A

Report On Research Project

"Collision Alert System At Blind Spot Using Motion Sensor"

(Under-"Undergraduate Research Experience" Track)

Submitted

in partial fulfillment of the requirements for the degree of

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by

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(An Empowered autonomous Institute, Affiliated to Shivaji University, Kolhapur)

Department of Electronics &Telecommunication Engineering

CERTIFICATE

This is to certify that the project work titled **"Collision Alert System At Blind Spot Using Motion Sensor"** under- "Undergraduate Research Experience" track is the bona fide work submitted by the following student, to the Rajarambapu Institute of Technology, Rajaramnagar during the academic year 2024-25, in partial fulfillment for the award of the degree of B. Tech in Electronics & Telecommunication Engineering under our supervision. The contents of this report, in full or in parts, have not been submitted to any other Institution or University for the award of any degree.

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DECLARATION

I declare that this report reflects my thoughts about the subject in my own words. I have sufficiently cited and referenced the original sources, referred or considered in this work. I have not plagiarized or submitted the same work for the award of any other degree. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute.

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ABSTRACT

Collisions in blind corners of buildings, passages, and hallways are common, especially in high traffic areas like offices, hospitals, schools, and shopping malls. These incidents can cause injuries, disruptions, and inefficiencies in movement. Existing solutions, such as mirrors and signs, require user awareness and may not always be effective. This technology solves the problem by actively detecting potential collisions and providing an immediate alert through a buzzer, reducing the chances of accidents. Discussion of Related Art The opening of doors continues to cause injuries to persons and damage to objects when doors are opened by a person on one side of the door while a person or moving object is on the opposite side of the door. When a person is about to operate a door from one side, they normally cannot determine whether or not a person or movable object carried or pushed by another person is on the other side of the door. As a consequence, the potential exists that the door may strike a person or movable object on the opposite side of the door. Similarly, people moving along or past a visual barrier, such as a wall or screen, may collide with other people or movable objects moving toward them from the other side of the visual barrier. It is therefore desirable to prevent injury and damage when people and/or movable objects approach each other from adjacent areas that are mutually not visible to one another. One solution to the problem as it relates to adjacent areas on opposite sides of a door is to place a window in the door so that a person about to open the door may observe activity on the opposite side before opening the door. This solution is not practical if the door is intended to provide privacy and/or security. Furthermore, where doors are opened quickly or people are moving quickly, it may be that a visual assessment through a window does not provide sufficient warning of a potential collision. One reason for this is that, the person opening the door must actively look through the window and assess what is observed. This may difficult when the area on the other side of the door is poorly lit or s when the person opening the door or the person/object on the other side of the door is moving quickly. One solution related to adjacent areas around blind corners in hallways and adjacent areas on different sides of other visual obstructions is to place a convex mirror such that people moving from opposite sides of the obstruction can see one another. This solution has the advantages of being simple and inexpensive but suffers form the draw-backs including not functioning well if one or both sides of the obstruction are poorly lit and that it requires each person to actively look at objects in the mirror to determine if anything or anyone is moving or obstructing the opposite side of the visual barrier.

Keywords – Collision Alert, Blind Spot, Real time operating system, Safety

CONTENTS

LIST OF FIGURES AND TABLES

Chapter 1. Introduction

1.1 Background

Human collision avoidance is a critical concern in a wide range of environments where individuals are constantly on the move. These include educational institutions, healthcare facilities, workplaces, and public venues. In such places, individuals may be walking or running, often unaware of others approaching from different directions. Traditional methods to prevent collisions, such as visual signage, designated lanes, or human vigilance, are often insufficient due to limited visibility, distractions, or high-speed movements. For instance, in schools and universities, students rushing between classes can unintentionally collide with one another, leading to minor or serious injuries. In hospitals or elder-care facilities, such collisions can be even more dangerous due to the frailty of patients or elderly residents.

The need for a non-intrusive, automated, and efficient collision avoidance mechanism has never been more relevant. With the growing complexity of indoor infrastructure and increased human density in confined spaces, technology-driven solutions are essential to proactively manage human movement. This is especially important in environments where visual contact between individuals may be restricted due to architectural design or obstructions, making manual collision prevention ineffective.

With the advent of smart sensing technologies and embedded systems, there is an increasing shift toward automated solutions for safety and monitoring. Sensor-based detection systems have emerged as reliable tools for capturing real-time human movement without requiring direct user interaction. Among these, Passive Infrared (PIR) sensors are particularly effective and affordable for motion detection applications. PIR sensors measure infrared radiation emitted from bodies, enabling them to detect motion within a specific range. They offer advantages such as low power consumption, ease of deployment, and immunity to ambient light conditions

1.2 Collision Alert in Blind Corners

Navigating through buildings, passages, and corners can often lead to unintended collisions, especially in high-traffic areas. This project proposes a collision detection and alert system that enhances pedestrian safety indoors. The system utilizes four proximity sensors strategically placed at building corners to detect the presence of individuals approaching from opposite directions. When two persons are detected within a predefined collision range, the sensors send signals to a microcontroller, which then activates a buzzer to alert them of a potential collision. This real-time warning system helps individuals take necessary precautions, reducing accidents and ensuring smooth movement within confined spaces. This technology is particularly useful in hospitals, offices, schools, and crowded buildings, where blind corners pose safety risks. The system is cost-effective, easy to implement, and operates autonomously, making it a practical solution for improving indoor pedestrian safety.

1.3 Problem Solved

Collisions in blind corners of buildings, passages, and hallways are common, especially in high-traffic areas like offices, hospitals, schools, and shopping malls. These incidents can cause injuries, disruptions, and inefficiencies in movement. Existing solutions, such as mirrors and signs, require user awareness and may not always be effective. This technology solves the problem by actively detecting potential collisions and providing an immediate alert through a buzzer, reducing the chances of accidents.

1.4 Advantages Over Competing Technologies:

1. Active Detection vs. Passive Solutions – Unlike mirrors or signs, which require users to pay attention, this system automatically detects potential collisions and alerts individuals.
2. Real-Time Warning – Provides an instant audible alert instead of relying on visual cues, making it more effective in low-visibility conditions.
3. Cost-Effective – Uses simple sensors and a microcontroller, making it affordable and easy to install compared to high-tech alternatives like camera-based AI systems.
4. Low Power Consumption – Unlike camera-based or AI-driven systems, which require continuous monitoring and processing, this system is energy-efficient.
5. Scalability – Can be deployed in multiple locations with minimal cost, making it versatile for different buildings and layouts.

1.5 Objectives of the Study

The primary objective of this invention is to enhance pedestrian safety within buildings by preventing collisions at blind corners, passages, and hallways. The system detects individuals approaching from opposite directions using two proximity sensors and alerts them via a buzzer if they are within a potential collision range.

1.6 Need It Fulfills:

Prevents Accidental Collisions in high-traffic indoor spaces like hospitals, offices, malls, and schools. Enhances Safety for visually impaired individuals, children, and the elderly. Reduces Workplace Accidents, especially in industrial settings where unexpected movement can lead to injuries. Increases Awareness by providing real-time, automatic alerts instead of relying on passive warning signs.

Chapter 2: Literature Review

Over the past two decades, there has been growing interest in applying sensor-based technologies for collision detection, motion tracking, and human safety systems. These technologies are increasingly integrated into public safety infrastructure, robotics, healthcare monitoring, and smart environments. This section reviews previous studies and developments that provide a foundation for the current research on human collision avoidance using PIR motion sensors.

Automotive collision avoidance systems (CAS) have been extensively studied and developed to prevent vehicle-to-vehicle collisions. These systems utilize sensors such as radar, lidar, and cameras to detect potential obstacles and provide warnings or automatic braking to avoid accidents. A comprehensive review by John Dahl et al. (2018) categorizes threat-assessment algorithms used in CAS, including single-behavior threat metrics, optimization methods, formal methods, probabilistic frameworks, and data-driven approaches like machine learning. These methodologies could be adapted for human-to-human collision detection by employing appropriate sensors and algorithms.[1]

Pedestrian detection systems in vehicles aim to identify and prevent collisions with individuals on foot. These systems often employ computer vision techniques and artificial intelligence to recognize pedestrians in the vehicle's path and initiate warnings or automatic braking. The principles of pedestrian detection, such as real-time image processing and pattern recognition, can be applied to detect individuals approaching a doorway from opposite sides. Implementing similar sensor technologies and algorithms could enhance the accuracy and reliability of a doorway collision warning system. [2]

Understanding human behavior and response to warning systems is crucial in designing effective collision avoidance technologies. Research by Shreeraman (2018) examines the effects of driver, vehicle, and environment characteristics on collision warning system design, emphasizing the importance of user acceptance and appropriate warning strategies. These insights highlight the need for intuitive and non-intrusive alert mechanisms in human-to-human collision warning systems to ensure users respond effectively without experiencing alarm fatigue. [3]

The selection of appropriate sensors is vital for accurate detection in collision warning systems. Ultrasonic sensors, infrared sensors, and cameras have been utilized in various applications to detect obstacles and measure distances. For instance, an Arduino-based forward collision detection system employs ultrasonic sensors to detect vehicles ahead and alert drivers to potential collisions. Adapting such sensor technologies for doorway applications involves configuring them to detect human presence and movement accurately, considering factors like sensor range, field of view, and environmental conditions.[4]

Research into door collision avoidance has primarily focused on preventing accidents between doors and obstacles, including humans. For instance, a patent by Rhode et al. (2018) discusses systems and methods for vehicle door collision avoidance, utilizing sensors to detect obstacles and prevent door operation to avoid collisions. Although centered on vehicle applications, the principles of obstacle detection and preventive measures can be adapted for human-to-human collision scenarios in doorway settings. [5]

Advancements in sensor technologies have significantly contributed to collision prevention systems. Pepperl and Fuchs offers dual-technology sensors combining motion detection and presence sensing to enhance safety in automatic door applications. These sensors utilize active infrared technology to create protective fields, preventing collisions by detecting the presence of individuals near doorways. Such technologies can be adapted to monitor both sides of a door, providing warnings when two people approach simultaneously. [6]

Similarly, OndoSense provides radar sensors designed for collision avoidance, capable of reliable obstacle detection even in challenging environmental conditions. These sensors can be employed in various applications, including monitoring pedestrian traffic in doorways to prevent collisions. [7]

PIR (Passive Infrared) sensors have been widely utilized for motion detection due to their affordability, energy efficiency, and ease of deployment. Mainetti et al. (2013) demonstrated that PIR sensors could effectively detect human presence in smart building applications, especially in low-light conditions where vision-based systems underperform. Rida et al. (2015) further illustrated how PIR sensors could be integrated into Internet of Things (IoT) frameworks for intelligent home automation and presence-based energy control.[8]

In the wake of the COVID-19 pandemic, wearable sensor technologies gained attention for enforcing social distancing. Ahmed et al. (2021) developed a wearable system using ultrasonic sensors that alerted users when interpersonal distance dropped below a threshold. However, the practicality of wearable systems is often challenged by issues such as discomfort, battery constraints, and the need for user compliance.[9]

For mobility assistance, Smith and Lee (2019) designed a collision detection system for motorized wheelchairs using infrared sensors. Although their system was effective for obstacle avoidance in a controlled setting, it was tailored to assistive devices and lacked generalizability to common pedestrian interactions.[10]

Zhao and Cook (2018) reviewed the concept of ambient intelligence, where unobtrusive sensors embedded in the environment monitor and respond to user behavior. They emphasized the use of PIR sensors for non-intrusive presence detection without compromising privacy, supporting the direction of the present study.[11]

More complex approaches utilize computer vision systems, such as the YOLO (You Only Look Once) object detection model by Redmon and Farhadi (2018). While these models offer real-time, high-accuracy object tracking, they require substantial processing power and raise concerns about surveillance and privacy, making them unsuitable for lightweight, privacy-preserving applications.[12]

Research by Nguyen et al. (2017) a hybrid sensor system combining PIR and ultrasonic sensors for indoor localization. This multi-sensor setup enhanced accuracy but increased system complexity and power demands. In contrast, simpler systems like the one proposed in this paper aim to achieve sufficient reliability using only passive sensors and a logical detection sequence. Indoor navigation aids for the visually impaired, utilizing a combination of sensors for pathfinding and collision warning. While valuable in accessibility design, the reliance on continuous user feedback mechanisms limits scalability to general applications.[13]

Open-source hardware platforms such as Arduino have significantly contributed to rapid prototyping of motion detection systems. Arduino.cc (2022) provides community-verified tutorials for integrating PIR sensors with microcontrollers, which serve as a valuable foundation for academic and hobbyist implementations alike.[14]

Chapter 3: Design and Simulation Implementation

3.1. Block Diagram

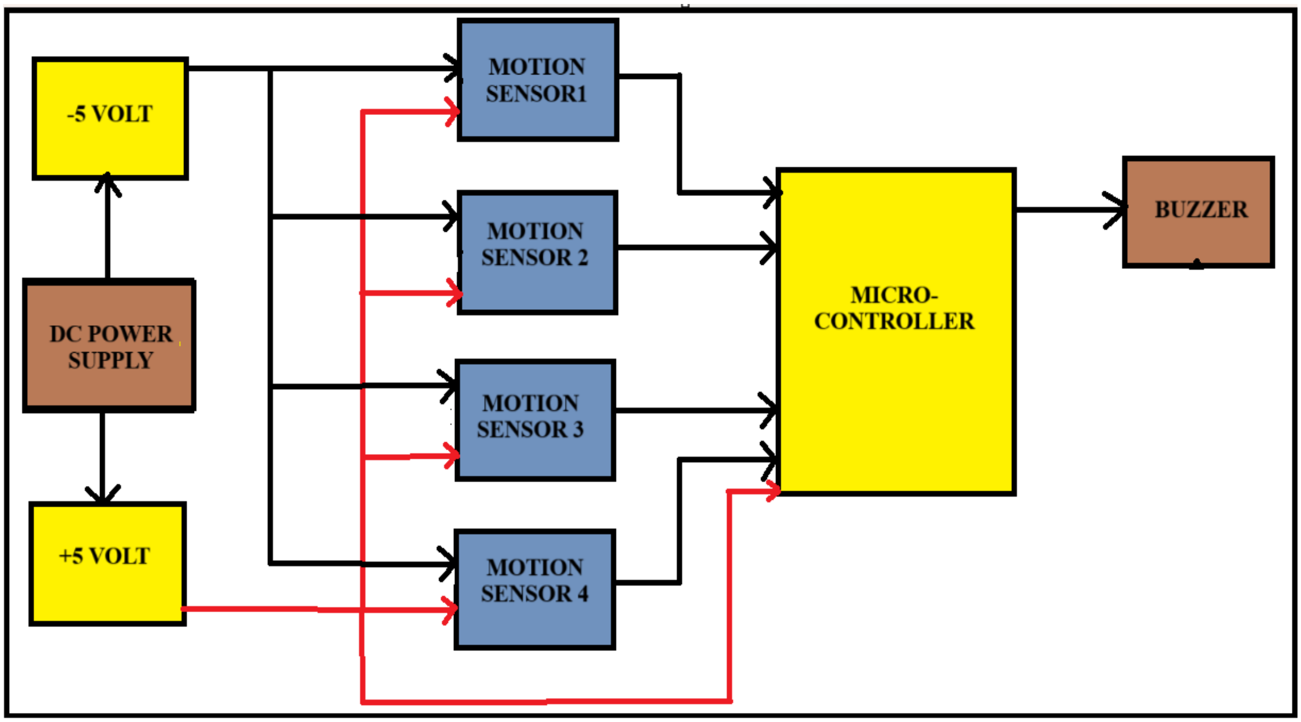

Figure 3.1: *Block Diagram of detection system of collision alert*

As shown in Fig.3.1 the collision alert system is designed to monitor two individuals walking or running toward each other from opposite directions in a defined indoor space. The setup uses four PIR sensors to detect motion within a range of 30 feet. The system operates based on specific timing conditions and sensor activation sequences that indicate a possible collision scenario. When such a pattern is detected, the system activates a buzzer to alert both individuals, thus preventing potential contact.

3.2. Power Supply and Voltage Regulation:

To power the motion sensors and microcontroller, a 5V regulated DC power supply is required. Since the available power source is AC, a custom-designed 5V AC to DC converter circuit was developed.

This +5V output is used to power the four PIR motion sensors and the microcontroller unit.

3.3. Sensor Configuration and Placement:

The four PIR motion sensors are strategically positioned to cover two movement paths from opposite directions:

Sensor 3 and Sensor 4 are placed at the rear entry points of two opposing paths. Their role is to detect initial motion, indicating the entry of a person.

Sensor 1 and Sensor 2 are placed further along each path, closer to the potential point of collision.

The sensors are configured to send a digital HIGH signal to the microcontroller when motion is detected in their field of view.

3.4. Microcontroller Integration

Functional Logic Flow:

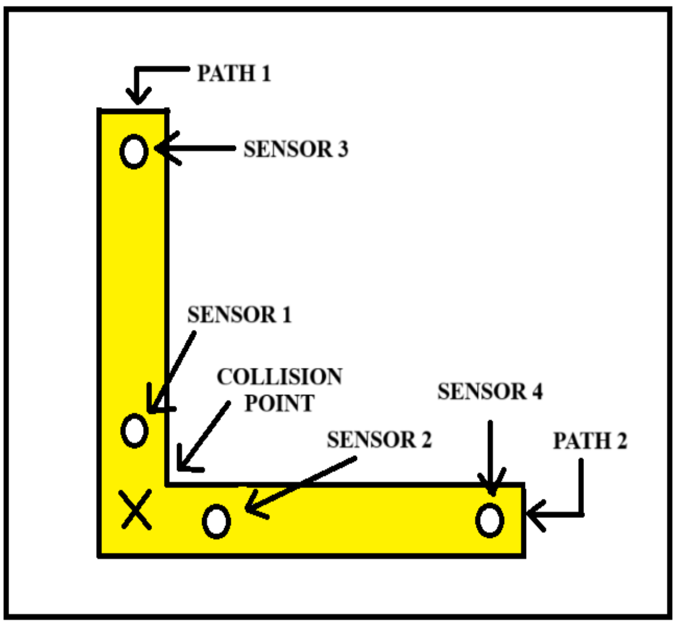

Figure 3.2: *Schematic of sensor placement*

1. Activation Window 1 (Rear Detection):

As shown in Fig.3.2 if Sensor 3 or Sensor 4 detects motion, a 7-second timer is started.

Within this 7-second window, if both Sensor 1 and Sensor 2 detect motion, the system interprets this as two individuals approaching each other and activates the buzzer to issue an alert.

If no motion is detected by Sensor 1 and Sensor 2 within 7 seconds, the activation window is closed, and no alert is triggered.

2. Activation Window 2 (Direct Detection):

If Sensor 1 and Sensor 2 detect motion simultaneously or within 5 seconds of each other without prior activation of Sensor 3 or Sensor 4, the system still interprets this as a direct potential collision.

In this case, the buzzer is triggered as a safety measure.

This two-condition logic allows the system to detect both approaching individuals from opposite ends and individuals approaching directly without rear detection, thereby increasing accuracy and reducing false positives.

3.5. Buzzer Alert Mechanism

The buzzer is connected to a digital output pin of the microcontroller. Once the logic conditions are met, the buzzer is turned on using a HIGH signal. The alert continues for a fixed duration or until the collision window is resolved. The buzzer is powered through a transistor switch circuit to ensure sufficient current drive and isolation from the microcontroller.

Chapter 4: Simulation Testing & Results

4.1 Introduction

This section presents the testing and simulation results of the Collision Alert System. The main objective of this phase was to verify the correct functionality of the designed circuit and ensure that all components respond as expected under various conditions. Simulations were carried out using the Proteus software to observe system behavior in real-time. Test cases included different obstacle distances and sensor inputs to evaluate the system's ability to detect potential collisions and trigger alerts accurately.

4.2 Proteus Simulation

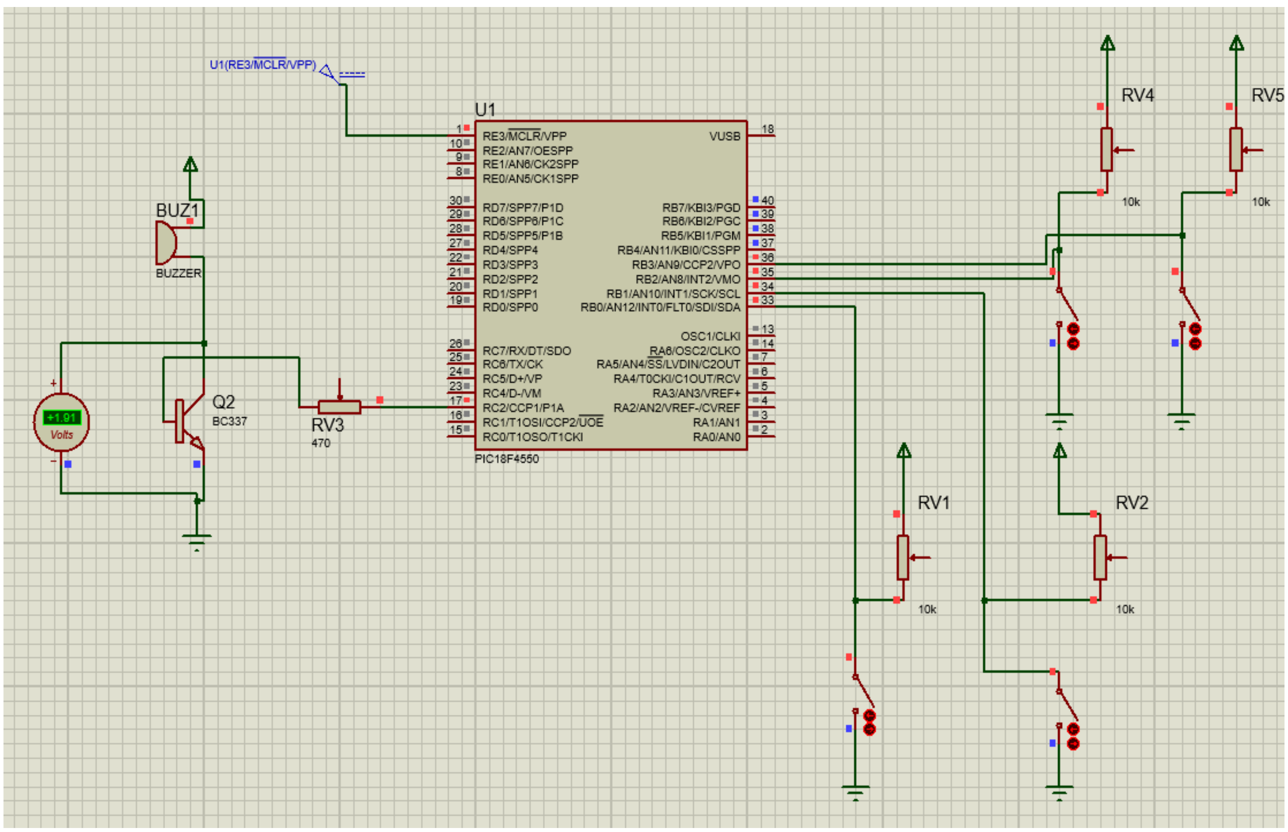

Figure 4.1- Circuit Diagram in Proteus

As shown in Fig.4.1 When any two opposing sensors are triggered simultaneously, the microcontroller interprets this as two individuals approaching a blind corner from opposite directions. It then sends a signal to the transistor base, turning it ON. This activates the buzzer , alerting both individuals of the potential collision.This design ensures real-time detection and response, making it highly suitable for use in narrow corridors, intersections, or corners in schools, offices, and public buildings.

4.3 Test Setup Summary

Table.4.3.1- Test Summary Table

Sensor 1	Sensor 2	Sensor 3	Sensor 4	Buzzer
ON	ON	ON	ON	ON
ON	ON	DON’T CARE	DON’T CARE	ON
OFF	OFF	DON’T CARE	DON’T CARE	OFF
ON	OFF	ON	ON	OFF
OFF	ON	OFF	OFF	OFF

Table.4.3.1 shows the various test cases and their output.

Test Case 1: All Sensors ON

Condition: Sensor 1 = ON, Sensor 2 = ON, Sensor 3 = ON, Sensor 4 = ON

Description: When all four sensors are ON, the system detects a full activation scenario.

Expected Result: Buzzer will turn ON

Test Case 2: Only Sensor 1 and Sensor 2 are ON

Condition: Sensor 1 = ON, Sensor 2 = ON, Sensor 3 = Don’t Care, Sensor 4 = Don’t Care

Description: When only Sensor 1 and Sensor 2 are ON, and Sensor 3 and 4 are in any state (ON or OFF), it still meets the activation logic for the buzzer.

Expected Result: Buzzer will turn ON

Test Case 3: Both Sensor 1 and Sensor 2 are OFF

Condition: Sensor 1 = OFF, Sensor 2 = OFF, Sensor 3 = Don’t Care, Sensor 4 = Don’t Care

Description: Neither of the main sensors is active, regardless of other sensor states.

Expected Result: Buzzer will remain OFF

Test Case 4: Sensor 1 ON and Sensor 2 OFF

Condition: Sensor 1 = ON, Sensor 2 = OFF, Sensor 3 = ON, Sensor 4 = ON

Description: Even though Sensor 1, 3, and 4 are ON, Sensor 2 is OFF — which breaks the necessary condition for buzzer activation.

Expected Result: Buzzer will remain OFF

Test Case 5: Sensor 1 OFF and Sensor 2 ON

Condition: Sensor 1 = OFF, Sensor 2 = ON, Sensor 3 = OFF, Sensor 4 = OFF

Description: Sensor 2 is ON but Sensor 1 is OFF, making the condition incomplete for buzzer activation.

Expected Result: Buzzer will remain OFF

Chapter 5: Results and Discussions

The opening of doors continues to cause injuries to persons and damage to objects when doors are opened by a person on one side of the door while a person or moving object is on the opposite side of the door. When a person is about to operate a door from one side, they normally cannot determine whether or not a person or movable object carried or pushed by another person is on the other side of the door. As a consequence, the potential exists that the door may strike a person or movable object on the opposite side of the door. Similarly, people moving along or past a visual barrier, such as a wall or screen, may collide with other people or movable objects moving toward them from the other side of the visual barrier. It is therefore desirable to prevent injury and damage when people and/or movable objects approach each other from adjacent areas that are mutually not visible to one another. One solution to the problem as it relates to adjacent areas on opposite sides of a door is to place a window in the door so that a person about to open the door may observe activity on the opposite side before opening the door. This solution is not practical if the door is intended to provide privacy and/or security. Furthermore, where doors are opened quickly or people are moving quickly, it may be that a visual assessment through a window does not provide sufficient warning of a potential collision. One reason for this is that, the person opening the door must actively look through the window and assess what is observed. This may be difficult when the area on the other side of the door is poorly lit or s when the person opening the door or the person/object on the other side of the door is moving quickly. One solution related to adjacent areas around blind corners in hallways and adjacent areas on different sides of other visual obstructions is to place a convex mirror such that people moving from opposite sides of the obstruction can see one another. This solution has the advantages of being simple and inexpensive but suffers form the draw-backs including not functioning well if one or both sides of the obstruction are poorly lit and that it requires each person to actively look at objects in the mirror to determine if anything or anyone is moving or obstructing the opposite side of the visual barrier.

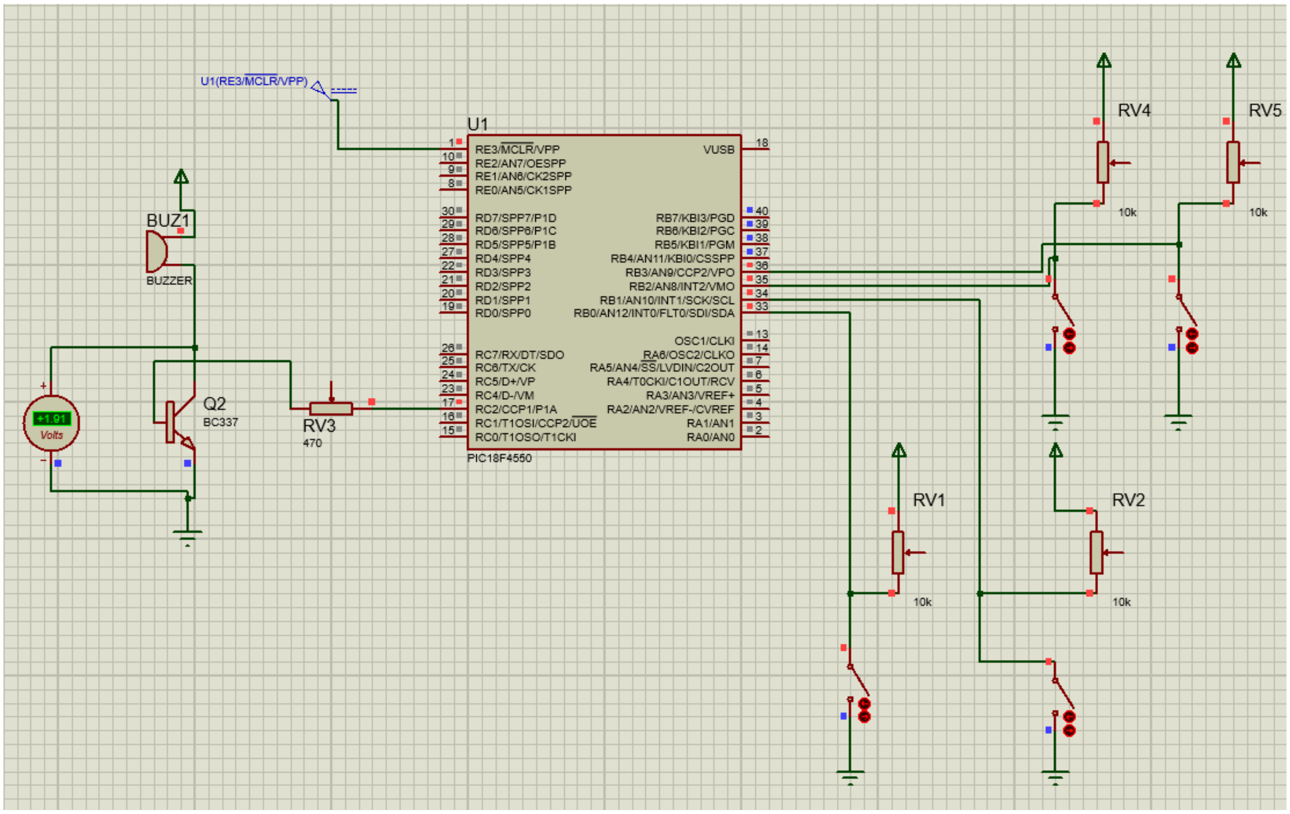

Figure 5.1 – All Sensors are ON

As shown in Fig.5.1 condition: Sensor 1 = ON, Sensor 2 = ON, Sensor 3 = ON, Sensor 4 = ON

Description: When all four sensors are ON, the system detects a full activation scenario.

Result: Buzzer is turn ON

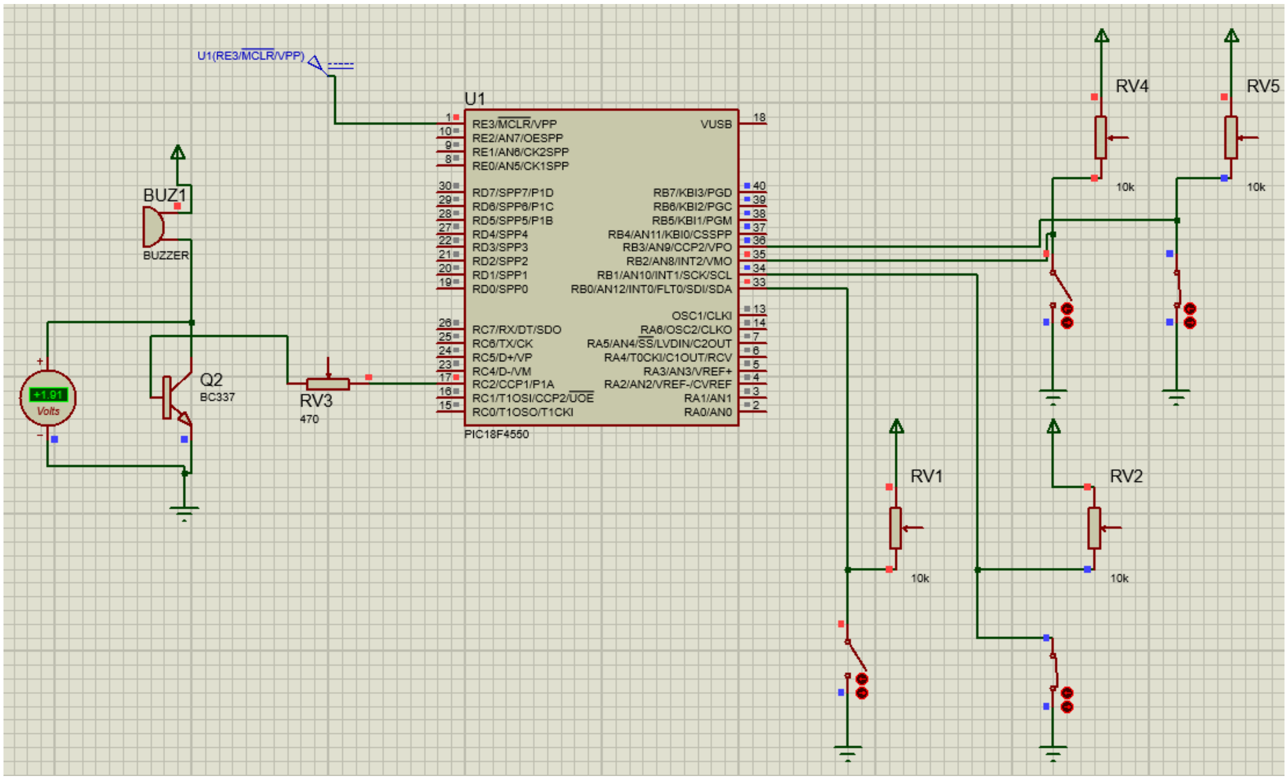

Figure 5.2 – Sensors 1 and 2 are ON

As shown in Fig.5.2 condition: Sensor 1 = ON, Sensor 2 = ON, Sensor 3 = OFF, Sensor 4 = OFF.

Description: When only Sensor 1 and Sensor 2 are ON, and Sensor 3 and 4 are in any state (ON or OFF), it still meets the activation logic for the buzzer.

Result: Buzzer will turn ON

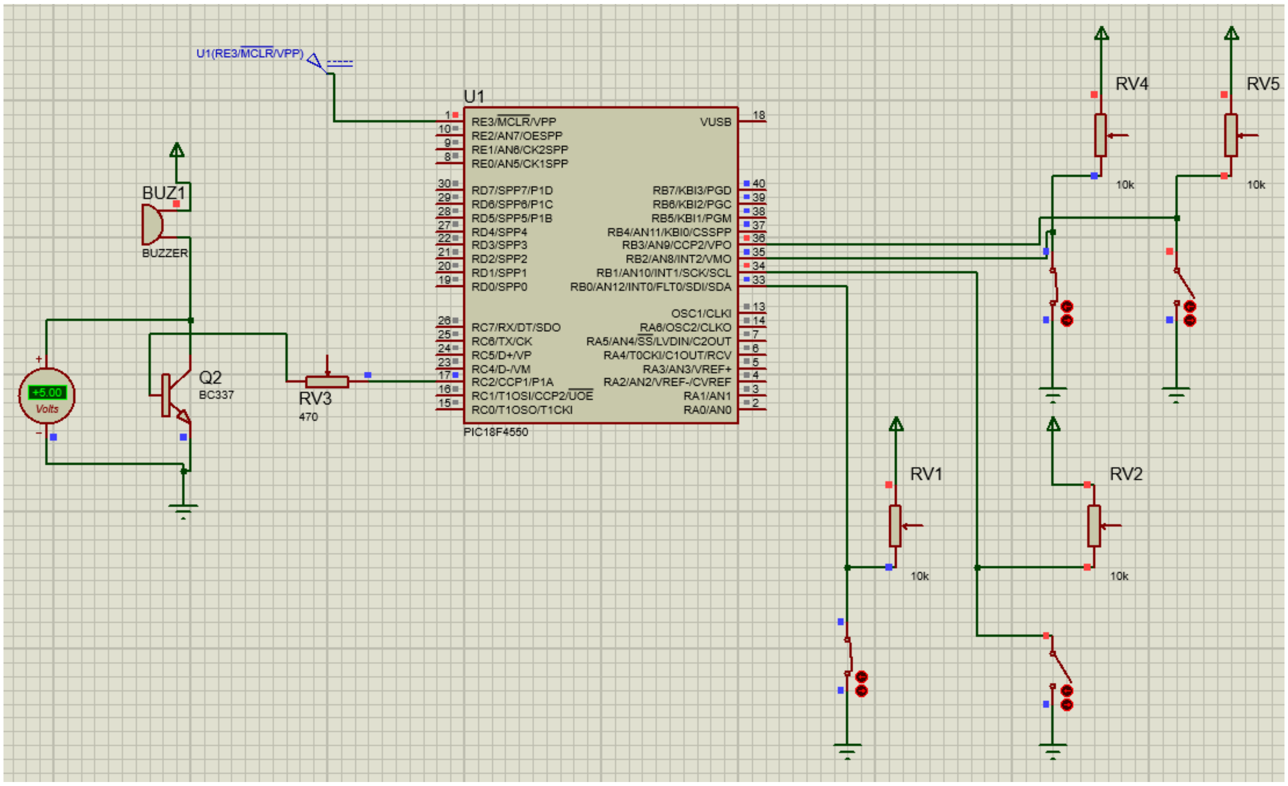

Figure 5.3 – Sensor 3 and 4 are ON

As shown in Fig.5.3 condition: Sensor 1 = OFF, Sensor 2 = OFF, Sensor 3 = ON, Sensor 4 = ON.

Description: Neither of the main sensors is active, regardless of other sensor states.

Result: Buzzer will remain OFF

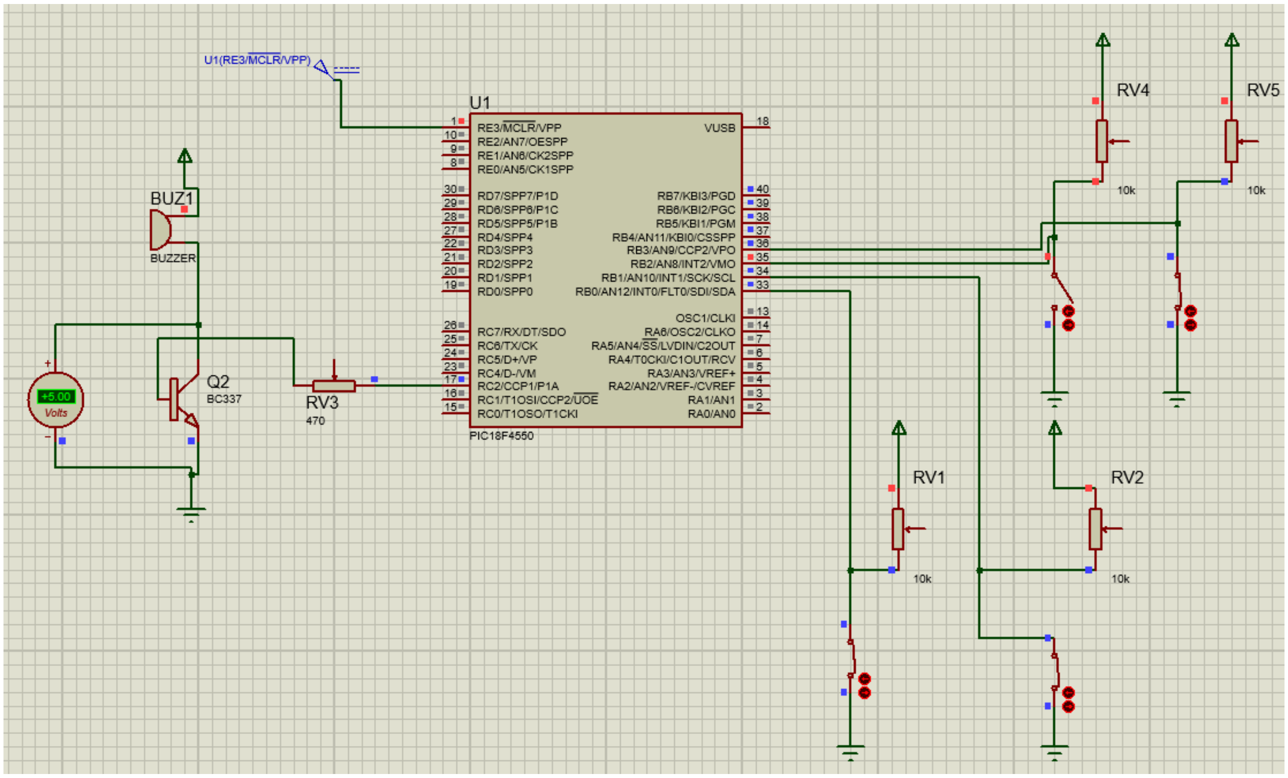

Figure 5.4 – Only Sensor 2 is ON

As shown in Fig5.4 condition: Sensor 1 = OFF, Sensor 2 = ON, Sensor 3 = OFF, Sensor 4 = OFF.

Description: Only one of the main sensors is active, regardless of other sensor states.

Result: Buzzer will remain OFF

Chapter 6 Conclusion

In conclusion, the collision alert system presented in this project offers a groundbreaking approach to enhancing personal safety in indoor environments. By integrating four PIR motion sensors instead of the conventional two, the system effectively determines movement direction, significantly reducing false alerts and ensuring that only genuine collision risks trigger warnings. The logical, time-based sequence processed by the microcontroller ensures that movement detection is both accurate and efficient, minimizing unnecessary interruptions while maintaining a proactive safety mechanism.

Beyond its core functionality, the system boasts several advantages, including its low power consumption, ease of deployment, and privacy-preserving design, making it a strong alternative to camera-based solutions. Unlike surveillance systems that require extensive monitoring and raise privacy concerns, this sensor-based approach provides a discreet yet highly effective means of detecting potential collisions without compromising individuals' privacy.

Furthermore, the adaptability of this framework opens doors for future enhancements. With the integration of wireless communication, the system could enable centralized monitoring and real-time alerts across multiple locations, improving the overall safety of larger facilities. Additionally, implementing machine learning algorithms could refine the recognition patterns, allowing for intelligent differentiation between typical movement behaviors and collision risks, thus further reducing false alarms.

The significance of this innovation extends beyond its immediate applications, paving the way for the development of smarter safety solutions in schools, public facilities, and other indoor spaces where human movement needs to be monitored efficiently. As advancements continue in sensor technologies and intelligent safety systems, this collision alert framework stands as a strong foundation for future improvements. Its ability to balance effectiveness, privacy, and scalability ensures that it remains a practical and forward-thinking approach to accident prevention in modern environments.

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