E-ISSN:2250-0758
P-ISSN:2394-6962

Research Article

IoT

International Journal of Engineering and Management Research

2025 Volume 15 Number 2 April

Publisher
Vandana Publications
www.vandanapublications.com

IOT-Based Accident Prevention System: A Model Experiment for U-Turn Curves

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DOI:10.5281/zenodo.15365062

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In today's world, the combination of high population density and the widespread use of vehicles has led to a serious concern: the increasing number of road accidents. Every year, thousands of people lose their lives or suffer serious injuries in such incidents. In developing countries like India, road accidents remain one of the leading causes of death. National highways, as well as mountain and hill areas, have dangerous roads and curves that are narrow and single-lane. Accidents at U-turns commonly occur due to limited sight distance, especially on curved or hilly roads, where drivers cannot see oncoming traffic in time to react safely. Inadequate road signage, poor lighting, and lack of dedicated turning lanes further increase the risk. Additionally, high vehicle speeds, misjudgment of gaps in traffic, and sudden or illegal U-turns made without proper signaling often lead to collisions. In areas with high traffic volume or narrow roads, the risk multiplies as vehicles may not have sufficient space or time to complete a U-turn safely. Addressing these risks requires a combination of improved road design, warning systems, enforcement of traffic laws, and driver awareness. At these curved sections, drivers are often unable to see oncoming vehicles or obstacles, and if their vehicle is not in good condition, it becomes difficult to control, increasing the risk of accidents. To minimize such accidents, we propose a project aimed at preventing collisions at U-turns by alerting drivers to oncoming vehicles. This is done by keeping an ultra sound sonic sensor on both sides of the U-turn and so that if vehicle comes from one end of the curve, then sensor senses and it gives signal to Arduino and Arduino gives command to LED lights of the other side in order to alert the driver.

Keywords: U Turn, IOT, LED Light, Sensor, Signal, Vehicle, Driver, Accident, Prevention

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How to Cite this Article

Devaki K, Manojna BK, Reddy BJ, Reddy BS, Reddy KH, IOT-Based Accident Prevention System: A Model Experiment for U-Turn Curves. Int J Engg Mgmt Res. 2025;15(2):108-114.
Available From
https://ijemr.vandanapublications.com/index.php/j/article/view/1738

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Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
2025-03-06	2025-03-31			2025-04-20

Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
None	Nil	Yes	4.91	

1. Introduction

The constantly growing transportation sector has led to a daily increase in road accidents. These accidents often occur due to human error, such as carelessness and violations of traffic rules. To address specific safety issues at intersections, indirect left-turn treatments have increasingly been adopted as design alternatives. These methods help mitigate the risks associated with right/left-turn manoeuvres from side streets or driveways at two-way stop-controlled intersections. This project proposes a system designed to prevent vehicle collisions, particularly in high-risk areas such as U-turn bends, hairpin bends, sharp corners, and blind curves. The system alerts drivers towards the possible accidents through the sensors and warning signals. To reduce accidents caused by driver negligence, the system provides warnings through light indicators. This accident-avoidance system employs infrared sensors and IOT technology to enhance road safety. It is designed to minimize the severity of accidents and improve overall traffic management. By detecting oncoming vehicles and warning drivers in advance, the system helps to prevent collisions. Traffic signals continue to play a crucial role in managing the allocation of road space by assigning right-of-way to different traffic movements in a controlled manner.

What is IOT System

Devices that connect wirelessly to a network and have the ability to transmit data are known as Internet of Things (IoT) devices. Examples of these include sensors, actuators, and appliances. IoT makes it possible to connect to the internet through a variety of conventionally dumb or non-internet-enabled physical devices and commonplace items, in addition to standard computing devices like desktops, laptops, smartphones, and tablets. These gadgets are equipped with technology that allows for remote monitoring and control, as well as internet-based communication and interaction. IoT devices are used in both consumer and industrial settings, and they are frequently incorporated into other tools like mobile phones, medical equipment, and industrial machinery. They can also be applied in smart cities across a wide range. They are then utilized to communicate with other IoT devices via a network or send data. In addition to offering real-time data for industrial or enterprise use cases, IoT and IoT devices help consumers make everyday tasks quicker, simpler, or more convenient.

2. Items Used to Make the Prototype

To test this, experiment the following items are used.

Sl. No	Particulars of the items	Quantity
01	Arduino Uno	01
02	Ultra Sonic Sensors	02
03	LED Lights - Red	02
04	LED Lights – Yellow	02
05	LED Lights - Green	02
06	Bread Board	01
07	Jumper wires M-M	01
08	Jumper wires M-F	01
09	Jumper wires F-F	01
10	Cardboard sheet	A1/A3 Size

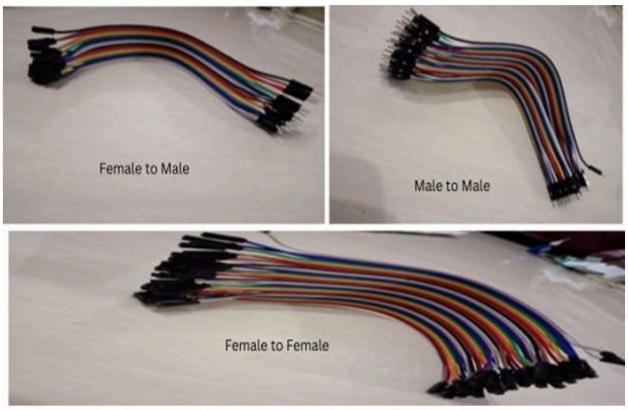
3. Process of Making the Prototype

To make the prototype, we need the following items: a cardboard sheet, one Arduino Uno, two ultrasonic sensors, two sets of LED lights in red, yellow, and green colors, a breadboard, and jumper wires (male-to-female, female-to-female and male-to-male). After gathering the required items, take the cardboard sheet, cover it with white paper, and draw the U-turn Road according to the correct dimensions as shown in the figure. Next, we have to place the sensors, LED lights, breadboard, and Arduino Uno based on the U-turn markings, as shown in the figure. Before connecting the jumper wires, it's important to understand the basic purpose of each type of jumper wire.

1. Jumper Wire

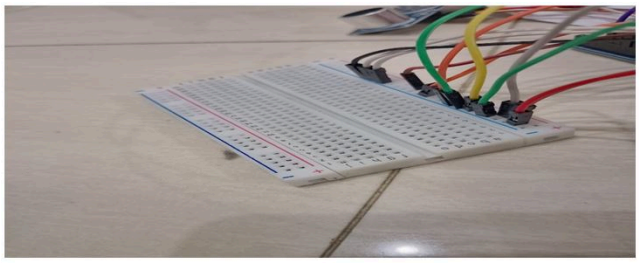
- **Male-to-Male (M-M)** jumper wires have pins on both ends and are used to connect two female ports, such as on a breadboard and Arduino.
- **Male-to-Female (M-F)** jumper wires have one pin and one socket, useful for connecting a male header (like on a sensor) to a female port.
- **Female-to-Female (F-F)** jumper wires have sockets on both ends and are used to connect two male pins or headers.

These wires are essential for making temporary connections in electronic circuits without soldering.



2. Bread Board

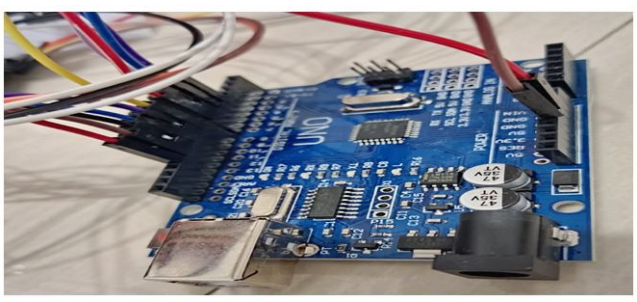
A **breadboard** is an instrument for creating and testing electronic circuits without soldering. To make temporary circuits, jumper wires and electronic components can be inserted into its grid of holes. To make wiring easier, the internal connections are arranged in rows and columns. Before building a permanent version, circuit designs can be tested and prototyped using breadboards.



3. Arduino Uno

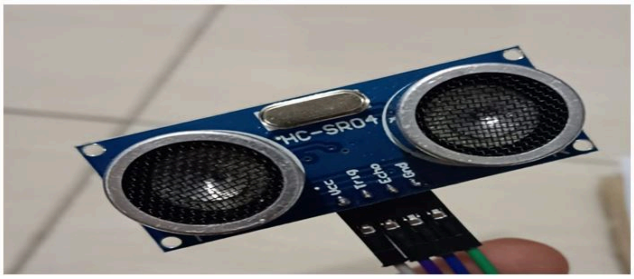
Arduino Uno is a micro controller where mostly used in IOT projects and also in electronics for Starters and experienced individuals. In Audino uno it contains 14 pins of digital output and input. Power jack, reset button and USB port. The power supply could be about 5v. You can connect an USB wire for the pc or laptop an do the work. Generally, it is like a brain to all IOT sensors.

In our project this will be helpful to connect the Ultra sonic sensors and leds. We have to connect ground and Vcc for the bread board.

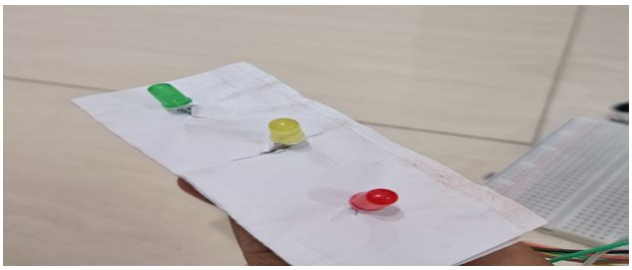


4. Ultra Sonic Sensor

An **ultrasonic sensor** is commonly used to measure the distance of an object. In our U-turn Road project, it is specifically used to detect an approaching car. The sensor can measure distances ranging from a minimum of 2 cm to a maximum of 400 cm. When a car is moderately far, the system activates a yellow LED, and when it comes very close, it triggers a red LED.



5. Led Lights

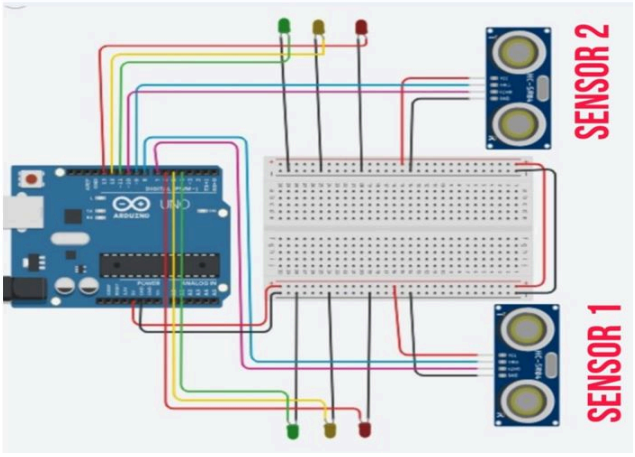


In our project, we utilized three LEDs: red, green, and yellow. As depicted in the illustration, the longer leg of the LED serves as the positive terminal (anode), while the shorter leg functions as the negative terminal (cathode). These three LEDs are employed to signal the location and distance of an oncoming vehicle. Two sets of LEDs need to be linked to the ground using jumper wires.

For the positive terminals: The Arduino Uno's red, yellow, and green LEDs are connected to pins 6, 5, and 4, respectively, in Set 1. In Set 2, pin 13 is linked to the red LED, pin 12 to the yellow LED, and pin 11 to the green LED.

To help visualize the setup, refer to the pin diagram provided.

To upload and get the output we have to connect an USB cable for the laptop or an pc and also, we have to download Arduino IDE app vision 1.8.19. We have to upload a code to run the project.




```
const int trig1=8;
const int trig2=9;
const int echno1=7;
const int echno2=10;
const int red1=6;
const int red2=13;
const int yel1=5;
const int yel2=12;
const int gr1=4;
const int gr2=11;
void setup()
{
 pinMode(trig1,OUTPUT);
 pinMode(trig2,OUTPUT);
 pinMode(echno1,INPUT);
 pinMode(echno2,INPUT);
pinMode(red1,OUTPUT);
 pinMode(red2,OUTPUT);
 pinMode(yel1,OUTPUT);
 pinMode(yel2,OUTPUT);
 pinMode(gr1,OUTPUT);
 pinMode(gr2,OUTPUT);
}
void loop()
{
 digitalWrite(trig1, HIGH);
 delayMicroseconds(10);
 digitalWrite(trig1, LOW);
 int duration = pulseIn(echno1, HIGH);
 int distance = duration * 0.034 / 2;
 // Check distance and alert drivers
 if (distance <7) { // Adjust distance threshold
 digitalWrite(red2, HIGH); // Red LED indicates danger
digitalWrite(yel2, LOW);
 digitalWrite(gr2, LOW);
 } else if (distance <20) {
 digitalWrite(red2, LOW);
 digitalWrite(yel2, HIGH); // Yellow LED indicates caution
 digitalWrite(gr2, LOW);
 } else {
 digitalWrite(red2, LOW);
 digitalWrite(yel2, LOW);
 digitalWrite(gr2, HIGH); // Green LED indicates safe distance
 }
 digitalWrite(trig2, HIGH);
 delayMicroseconds(10);
 digitalWrite(trig2, LOW);
```

```
 digitalWrite(yel2, LOW);
 digitalWrite(gr2, HIGH); // Green LED indicates safe distance
 }
 digitalWrite(trig2, HIGH);
 delayMicroseconds(10);
 digitalWrite(trig2, LOW);
 int duration2= pulseIn(echno2, HIGH);
 int distance2= duration2 * 0.034 / 2;
// Check distance and alert drivers
 if (distance2<7) { // Adjust distance threshold
 digitalWrite(red1, HIGH); // Red LED indicates danger
 digitalWrite(yel1, LOW);
 digitalWrite(gr1, LOW);
 } else if (distance2<20) {
 digitalWrite(red1, LOW);
 digitalWrite(yel1, HIGH); // Yellow LED indicates caution
 digitalWrite(gr1, LOW);
 } else {
 digitalWrite(red1, LOW);
 digitalWrite(yel1, LOW);
 digitalWrite(gr1, HIGH); // Green LED indicates safe distance
 }
 delay(100);
}
```

Now we have to mark the single-lane road on the cardboard sheet. We have to place the Arduino Uno, ultrasonic sensors, red, yellow, and green LED lights, breadboard, and jumper wires (male-to-female, female-to-female and male-to-male,) in their designated positions as shown in the figure below. Now, it is time to test the prototype.

4. Findings and Testing the Prototype

To test this experiment, we used model toy cars and started operating them from both sides of the road. When the cars are at a distance, the green LED lights are lit. As the cars approach each other and are at a moderate distance, the yellow LED lights are giving indication. When the cars get very close, the red LED lights turn on, alerting the driver to slow down their vehicle speed. All these steps are demonstrated in the figures below.

Figure 1: Both the cars from the starting points of both the side of the road, both the cars are about to start.

Figure 2: If there is only one car on the road, a green LED light on the same side will blink, while a yellow LED light on the opposite side will blink to alert oncoming vehicles.

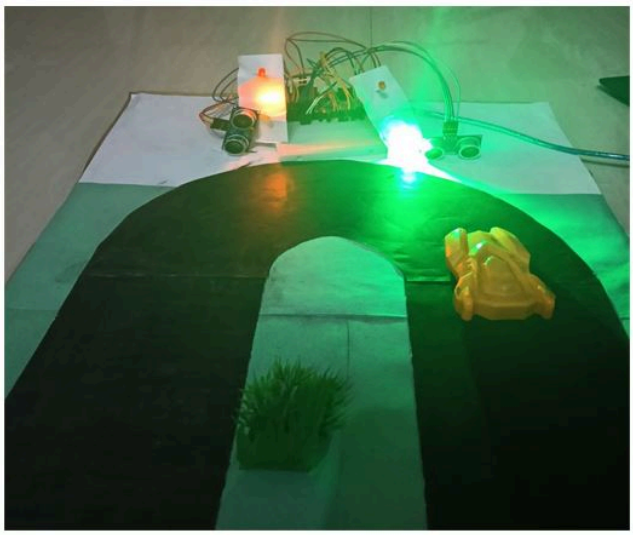


Figure 3: When two cars start, green LED lights start blinking on both sides.

Figure 4: When two cars from opposite sides reached to moderate distance, yellow LED lights start blinking to alert drivers on both sides.

Figure 5: When two cars are reached to very near-by distance red color LED lights are blinked to alert the danger.

5. Conclusion

The suggested system is very useful for IoT-driven real-time applications that need quick reactions, like identifying possible accidents and sending out warnings in low-visibility situations like U-turns, because it allows for localized and dependable data processing. Low latency, regional information management, and improved traffic control capabilities are just a few of its many advantages. With real-time alerts based on distance calculation and obstacle detection systems, these features are essential for lowering accident risks and improving road safety in dangerous situations. Research has shown that it is possible to address particular road safety issues with straightforward but efficient IoT solutions. Using ultrasonic sensor technology, the system accurately detects U-turns, which are frequently accident-prone in blind spots. LED integration also gives pedestrians and cars in the area visual alerts that are easy to read and comprehend. Apart from the system's potentiality, it is critical to recognize its drawbacks and difficulties. Test results show that the suggested model offers improvements in response time and execution speed when compared to alternative designs. This study presents an Internet of Things (IOT)-based solution for real-time collision detection, improving traffic flow, and transmitting vital data for quick response.

Future studies can improve the application of IoT mechanisms to predict pedestrians, guide U-turn predictions, and offer real-time driver assistance.

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