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IoT Based Accident Prevention System for Hairpin Bend Roads

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Abstract

According to survey, 10% of the total vehicle accidents happen on curved segments in hill stations. It is risky while driving in bends and curves. In order to provide solution, an IoT based Accident Prevention System for Hairpin Bend Roads has been proposed in this work. The objectives of the proposed work are to provide a safe and comfort hill travel by avoiding accidents mainly at the Hairpin bends and U curves, and to alert the drivers of both the vehicles approaching the bend, by generating traffic warning signal that indicates the arrival of a vehicle ahead on the opposite side of the bend. The proposed system includes ultrasonic sensor to detect any vehicle reaching the hairpin bend and alert immediately the vehicles on the other side by enabling an yellow signal. In the proposed work, NodeMCU is used as a processing element which supports ESP-NOW communication technology to enable two-way communication. Therefore, this system reduces the incidence of vehicle collision especially in the forest or hilly region which has poor internet connection. To solve connectivity issues, it has been implemented with machine-to-machine communication protocol without internet.

Keywords: Internet of Things, Road safety system, NODE MCU Sensor System and ESP - NOW protocol

1. Introduction

Every year, almost 60,000 individuals are killed in traffic accidents. Accidents result in property loss, injury, and sometimes death. Accidents cannot be completely avoided, but they can be mitigated with appropriate traffic management. India has the highest rate of traffic accidents in the world [5]. Most of road accidents are caused at high speeds or when the driver is unaware of other vehicles approaching from behind, especially in deep turns. Hair pin curves are a form of curve like this. The current system employs convex mirrors at

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curves to allow the driver to readily spot vehicles approaching from the other direction. This technique is successful during the day but not at night.

In the proposed system, sensors are placed at hairpin corners; they perform extremely well at night. The problem can be fixed by placing sensors on each side of the bends. If the vehicle is 5 meters away from the curve, the sensor transmits a signal in the form of light to the vehicle approaching from the other direction. The sensor on the other side of the curve sends a signal to the vehicle approaching from the opposite direction in the same way. As a result of the use of sensors, a greater number of accidents, particularly at deep turns, can be avoided. Reducing the number of accidents improves a person's well-being. The objectives of the proposed system are

- To provide a safe and comfort hill travel by avoiding the accident mainly at Hairpin and U curves
- To alert both the vehicle drivers approaching hairpin or U curves through generating traffic warning signal that indicates a vehicle ahead on the opposite side of road bend.

It is used to control the accidents by displaying alert message to the drivers on the opposite side. To avoid the road accidents and improve the ability of vehicle detection has always been the focus of the research [6].

2. Related Work

Bhumika R & Harshith S A, (2021) [2] proposed Accident prevention and Road safety in Hilly Region using IoT Module which is used to screen and improve the security in sloping regions by utilizing wireless sensor networks and Internet of Things. Remote sensing employs self-contained detecting devices in areas vulnerable to the aforementioned causes, and these sensors then send data to workers about the likelihood of a setback, thereby providing an alert sign to all so that appropriate assistance can be provided and steps taken to avoid or mitigate the disaster's consequences.

Sujatakadu, et al., [3] proposed accident identification and alert system using GPS which aims at providing immediate aid to the person driving whenever an accident occurs. This work helps in the reduction of accident rates by detecting accidents and alerting family members, as well as neighbouring police control rooms and hospitals. This also concentrates

on accident prevention rather than immediate action in the case of an accident, in order to save lives.

T Kalyani, et al., (2019) [4] proposed Accident detection and alert system, which detects the accidents using vibration sensor when the vehicle is involved in the accident and sends the information to the registered number through GSM module. The location of the device is provided through a tracking system using GPS to cover the geographical coordinates of the entire area.

Jessen Joseph Leo & R Monisha [1] proposed "Vehicle Movement Control and Accident Avoidance in Hilly Track" which provides an interface between the man and the machine to lessen the burden on the drivers. Sensors, communication and GPS converge in the suggested system to produce a synergic answer to this threat. The location of the vehicles in relation to the hairpin turn is determined by GPS technology, which determines the order in which vehicles must proceed. The vehicle's speed is automatically controlled based on GPS data on the curve's type. If a vehicle breaks down in the control zone, the information is relayed to another vehicle, which can then take appropriate action.

Vehicle Horn , Headlights and Convex Mirrors and CCTV are the methods being followed to avoid accidents in a hairpin bend on a Hilly track, Ghats and zero visibility regions [7,8]. Most of the existing system are implemented using wired technology, wireless communication, and camera. These methods are difficult to maintain and not cost effective. The CCTV camera system can only cover a limited area and might not cover all activity due its positions [9].

From the literature survey, it has been observed that all the existing systems require internet connection. But the network connectivity will be low in hilly/forest area. To solve this, ESP NOW protocol has been implemented in the proposed system to establish the communication between the systems without internet which alerts both the vehicle drivers approaching hairpin or U curves through generating warning signal which indicates a vehicle ahead on the opposite side of road bend through displays.

3. Proposed System

The main objective of a project is to provide a safe and comfort travel in hill regions without using internet. The proposed system consists of two systems. One system is

established in uphill and another system is established in downhill. Fig 1 shows the block diagram of the proposed system.

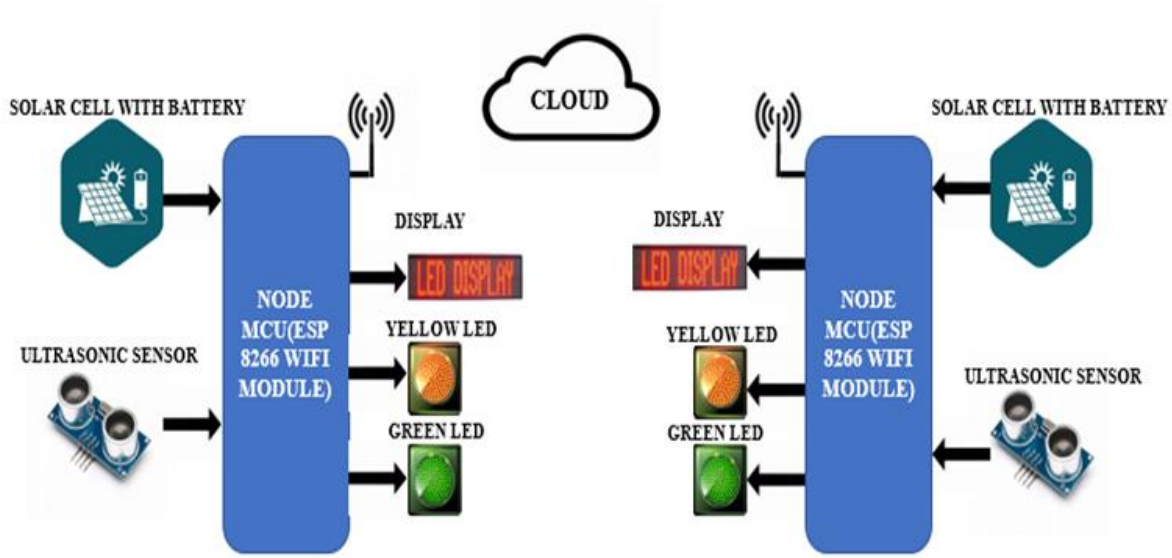

Figure 1. Proposed system model

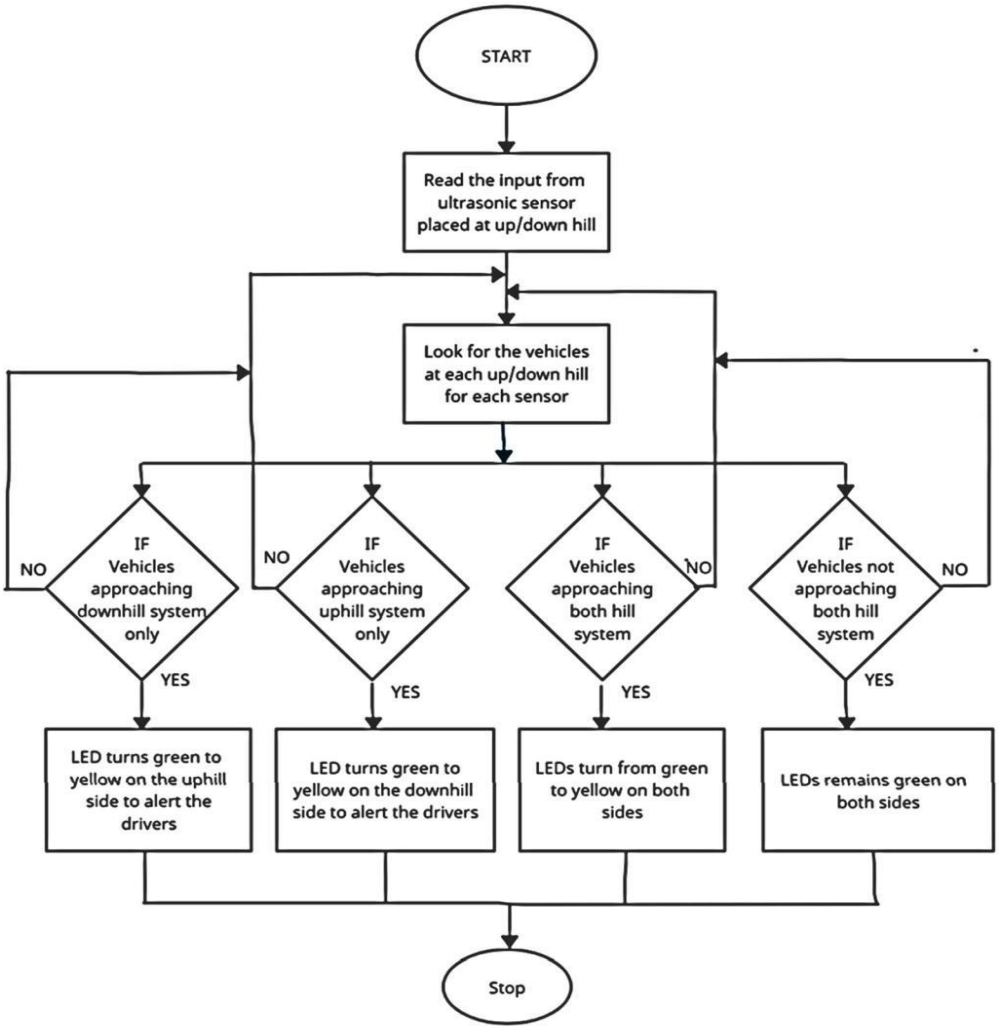

Figure 2. Flowchart of the proposed system

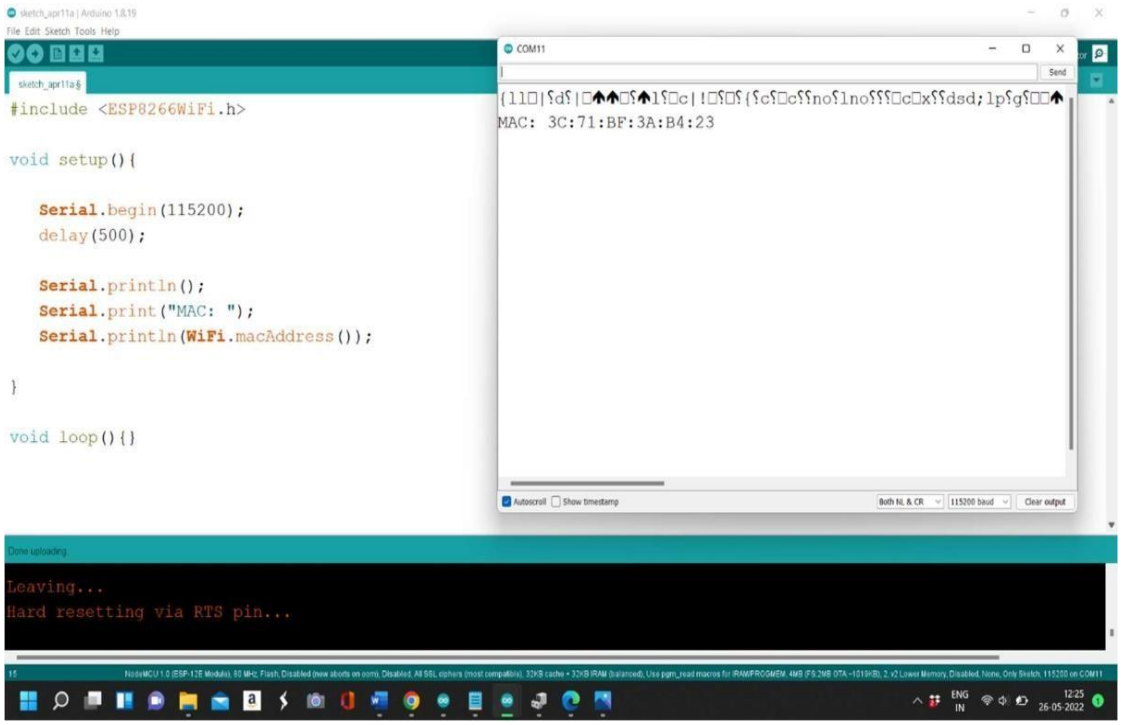

Figure 3. Finding MAC addresses of Node MCU

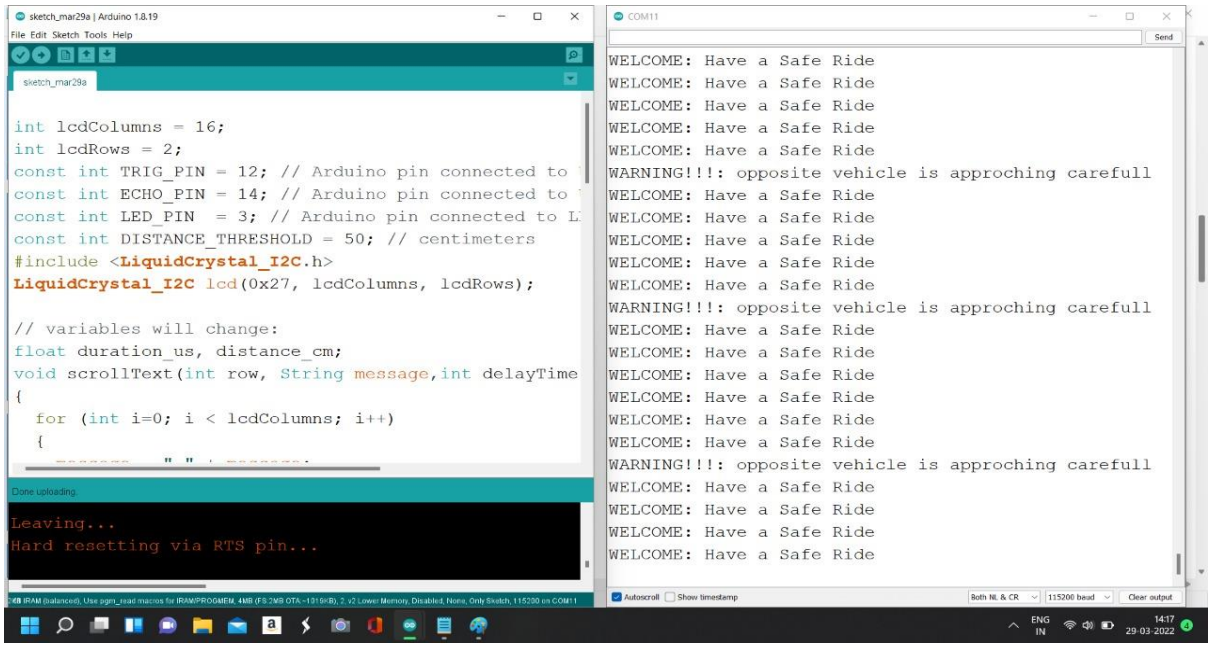

Figure 4. Two-way communication between two Node MCUs

Each system consists of one ultrasonic sensor for detecting the vehicle, NodeMCU module is used to establish the communication between uphill and downhill system, LCD and LED are used for alerting the vehicle drivers and solar cell is used for restoring the power supply. If one vehicle is approaching one system, ultrasonic sensor detects the vehicle by transmitting Ultrasonic waves. NodeMCU present in the system transmits ‘1’ if vehicle is

detected otherwise transmit ‘0’ if vehicle is not detected. If the system receives ‘1’, the LED present in the system changes from green to yellow. If the system receives ‘0’ the LED changes from yellow to green. If the vehicle is detected on the uphill system, the LED present in the downhill system turns from green to yellow. If the vehicle is detected on the downhill system the LED present in the uphill system turns from green to yellow. If the vehicle is detected on the uphill and downhill system, the LED changes from green to yellow on both sides of the system. If no vehicle is detected, the LED turns from yellow to green on both sides of the systems.

Fig 2 describes workflow of the proposed system. At first step ultrasonic sensor senses the vehicle until the vehicle is detected on both side of the roads. The protocol implemented in NODE MCU is used to provide a communication between the systems without using internet. MAC address is used in place of internet. ESP-NOW protocol is a fast, connectionless communication technology featuring short packet transmission which enables multiple devices to communicate with one another without using WI-FI by finding and pairing MAC addresses of the NodeMCUs and its response speed is high when compared to other protocol. Fig 3 & 4 shows the communication between two NODE MCUs placed in both uphill and downhill system using ESP NOW protocol.

4. Results and Discussion

The proposed sensor-based safety system can be placed at a hairpin bends to alert vehicle drivers using the road. If The road is narrow, has sharp bends and deep valley sides. Visibility of vehicles coming in the opposite direction at the hairpin bends is not much and hence there are risks of accidents [7,10].

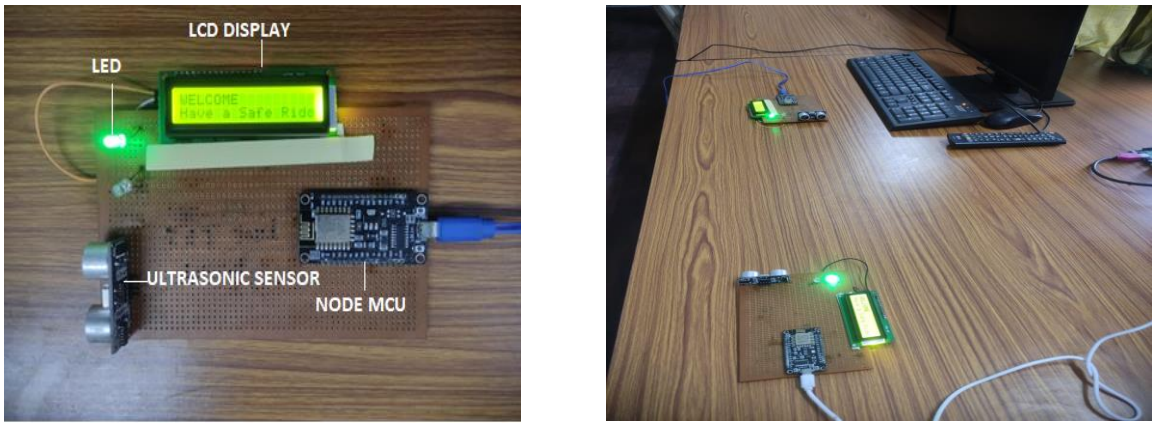

Figure 5. Hardware setup of the proposed system a) top view. b) side view

The system has been developed to warn the vehicles of those coming in the opposite direction at the bends. Two systems are placed at the bend to warn drivers of vehicles coming in both the directions. Each system has NODE MCU module, ultrasonic sensor and LCD display that are powered by solar energy. When a vehicle passes within five feet of the sensor, it displays a warning message on the board and gives warning blinks. This alerts the driver of the vehicle coming in the opposite direction to slow down. Fig 5 shows the hardware setup of the proposed system.

4.1 Case (i) Vehicle Approaching Downhill System

If the vehicle is detected on the downhill system, the LED present in the uphill system turns from green to yellow which is shown in Fig 6.

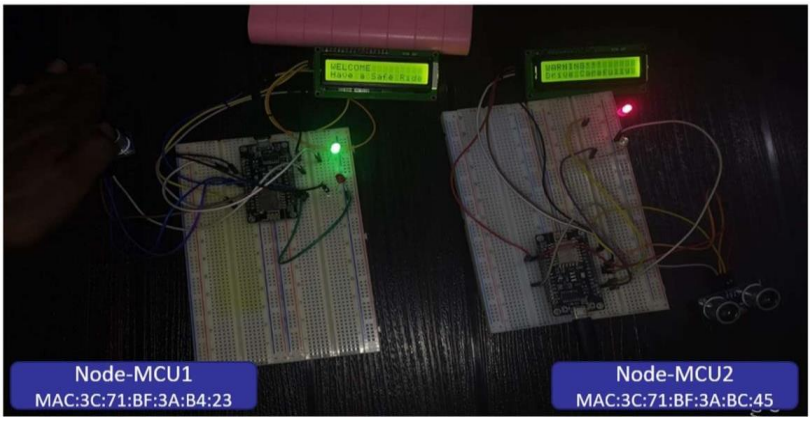

Figure 6. Vehicle approaching downhill

4.2 Case(ii) Vehicle Approaching Uphill System

If the vehicle is detected on the uphill system, the LED present in thedownhill system turns from green to yellow which is shown in Fig 7.

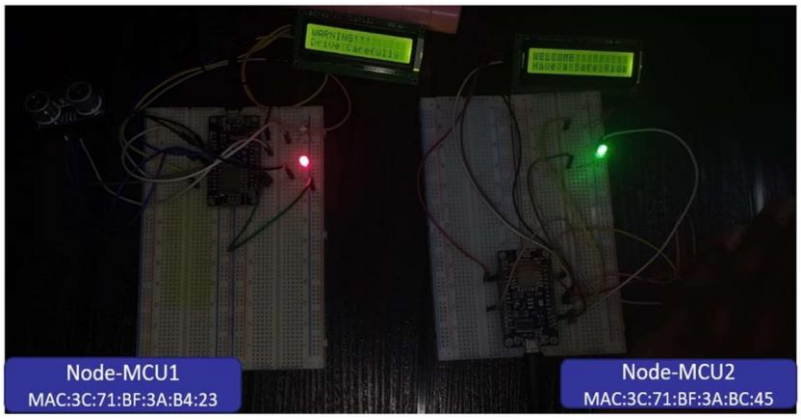

Figure 7. Vehicle approaching uphill

4.3 Case (iii) Vehicles not approaching both the systems

If no vehicle detected on both uphill and downhill system, the LED present in both the system changes from yellow to green.

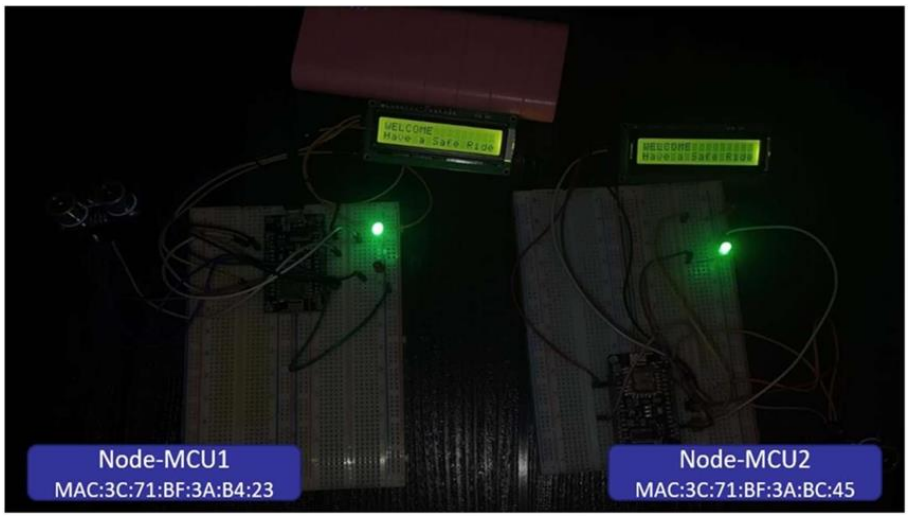

Figure 8. Vehicles not approaching both the systems

4.4 Case (iv) Vehicle approaching both the systems

If vehicle is detected on both uphill and downhill system, the LED present in both the system changes from green to yellow.

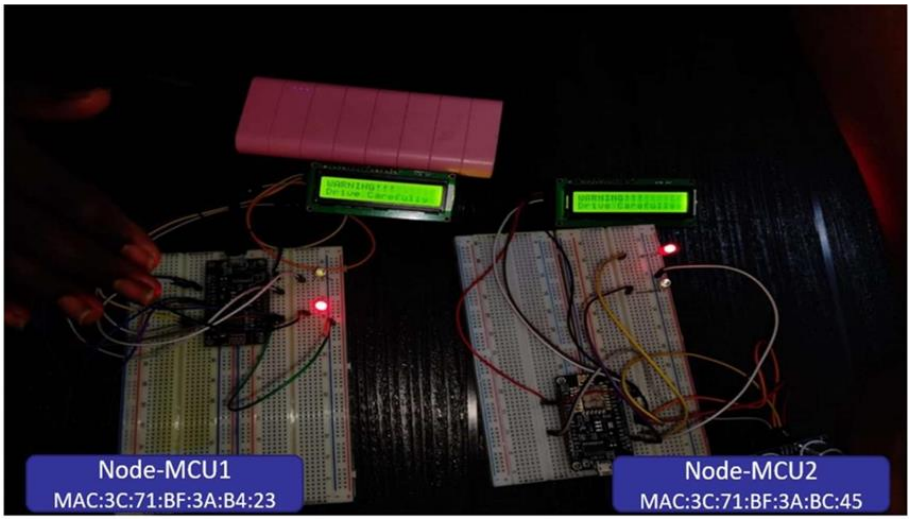

Figure 9. Vehicle approaching both the systems

5. Conclusion

As the usage of vehicles is being increased drastically, the hazards due to vehicles also increases. This paper has proposed a solution to overcome one such road accident

occurring on the hairpin bend roads, by introducing the vehicle detection system. Node MCU is the heart of the system which helps in transferring the message to different devices in the system. With the help of ESP-NOW, it alerts the drivers of both the vehicles approaching hairpin or U curves by generating traffic warning signal that indicates that there is a vehicle ahead on the opposite side of the bend through displays, without internet. The proposed program conveys the vehicle detection message and provides user a warning. For future scope, solar energy can be used to recharge the battery because it is difficult to bring electricity from urban areas. Machine learning can be used for image processing to give appropriate object detection like human beings, animals, vehicle and many more on the bends.

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