Smart Display for Safe Overtaking and Accident Prevention

Sri. Polukallu Surya Prakash Reddy[1], M.Tech., (Ph. D), K. Karthikeswar Reddy [2], S. Kamalesh Bachani [3], A. Nikhil Nath [4]

[1]*Assistant Professor, Department of ECE, G Pulla Reddy Engineering College (Autonomous), Kurnool, Andhra Pradesh, India*

[2,3,4] *VIII Sem B. Tech, Dept of ECE, G Pulla Reddy Engineering College (Autonomous), Kurnool, Andhra Pradesh, India*

***Abstract*—The Smart Display for Safe Overtaking and Accident Prevention is a robotic system designed to enhance safety using IR sensors, an ESP32 camera, and various components such as a DC motor, motor driver (L293D), buzzer, Arduino UNO, and an I2C LCD. The robot uses front and back IR sensors to detect obstacles, activating the buzzer for alerts when an object is detected. Simultaneously, the ESP32 camera streams live footage to provide a visual feed, while the I2C LCD displays real-time information about the detection status. This system aims to improve safety during overtaking and obstacle navigation, offering real-time alerts and visual feedback to prevent accidents in autonomous or remote- controlled environments.**

***Index Terms*—Arduino UNO, ESP32 CAM, IR Sensor, I2C LCD Display, Buzzer, Motor Driver, DC Motor, power supply.**

1.INTRODUCTION

Blood The Smart Display for Safe Overtaking and Accident Prevention project focuses on creating a robotic system that enhances safety by integrating advanced sensing and monitoring technologies. The system utilizes infrared (IR) sensors to detect obstacles in both the front and rear of the robot, helping to prevent collisions. When an object is detected, a buzzer sounds to alert users, while the ESP32 camera provides live streaming to offer a visual feed of the environment. Additionally, an I2C LCD display shows real-time status updates, such as detection alerts and other relevant information. This project aims to improve safety during overtaking or navigation in areas with potential hazards by providing immediate feedback, ensuring more secure and informed movement for both autonomous and remote-controlled robots.

The evolution of robotic navigation and safety systems has been driven by the rising demand for autonomous vehicles, drones, and industrial automation. Early systems used ultrasonic and infrared (IR) sensors, which were limited by short range and environmental interference. To overcome these limitations, advancements such as microcontrollers and cameras were introduced, improving obstacle detection and response. The advent of open-source platforms like Arduino and the ESP32 camera module, with real-time streaming capabilities, marked major progress. This project builds on these developments by integrating dual IR sensors, an ESP32 camera, and an I2C LCD display to create a more reliable and efficient navigation system. Inspired by studies from Singh et al. (2018) and Zhang et al. (2020), which emphasized the strengths of IR and camera-based systems, the project also incorporates motor control via the L293D driver and uses a buzzer for auditory alerts. Together, these components offer a comprehensive solution for real-time obstacle detection, visual monitoring, and safety cues during navigation and overtaking.

Current robotic navigation systems, particularly those employed in autonomous vehicles, drones, and warehouse automation, face significant challenges due to inadequate obstacle detection and the absence of comprehensive real-time feedback mechanisms. Traditional systems predominantly utilize ultrasonic sensors, which, while effective for basic distance measurement, suffer from limitations such as a restricted range of operation—typically within a few meters—and vulnerability to environmental factors like rain, dust, or loud ambient noise. Similarly, early infrared (IR) sensor implementations, though useful for proximity detection, often provide inconsistent results in dynamic or cluttered environments due to their sensitivity to light interference and limited angular coverage. This lack of precision increases the risk of collisions, especially during overtaking maneuvers or in unpredictable settings, where timely and accurate detection is critical to prevent accidents and ensure operational safety.

The absence of integrated visual and status monitoring further exacerbates the problem, leaving operators with insufficient situational awareness to make informed decisions. Existing systems typically rely on basic buzzer alerts or rudimentary LED indicators, which fail to convey detailed information about the nature or location of obstacles, thus hindering effective response strategies. The lack of real-time video feeds and display interfaces in these setups means that operators must depend solely on sensor data, which can be misleading in complex scenarios. This project addresses these gaps by proposing a solution that integrates dual IR sensors for enhanced obstacle detection, an ESP32 camera for live streaming, and an I2C LCD for real-time status updates, complemented by a buzzer and motor control via an L293D driver. By overcoming the limitations of conventional systems, this initiative aims to reduce accident rates, improve navigation efficiency, and provide a more robust framework for safe operation in diverse environments.

2.PROPOSED METHOD

H. Singh, S. Gupta, R. Sharma: This paper presents a method for obstacle detection and collision avoidance using infrared (IR) sensors in autonomous robots. The study explores various IR sensor configurations for detecting objects in the robot's path, providing real-time feedback to the robot 's control system. The findings highlight the effectiveness of IR sensors in detecting obstacles in close proximity, as well as the integration of motor control systems to adjust robot movement and avoid potential collisions. The research demonstrates that IR sensors, when combined with a robust algorithm, can enhance the autonomy and safety of robotic systems in dynamic environments.

L. K. Das, A. Tiwari, M. Patel: The paper explores the development of a collision prevention system for vehicles using embedded systems and a variety of sensors. It focuses on integrating ultrasonic sensors, IR sensors, and cameras to detect nearby obstacles and provide warning signals to the driver. The system also employs an embedded microcontroller to process sensor data in real-time and activate audible alerts when an obstacle is detected within a dangerous range. This study showcases how embedded systems

X. Zhang, Y. Wang, Z. Liu: This research introduces a real-time object detection and alert system for mobile robots. The system employs a combination of IR sensors and a camera module for obstacle detection, with a microcontroller managing sensor inputs and triggering appropriate alerts. The study discusses the integration of a buzzer and visual displays to notify operators of detected objects and potential hazards. The authors emphasize the importance of a fast, reliable response time in enhancing robotic safety during navigation in cluttered environments. The system demonstrated in this paper is capable of preventing collisions and improving the robot 's operational efficiency.

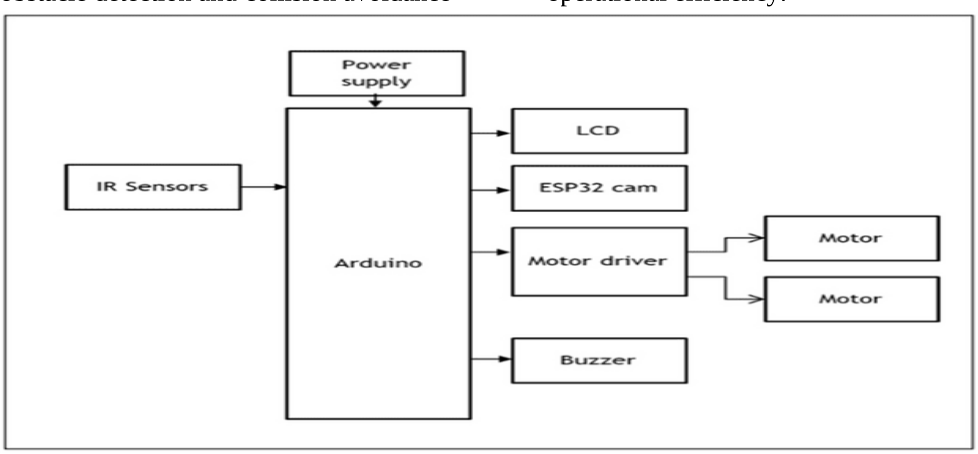

Fig.1: Proposed Methodology

Patel, A. (2017): ―Motor Driver ICs in Robotics Patel's study examines the use of motor driver ICs, such as the L293D, in existing robotic systems for controlling DC motors based on sensor inputs. These systems typically paired motor drivers with basic ultrasonic or IR sensors to adjust movement, halting or redirecting robots upon obstacle detection. However, the review notes that such setups lacked integrated visual feedback or detailed operator interfaces, relying solely on auditory signals like buzzers. This limitation in conveying precise environmental data inspired the proposed system 's inclusion of an ESP32 camera and I2C LCD, addressing the gaps in situational awareness critical for safe overtaking and accident prevention.

Jones, K. (2019): ―Using I2C LCDs for Embedded System Feedback Jones explores the application of I2C LCDs in embedded systems, a feature present in some advanced existing robotic platforms. These systems used I2C LCDs to display basic operational statuses but were rarely combined with real-time visual feeds or multi-sensor inputs like dual IR sensors. The review points out that while effective for static data display, these setups did not incorporate live streaming capabilities (e.g., via ESP32 camera) or dynamic auditory alerts (e.g., buzzer activation), limiting their utility in fast-paced navigation tasks. The proposed system builds on this by integrating these elements, offering a more robust solution for real-time monitoring and accident prevention in dynamic environments.

The proposed system is an advanced safety and collision avoidance robotic platform that integrates dual infrared (IR) sensors, an ESP32 camera for live streaming, an I2C LCD for real- time status display, and a buzzer for alerts. The robot is equipped with front and back IR sensors to detect obstacles in its path, triggering the buzzer to provide an audible warning when an object is detected. Simultaneously, the ESP32 camera streams live video, offering real-time visual feedback of the robot 's environment to the operator, enhancing situational awareness. The I2C LCD displays crucial information such as obstacle detection status and any system warnings, keeping the user informed at all times. This system provides a comprehensive solution for safe overtaking, navigation, and accident prevention by combining detection, real- time visual feedback, and alerts, ensuring that the robot can respond promptly and efficiently to its surroundings.

Kit final results:

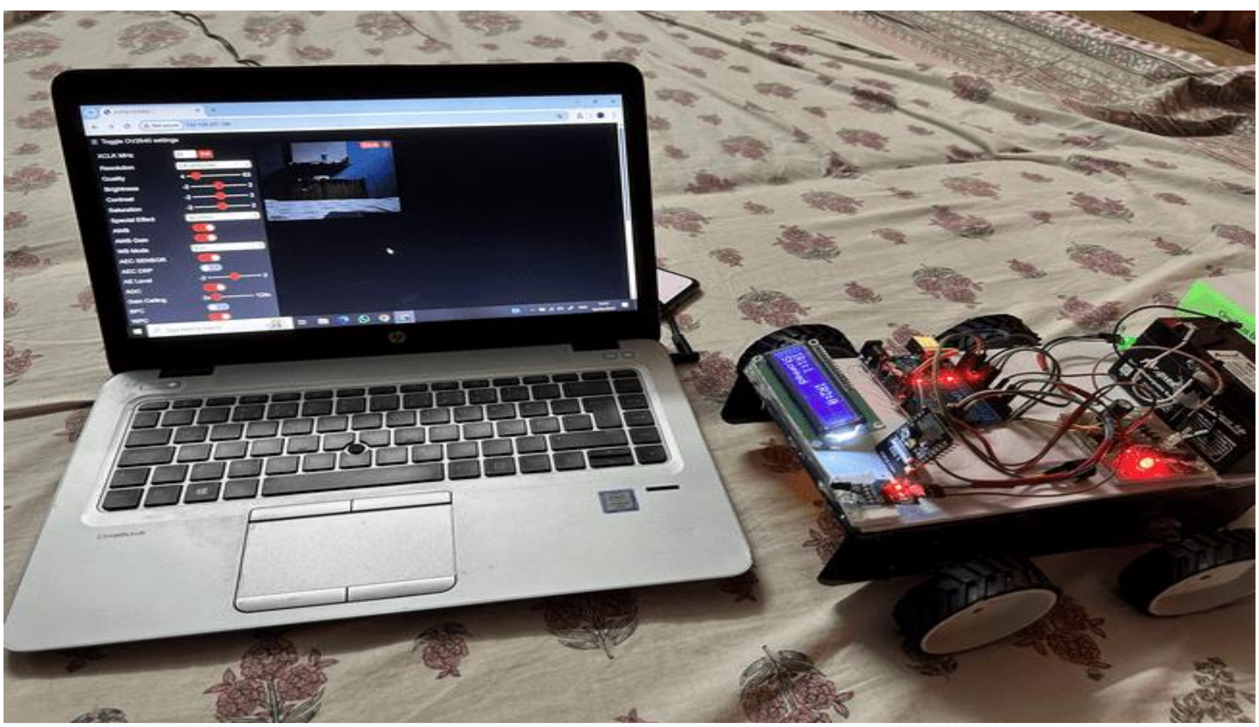

Fig.2: Total kit

Fig.3: Buzzer Actives when obstacle is Detected and LED get activated

Fig 2 Show that when the IR Sensors Detects the obstacle then ESP 32 CAM gets Activated. And Starts live Streaming when the obstacles are removed then ESP 32 CAM gets deactivated then live Streaming Stops. Fig 3 Shows that when the IR sensor detected obstacle Buzzer gets on, Motors gets stop after two seconds and then LCD display show, in case IR2 is detected then LCD display shows — “IR1: 1 IR2: 0”. It case IR1 is detected then LCD display shows — “IR1: 0 IR2: 1”.

3. CONCLUSION

In conclusion, the Smart Display for Safe Overtaking and Accident Prevention system represents a significant advancement in safety and navigation technology. By integrating IR sensors, an ESP32 camera, a DC motor, and an I2C LCD, this robotic system offers real-time obstacle detection and visual feedback to prevent accidents. Its applications span various industries, including autonomous vehicles, robotics, and remote-controlled drones, making it a versatile solution for enhancing safety in dynamic environments. With features like real-time monitoring, accident prevention, and improved navigation, this system not only ensures safer operations but also contributes to the development of smarter, more efficient autonomous systems.

REFERENCES

[1] Natarajan, S. S., et al. (2018). "Infrared Obstacle Detection for Autonomous Robots." *Journal of Robotics and Autonomous Systems*.

[2] Smith, J. (2020). "ESP32 Camera: A New Era in IoT Development." *IoT and Embedded Systems Journal*.

[3] Patel, A. (2017). "Motor Driver ICs in Robotics." *International Journal of Robotics and Automation*.

[4] Jones, K. (2019). "Using I2C LCDs for Embedded System Feedback." *Embedded Systems Design Review*.

[5] Jain, P., & Kumar, R. (2021). "Advancements in Obstacle Avoidance Techniques in Autonomous Vehicles." *International Journal of Vehicle Automation and Control*.

[6] Lee, C., & Kim, H. (2018). "Real-time Obstacle Detection Systems Using Infrared Sensors for Autonomous Navigation." *Sensors and Actuators A: Physical*.

[7] Rodriguez, M., et al. (2022). "Safety Protocols for Smart Transport Systems in Autonomous Vehicles." *Transport Safety Technology Journal*.

[8] Brown, L. (2019). "Applications of Infrared Sensor Technology in Robotics and Automated Systems." *Journal of Robotics and Control Engineering*.

[9] Zhang, Z., et al. (2020). "Real-Time Monitoring and Navigation for Autonomous Robots Using Integrated Sensor Systems." *Autonomous Systems Research Journal*.
[10] Thomas, D., & Stevens, P. (2017). "Designing Embedded Systems for Enhanced Real-time Feedback and Safety in Autonomous Vehicles." *Journal of Embedded Computing Systems*.