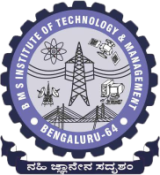
## BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

**(An Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE New Delhi)**

**Yelahanka, Bengaluru 560019**

**Department of Computer Science and Engineering**

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**Mini Project Synopsis**

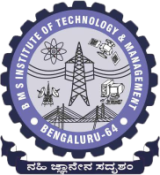
**Academic Year 2024-25**

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| --- | --- | --- | --- | --- |
| **Batch No: 3** | | **Guide Name: AMBIKA G N** | | **Submission Date: 13/11/2024** |
| **AI-Powered Obstacle Detection for Railway Safety** | | | | |
| **Sl No** | **USN** | | **Name** | |
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| **Project Category** | | | **Product development** | |

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**Synopsis for the Mini Project work**

***“AI-Powered Obstacle Detection for Railway Safety”***

**Submitted By** :

1. SHREYA R - 1BY22CS169

2. SIDDHARTH GIRISH NAIDU - 1BY22CS174

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**Under the Guidance of:**

Prof. Ambika G N

Assistant Professor

Dept. of CSE

2024-2025

**ABSTRACT:**

This mini-project demonstrates an obstacle detection and response system implemented on the Firebird V robot using onboard IR and Sharp IR proximity sensors. The objective is to enable the robot to detect obstacles and trigger an emergency alarm (a beep) while halting its movement. The system is powered by the ATmega2560 microcontroller, utilizing the ADC for sensor data processing. The system provides an effective and simple solution for obstacle avoidance in environments where additional external hardware cannot be incorporated. The implementation ensures cost-efficiency and system responsiveness without adding any external components, relying solely on the robot’s built-in sensors and processing power.

**INTRODUCTION:**

The safety of railway operations is paramount, yet the presence of obstacles on or near tracks poses a significant risk, leading to accidents and service interruptions. As the railway industry evolves, there is an increasing demand for innovative solutions that can adapt to ever-changing environments. This project addresses this need by developing an AI-driven Obstacle Detection System, utilizing the Firebird V robot as a practical testing platform. By leveraging cutting-edge sensors and advanced artificial intelligence, the system is designed to detect and classify obstacles in real time, enhancing the safety and efficiency of train operations. The initiative not only aims to reduce the likelihood of accidents but also to support the integration of autonomous technologies within modern railway networks. Ultimately, this project represents a step forward in harnessing robotics and AI to create safer, more responsive railway systems for the future.

**METHODOLOGY:**

Theoretical Analysis:

The theoretical basis behind this project involves sensor data acquisition through the ADC of the ATmega2560 microcontroller, obstacle detection logic, and motor control mechanisms. By interpreting the sensor data, the robot’s path is altered to avoid obstacles.Additionally, the growing potential of AI and machine learning to solve real-world problems in various sectors, including transportation, provided further motivation. This project offers an opportunity to contribute to the broader goal of enhancing transportation safety while exploring the intersection of AI, robotics, and real-time systems.

**EXPERIMETAL OBSERVATION:**

**Real-world testing of the sensors (IR and Sharp IR) showed varying detection ranges depending on environmental factors. The robot's response to obstacles was evaluated under different scenarios, like objects placed in front, left, right, and multiple obstructions at once.**

**NOVEL ALGORITHMS:**

**A novel algorithm was implemented to combine sensor readings and determine the presence of an obstacle. Once an object is detected, the system triggers an emergency alarm and halts the robot's movement. This is achieved through straightforward control logic, which uses basic condition checks on sensor values.**.

**MODULE IMPLEMENTATION**

ADC Initialization:

ADC channels are configured for sensor readings. This module initializes the ADC, selects channels corresponding to the IR sensors, and processes the readings.

Object Detection Logic:

The sensor values are compared to predefined thresholds to determine if an obstacle is present. Based on the comparison, the appropriate action (alarm and stop) is executed.

Motor Control:

The motor control system allows the robot to move or stop based on the obstacle detection logic. If an obstacle is detected, the motors are stopped.

Main Program:

The main program integrates the ADC reading, object detection logic, and motor control. It continuously checks for sensor values, compares them with the thresholds, and triggers the alarm and stop commands when necessary.

**IMPLEMENTATION**

**Programming Language:**

**C Programming: The implementation is done in C, utilizing the AVR-GCC toolchain. The microcontroller's ADC is programmed to capture and process analog sensor signals.**

**Algorithm Used:**

**Sensor Data Processing:**

**The ADC of the ATmega2560 reads the analog output of the IR and Sharp IR sensors. Each sensor’s value is compared with a preset threshold to determine if an obstacle is within range.**

**Obstacle Detection:**

**A condition checks the sensor values to detect obstacles. If an obstacle is detected (value > threshold), the emergency alarm is triggered, and motor control commands stop the robot.**

**Emergency Alarm and Stop Logic:**

**Upon obstacle detection, the robot sounds an emergency beep using a buzzer and then halts by stopping all motor actions.**

**Results and Discussion**

**Behavior Observation:**

**The system reliably detected obstacles in all test scenarios. When an obstacle was detected, the robot sounded the emergency alarm (a beep) and halted immediately, preventing collision.**

**Sensor Performance:**

**The IR proximity sensors performed well under most conditions, although their performance slightly degraded with ambient lighting changes. The Sharp IR sensor showed accurate distance measurements, but its readings were sometimes influenced by reflective surfaces.**

**Threshold Calibration:**

**Proper threshold calibration was necessary to ensure accurate detection. If the thresholds were set too low, false alarms occurred, while setting them too high led to missed detections.**

**Algorithm Efficiency:**

**The detection algorithm was efficient in distinguishing obstacles and providing quick responses. The robot showed timely reactions to obstacles without delay.**

**Testing Insights:**

**The robot showed promising results in both static and dynamic environments. However, further improvement could be made by fine-tuning the sensor sensitivity and enhancing the motor control system for more nuanced navigation in complex scenarios.**

**Conclusion**

**The project successfully implemented an obstacle detection and response system for the Firebird V robot using its onboard IR and Sharp IR sensors. The robot demonstrated effective obstacle avoidance by detecting obstacles, triggering an emergency alarm, and halting its movement when necessary. The system performed well under various testing conditions, although further optimization can improve performance. Future work may involve integrating more advanced algorithms for complex navigation tasks, such as pathfinding and dynamic obstacle avoidance.**

**References:**

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