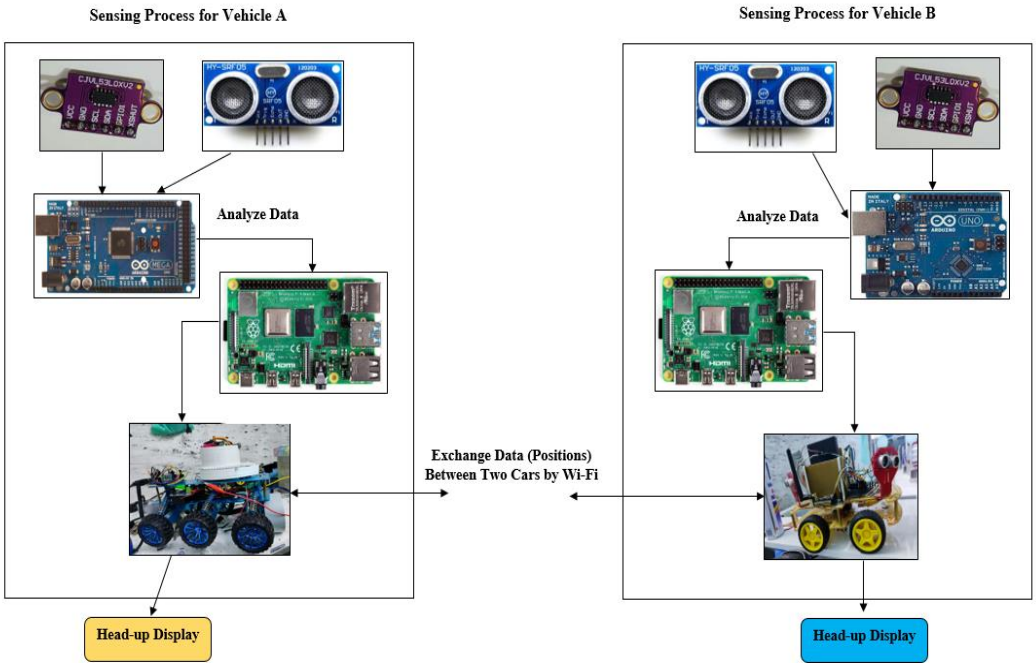

FIG. 3. CPMV ARCHITECTURE.

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A. The System Components

The Collision Prediction of Moving Vehicle (CPMV) system is made up of many components. These components are Raspberry Pi 4 is a small electrical chip that can be programmed to execute any task using any high-level programming language. This interface uses the Arduino; the DC Motor Driver L298N will provide a normalized control between the speed of DC motors and spinning directions in the design. In addition to the ultrasonic sensors, X4 total of four ultrasonic sensors are employed. By delivering ultrasonic waves and converting the echoed wave resulting from reflection with the obstacle object into an electrical signal, this electronic device can measure the distances of a certain object. Ultrasonic wave signals arrive at a faster rate than sound waves. The USB to RS232s Port (USB-232) uses the FTDI chipset, and the RS232s to 5 V TTL Converters use the RS232s to 5 V TTL Converters (TTLs-232-5 P). It might be used to convert any completely duplex USB adapters to bidirectional 5 V TTL signals. This unit is powered by the universal port and requires no additional electricity. X4 DC motor DC motors are rotary-based electrical devices that transform electrical power into motion at a speed of 2000 RPM and a voltage of 5 volts. An AC to DC power source that transforms 5V at 1A is known as a 5V with 1A power supply. These devices operate in the switch mode, with the outputs neutralized to 5V (output >14V). As a result, a USB cable is necessary to feed the USB 'A' connectors used for output, such as the Arduino and Raspberry Pi.

B. The Proposed Collision System Steps

The following stages illustrate the process used to run the proposed Collision Prediction of Moving Vehicle (CPMV) method. At first, data is read from two sources by the Raspberry Pi. The first source comes from the car controller's Bluetooth signal, which receives data from it, while the four Ultrasonic sensors on the vehicle's four sides provide the second source of data. In the second phase, the cars wait for a command from the controller, such as moving the vehicle to the front, back, right, or left sides. Finally, after receiving the signal to advance and detecting an unanticipated barrier along the way, the vehicle will automatically self-inform to redirect itself in the other direction by analyzing the reflected ultrasonic wave, as shown in *Fig. 4*.

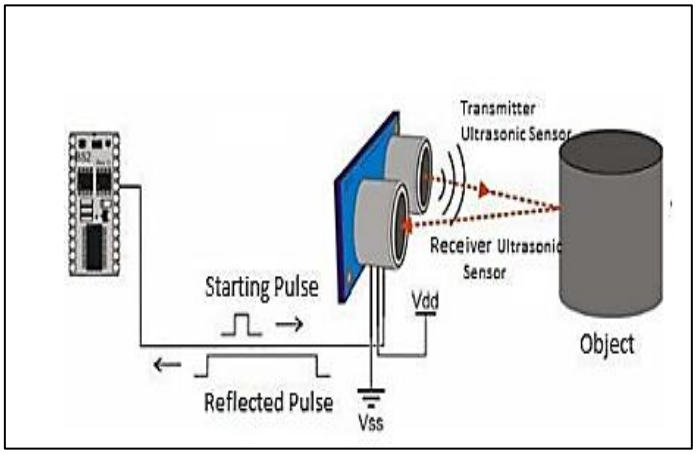

FIG. 4. SIGNAL REFLECTION MECHANISM.

A sensor configured for sensing at least a portion of a lane and a processor coupled to the sensor is included in an automatic signaling system for a vehicle with a turn signal light. The processor is configured to activate the vehicle's turn signal light based at least on a signal received from the sensor. Sensing at least a portion of a lane in which the vehicle is moving and automatically activating a turn signal light of the vehicle based at least on the sensed section of the lane are two methods for activating a turn signal light of a vehicle.

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The equations of ultrasonic waves were utilized to measure the distance between the vehicle and the obstacle in the development of the proposed CPMV system. As a result, equations may be used to formalize the true distance between the object and Eq. (1). *Fig. 5* depicts all of the system hardware components.

$$D_{o_1 o_2} = (P * 34000)/2 \quad \ldots (1)$$

Where D is the distance between the object (o1) and the obstacle (o2). The letter P denotes the pulse duration.

FIG. 5. THE HARDWARE COMPONENTS OF THE VEHICLE COLLISION CONTROL MODE.

The flowchart of the proposed system is shown in *Fig. 6*.

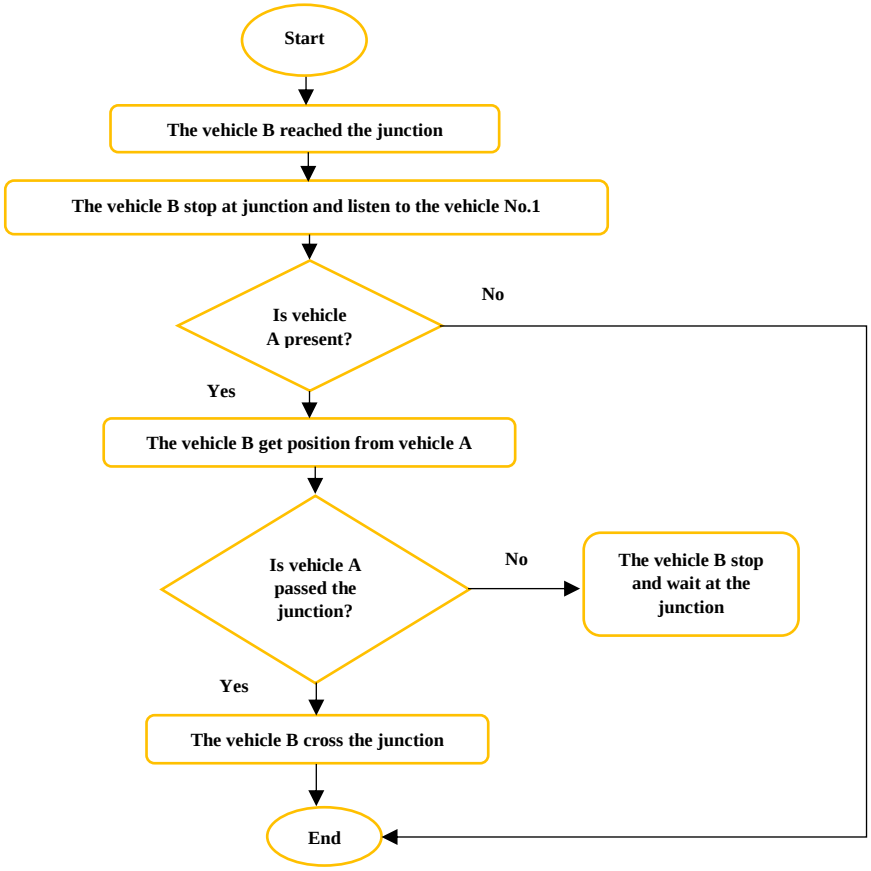

FIG. 6. FLOWCHART OF THE PROPOSED SYSTEM.

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III. TEST RESULTS AND DISCUSSION

Three scenarios are used in the experimentation to test the proposed system CPMV. The first scenario is about turning left. Turning left at a junction with oncoming traffic is a difficult operation. Drivers must monitor for oncoming traffic, cede the right of way when necessary, and decide when the intersection is safe to cross. When both vehicles had a signal, or neither vehicle had a signal or a stop sign on their approach, these collisions almost invariably occurred. These collisions typically occur when the turning driver fails to spot an oncoming car or miscalculates the gap required to make a successful left turn. Vehicle B turns left when it collides with Vehicle A, which is arriving from the other direction and passing on the right side of another vehicle, as illustrated in *Fig. 7*. Passing (overtaking) on the right of another vehicle is prohibited. As a result, Vehicle A would be held entirely accountable.

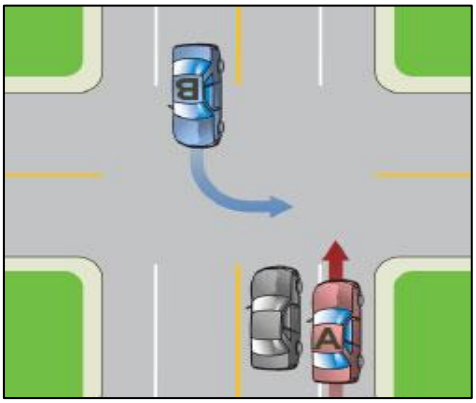

FIG. 7. TURNING LEFT SCENARIO.

Accidents occur in the second scenario when a car makes a right turn from a wide lane and collides with another vehicle attempting to pass on the right. Vehicle B collides with Vehicle A, which is passing on the right in *Fig. 8* while making a right turn in a wide lane. Drivers must make right turns as close as possible to the curb or edge of the road and not pass (overtake) another vehicle on the right. As a result, Vehicle A would be responsible for 75% of the damage, while Vehicle B would be responsible for 25%.

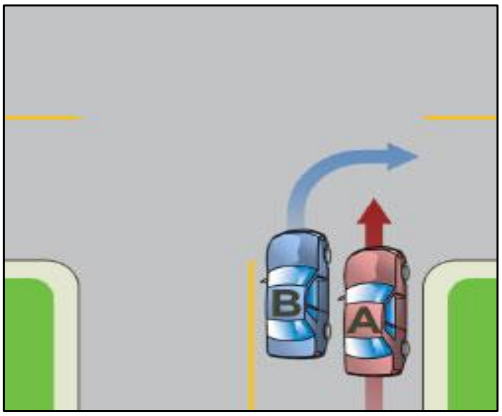

FIG. 8. TURNING RIGHT SCENARIO.

Rear-End/Lead Vehicle Stopped is the final circumstance. Vehicle A is traveling straight, and then it closes in on a halted lead B vehicle. Vehicle B is stopped or slowed down when it is rear-ended by

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Vehicle A, as shown in *Fig. 9*. Even in an emergency, drivers must be far enough behind another car to stop safely. As a result, the driver of Vehicle A would be held entirely accountable.

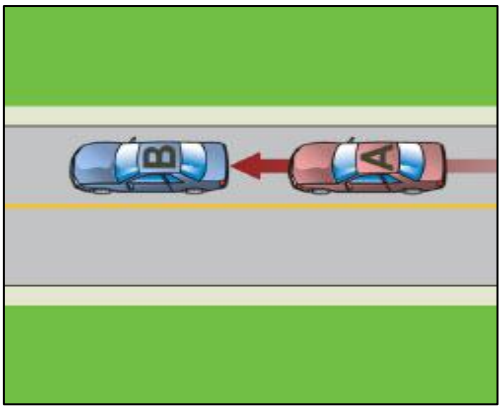

FIG. 9. REAR-END CRASH WITH TWO VEHICLES.

IV. CONCLUSIONS

Road traffic accidents are one of the top causes of death worldwide. As a result, using modern technologies like the Internet of Things and wireless sensing networks to solve this problem is a hot topic of research. This paper presents a smart vehicle prediction system that can alert the driver of any impending obstacles or other cars. A hardware and software platform has been used to create the system. It relies on the Raspberry Pi component to reflect the signal and analyze it in order to divert the car to safety. The test findings demonstrated that the proposed method of vehicular car positioning had obtained accurate results in steering the car away from the obstacles in each scenario after experimenting with the CPMV in two different situations. It is preferable to scale up the CPMV system as a guideline for future development. For example, a traffic police authority or any other higher government authority can fund and scale up CPMV and build Wi-Fi units on the many roads connecting the CPMV all over a metropolitan area. The suggested system uses a series of sensors to anticipate collisions between cars and between vehicles, people, vehicles, and infrastructure via Wi-Fi and Bluetooth, with a precision of 360° and distance of collision prediction of one meter and at a speed of 200-300 revolutions per minute.

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