iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** V **Month of publication:** May 2025

DOI: https://doi.org/10.22214/ijraset.2025.68324

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

Automated Line-Following Robot with Remote Speed Control Using Blynk

Mr. Rakesh M D[1], Dr. RudraSwamy S. B[2], M Vineeth[3], Meghana U[4]
Dept. of ECE, SJCE, JSS Science and Technology University, Mysuru, India

Abstract: Advances in industrial automation have increased the demand for more flexible, robotically varied, and remotely controlled systems to improve operational efficiency, productivity, and safety. This work discusses a line-following robot integrated with an IoT platform designed specifically for industrial applications, featuring dynamic speed control features. The robot has been powered using an ESP32 microcontroller, which supports the major components, including a highly precise line-following-accurate IR sensor and a motor driver module for movement control along a specific path. It also integrates a GSM module into this system, with alerts enabled in real time, whenever the speed goes beyond a threshold value and ensures safe continuity. The combination of Blynk app integration allows flexibility in changing the speed of the robot remotely in real time, something which no other robot would be able to come close to. This is particularly useful when the process allows changes in speeds according to the different requirements of such processes, for instance, fast material transport or slow movements in sensitive assembly processes. Its motor speed regulator through Blynk app control makes the robot adapt to its applications by ensuring optimized performance as well as safety improvement. The system is highly adaptable for different applications whether on an industrial level: material handling systems, assembly lines, or just warehouse operations. By using IoT technology, it shows the capability of real-time remote control and monitoring of industrial robots, which constitutes a scalable and efficient solution for modern industries in searching to streamline workflows, enhance safety, and improve overall productivity. This IoT integrated robot presents a step toward the future of intelligent industrial automation.
Keywords: Line Follower Robot, Blynk App, ESP32, GSM, Speed Control IR Sensor, Motor Driver Module, Industrial Automation, Remote Speed Regulation.

I. INTRODUCTION

The fast speed of industrial automation led to the need for an intelligent system using robots, one that could provide high efficiency with low operation costs and safety features [1]. Line follower robots proved to be very useful in such fields; they are handy tools in industries requiring the performance of tasks such as material transportation, product handling, and assembly line functioning. These types of robots follow a predetermined path on their own while utilizing sensors to make it reasonably precise. In this regard, they naturally reduce demand for the inclusion of human labour towards repetitive tasks. Moreover, they guarantee a uniform performance needed in fast workflow of busy industrial processes. Nonetheless, conventional line follower robots pose adaptability problems because industrial environments vary constantly [2]. For instance, in assembly lines where demand and operating requirements are not constant, as well as in warehouses with different kinds of products, the importance of on-line control of speed in the robot is paramount. For instance, fragile materials require slower and more careful operating conditions than those required for transportation of lighter goods in much bigger distances. In such situations, the poor control of speed would result in increased downtime, inefficiencies, or even damage to products.

To address this problem, this work presents a line follower robot using real-time speed control via an advanced IoT-based technology. This powerful ESP32 microcontroller is the core of the system, on which even wireless communication might be obtained through Wi-Fi and Bluetooth [3] for seamless integration applications with remote monitoring and control applications. This versatility is further enhanced by the Blynk app, where the operator can see and control the speed of the robot from distance. Blynk acts as a very interactive interface for management and operations, hence providing the whole entity with all controls regarding how it acts when it relates to the behaviour of the robot. Whether it is an adjustment of limited speed change for the set of tasks or streamlining by real time acquisition of data, the app ensures that the robot stays pliable for numerous applications in various industrial processes. Another important part of the system is the GSM module, used for real-time communication and alerts. The GSM module completes the functionality of the robot through the sending of alerts to specific operators in cases where certain operational limits, such as speed limits, have been exceeded. For instance, in cases where the robot will be operating in an area of high traffic or in which sensitive materials are being handled, making sure that the speed conditions are met is crucial.

In case the robot exceeds the prescribed speed limit, for instance, 80 km/h, an alert message is sent to the manager by the GSM module, thereby enabling remote control of the speed through the Blynk app. Real- time communication enhances safety and even makes it difficult to mishandle or accidentally damage the industries.

It can significantly impact the efficiency of operations in large- scale industrial applications such as warehouses or factories, where the control and speed of multiple robots operated may have to be dynamically adjusted from a distance [4]. For example, if a robot is assigned to carry cargo in a multi-story facility, then it must change its speed according to the nature of the load it carries. In such a situation, the robot always controls the speed in real time to result in proper flow between upstream and downstream processes. Flexibility is therefore very necessary in industries with fast flowing and slow, precise tasks. For example, in a warehouse, the robot would need to accelerate when carrying relatively light goods over long distances to facilitate timely arrival at the loading docks. On the other hand, when working with fragile items or crowded areas, slowing down will prevent breakage of goods and collision with other machines. Most importantly, the capability to control speed as per varying real-time conditions is very helpful in enhancing the efficient flow of operations and avoiding errors. For these above-mentioned reasons, it is very much necessary for modern industrial environments. But this project brings forward the potential of the technology IoT which will revolutionize industrial automation by using an app like Blynk along with an ESP32 microcontroller. The dual nature of the ESP32, being a dual communication protocol both in Wi-Fi and Bluetooth, enables proper data transmission and control without having to physically interface [5]. Therefore, it makes it easy for a robot to be controlled from remote areas where on-site presence is not always possible or is unsafe. For example, industries like chemical plants, and high-temperature manufacturing departments are hazardous environments where the ability to control and monitor robots from remote locations ensures not only safety but also makes sure that the workflows do not stop.

The Blynk application is a revolution regarding user interaction with industrial robots. Unlike most control systems, which usually are very demanding regarding specialized hardware and software, the app Blynk can be installed very easily on any smartphone or tablet to make its managing much easier for a wider circle of users, from experienced operators to novice personnel, of very complex industrial systems. The app enables speed parameters to be set, monitoring the path followed by the robot [6], and scheduling maintenance-all within a single interface. Accordingly, real-time feedback from the app enables operators to always monitor the status of the robot, thereby allowing for early intervention should something go wrong. This, in the context of this project, provides an innovative solution to problems with traditional line follower robots. The ESP32, GSM, and the application with Blynk, provides real-time control over speed, dynamic adaptability, and remote management, thus improving the overall efficiency of industrial processes while upholding safety protocols. This adaptive robot system is highly important because, for instance, it can optimize the workflows and minimize the downtime in operations. Just in manufacturing, logistics, and warehousing processes that are very sensitive to throughput speed, this type of technology is crucial. With IoT integration, the importance of such technologies further emphasizes the trend leading industrial automation into the future. The works highlight the potential of such connected systems in further improvement on operational efficiencies of industries seeking solutions that offer greater flexibility, scalability, and real- time responsiveness [7]. The control of robots at distance places great importance on performance monitoring and making live adjustments to their behaviour count for fully automated ecosystems in the industrial environment. The line follower robot project made an excellent demonstration of how the IoT-enabled technologies, such as ESP32 and the Blynk app, may be used to enhance industrial efficiency. The system offers a new way to optimize industrial processes by providing remote control of speed, real-time monitoring, and GSM-based messaging for safe and productive work in complex environments. With developments in the industrial sector moving toward automation, such intelligent adaptive systems will become all the more pertinent in the pursuit of operational excellence.

II. RELATED WORKS

This survey lays the groundwork for the proposed adaptive line follower robot, which aims to leverage these advancements to improve operational efficiency in industrial settings.

Hari Chandan T et al, the Vehicle Over-Speed Detection and Accident-Avoidance System is the IoT-based product that is designed to improve road safety in terms of vehicle speed monitoring and control. Sensed with the aid of ultrasonic sensors attached to an Arduino UNO microcontroller, it will sense the nearby objects or vehicles and automatically adjusts the car's speed so that safe distances from the other vehicle are maintained. The major components include an ultrasonic sensor, potentiometer, CAN controller, DC motor, GSM module, LCD display, and a buzzer. The system warns the driver when he surpasses a defined speed limit, and it sends SMS notifications to cab companies or the car rental agencies whenever there is overspeeding. Aims: This system cuts down the number of accidents as well as builds safer driving habits.[1].

Chang, Kuo-Chi, et al The project aims at using Arduino technology to develop a line-following robot that automates many sectors in society. The robot will employ four 3V geared DC motors, driven by an L298N motor driver IC to provide the required voltage since Arduino UNO cannot do so alone. Two IR sensors detect the line, and the ATmega328 microcontroller on the Arduino UNO implements a Fuzzy Logic Control algorithm to guide the robot along a predefined black or white path using Pulse Width Modulation (PWM) for control. The project has practical applications in industries, hospitals, and the environment which cannot be deployed for human people, such as areas with high temperatures. It can also facilitate blind people and decrease industrial costs by automating time-consuming activities. The technology shows the possibility of full-scale implementation soon because it is efficient and versatile.[2].

Kabir et al, this project aims at developing an Automatic Line Follower Robot (ALFR) that can help aid COVID-19 patients in isolation rooms. The robot helps tackle the issues that medical professionals face, including food delivery and medication, waste management, and minimizing direct interaction with infected people. The ALFR will follow a black line to deliver these essential articles, collect waste put into its designated baskets for proper disposal, and sanitize the isolation rooms using an integrated disinfectant machine.[3]

M. Pakdaman et al, the scope of the paper is TABAR, a miniature line sensor mobile robot constructed to participate in the line follower robot competition. The robot was designed to autonomously identify and follow a specified pathway, which consists of visible black lines on a white background or invisible magnetic fields. Lines of transition buses connected to the line follower robot convey the line and transmit IR images to the processor which is integrated inside the robot. The commands are sent to the motor driver after the processor interprets the information and decides what response is appropriate. As a result, the robot can stay on the route.[4].

Rakesh Kumar Godi et al, such proposed systems will actually help enhance driving safety by rapidly detecting accidents and alerting emergency contacts to ensure quicker assistance. With the increasing volume of road accidents, most fatalities stem from late treatment. Although the current state-of-the-art utilizes technologies such as V2V communication, smart sensing, and mobile edge computing, most of them major on two-wheelers and use Raspberry Pi microcontrollers. The proposed system uses an ESP32 microcontroller that is low in cost, compact, and energy- efficient with integrated Bluetooth and Wi-Fi. The exterior structural distortions due to accidents are detected by the installed flex and MEMS sensors of the automobile. On such distortions, the ESP32 device gathers GPS data and tries to send notifications to all registered contacts, thus focusing on efficient accident detection to minimize fatalities. [5].

Sarmad Majeed Malik et al, this project aims to construct an automated speed detection system that identifies over-speeding vehicles and extracts their license plate numbers, then notifies the Toll Plaza via email for fine processing. The system is focused on Punjab's license plates in Pakistan and uses the Doppler effect for speed measurements. When over-speeding is sensed, the image of the vehicle is captured by a camera, and employing DIP techniques in MATLAB, the license plate number is extracted. These extracted details are then sent as an e-mail to the Toll Plaza. The system has proven high performance to monitor over-speeding through the accurate detection of over-speeding and extraction of license plates, and hence is feasible for installation on roads to monitor and control traffic violations.[6].

Hamzah Hadi Qasim et al, this paper explores the integration of IoT technology in weather monitoring systems, highlighting the use of multiple weather sensors and ESP32 units in collecting and processing atmospheric data. It utilizes the Blynk platform as an interactive interface, letting the user access and control the data from a distance. Security measures are incorporated to protect sensitive information while it is in transmission. The functional model showed high accuracy of temperature measurements, 2% deviation in relative humidity at day, and 95% accuracy of rainfall data collection through a rain sensor. This system improves the decision-making quality of companies in agriculture, aviation, and environmental research since weather forecasts are both timely and reliable. [7].

The LFAH project integrates a Line Follower system to improve the performance and safety of autonomous vehicles. It combines reliable line-following algorithms with automatically adjustable headlights, using such sensors as line followers and proximity sensors. As it follows the road, headlights are adjusted based on where the vehicle is in position, giving way to improved illuminations and path exactness, especially at night. Field trials show that LFAH performs well in different lighting conditions and may eventually increase safety and performance levels in autonomous vehicles.[8].

Pornpanomchai et al, this research develops an image-processing- based vehicle speed detection system. In a video scene containing moving vehicles and reference points, six main components operate the system, namely, image acquisition, capturing and storing frames; image enhancement, improving the quality for accuracy; and image segmentation, detection of vehicle positions using image differentiation.

It also encompasses image analysis to detect the starting and ending reference points based on thresholding, speed detection so that vehicle speed may be calculated from detected positions, and reporting for a friendly presentation of the results. The system was tested regarding its usability, performance, and effectiveness whereby it showed optimal performance at a 320x240 resolution, having an average time of 70 seconds per video, thereby proving its feasibility under specific conditions.[9].

In their paper "Design and Implementation of a Line Follower Robot," S. Shirmohammadi and F. Baghbani present a comprehensive approach to creating an efficient line-following robot. The researchers detail the design process, which includes selecting appropriate sensors and components, developing the control algorithms, and integrating the hardware and software. They use infrared sensors for line detection and an L293D motor driver to control the robot's movement. The Arduino microcontroller serves as the central unit, processing sensor data and executing control commands to navigate the robot along a predefined path. The robot's performance is tested on various line patterns and surfaces to ensure robustness and reliability. The study concludes with an analysis of the robot's effectiveness and potential applications in educational and industrial contexts.[10]

In their work titled "Implementation of an Emergency Indicating Line Follower and Obstacle Avoiding Robot," P. Valsalan and P. Surendran present the development of a multifunctional robot that combines line-following capabilities with obstacle avoidance and emergency indication features. The researchers detail the integration of these systems using a microcontroller to process sensor data and control motor actions, ensuring seamless operation. The implementation is tested under various scenarios to validate the robot's efficiency in maintaining its path, avoiding obstacles, and indicating emergencies, showcasing its potential applications in industrial automation and safety-critical environments.[11].

In their paper "Line Follower Robot: Design and Hardware Application," S. Tayal, H. P. G. Rao, S. Bhardwaj, and H. Aggarwal present the development and implementation of a line- following robot focused on efficient design and practical hardware applications. The researchers detail the selection and integration of components such as infrared sensors for line detection, a microcontroller for processing sensor data, and motor drivers to control the robot's movement. They emphasize the robot's ability to navigate autonomously by following a predefined path marked by a line on the floor. The paper covers the algorithmic approach used to process the sensor inputs and adjust the motor outputs, ensuring precise and responsive navigation. Testing and validation are conducted under various conditions to demonstrate the robot's robustness and reliability. The study highlights the practical applications of line-following robots in automation, providing insights into the design considerations and challenges faced during the implementation process.[12].

In their paper "Autonomous Control of a Line Follower Robot Using a Q-Learning Controller," S. Saadatmand, S. Azizi, M. Kavousi, and D. Wunsch explore the application of reinforcement learning, specifically Q-learning, to enhance the autonomous navigation of a line-following robot. The researchers design a system where the robot learns to follow a line more effectively by iteratively improving its control strategy based on feedback from the environment. The Q-learning algorithm is implemented to adjust the robot's actions, such as speed and direction, in response to sensor inputs indicating the position relative to the line. This approach allows the robot to optimize its path-following behavior over time, improving its accuracy and adaptability to different line patterns. The study includes detailed experiments demonstrating the robot's performance improvements compared to traditional control methods, highlighting the potential of machine learning techniques in robotics to achieve more intelligent and efficient autonomous systems.[13].

In their paper "A Line Follower Robot from Design to Implementation: Technical Issues and Problems," M. Pakdaman, M. M. Sanaatiyan, and M. R. Ghahroudi present a comprehensive overview of the development process for a line-following robot, addressing key technical challenges and solutions. The researchers detail the design phase, which involves selecting appropriate sensors, microcontrollers, and motor drivers to ensure accurate line detection and reliable movement. They discuss the integration of infrared sensors for detecting the path and the implementation of control algorithms to process sensor data and drive the motors accordingly. The paper highlights various technical issues encountered, such as sensor calibration, noise reduction, and motor control precision. Through extensive testing, they identify and resolve problems related to the robot's navigation accuracy and responsiveness. The study provides valuable insights into the practical aspects of building a line-following robot, emphasizing the importance of thorough testing and iterative improvements to achieve optimal performance.[14]

Vivek Pandey; et al, this project aims at developing an IoT-based automatic accident detection and rescue system that will reduce fatalities caused by vehicle accidents. The system detects collisions with the ESP32 microcontroller integrated with the Blynk platform, processes data, and delivers real-time alerts. It informs parents or emergency contacts, communicates the site of an accident with the nearest available ambulance, and ensures timely hospital access for the victim. The system also comes equipped with an SOS button, so that if users feel they are in danger, they can alert registered mobile numbers.

The Blynk application on the smartphone can then send them SMS and call notifications and the actual location so they can be rescued in time. This system aims to save lives by minimizing delays in providing emergency response.[15].

Wan Norsyafizan W. Muhamad et al, the smart bike monitoring system will have real-time tracking of the health and performance of a cyclist. Sensors to be integrated into the system include the heart rate sensor, pulse oximetry sensor, magnet reed sensor, and GPS module connected to the microcontroller and Wi-Fi module, to send data directly to the Blynk application for monitoring via smartphones. The heart rate sensor tracks heart rate, the pulse oximetry sensor measures oxygen saturation, the magnet reed sensor calculates speed and distance, and the GPS module tracks the location of the cyclist. The user interface of the Blynk app shows parameters, such as heart rate, oxygen levels, speed, distance, and position, thus providing important information for cyclists and coaches in training or a tournament.[16].

Azidin, et al, this project is a speed detection system designed to help the Malaysian Police Force in the fight against highway thugs and illegal racers. The system tracks the speed of a vehicle in real- time using a NodeMCU ESP8266 microcontroller, IR sensor, and through the Blynk platform. Once an approaching vehicle triggers the IR sensor, the speed of the vehicle is automatically displayed on an LCD along with the Blynk app, and in case the vehicle exceeds the determined speed limit, then the system sends a notification. The system improves on the conventional methods by allowing prompt detection and intervention, enhancing road safety and law enforcement effectiveness. It provides a technological solution for the fight against unethical activities on roads and for ensuring safer highways.[17].

Snehal Kokare et al, the paper discusses the functionality of the Firebird V robot, which follows a white line on a black surface using three white line sensors: Left, Center, and Right. The robot stops and activates the buzzer for alertness when an obstacle is detected on its path. It also sends an "Obstacle is present" message wirelessly to a PC using ZigBee. The robot is using an IR Sharp range sensor for obstacle detection. DC motors guide the movement of the robot, and control over their speed is maintained through PWM control.

The experiment included measuring the voltage change of the Sharp IR range and proximity sensors with an increase in obstacle distance as well as voltage levels of the white line sensors on both white and black surfaces. In addition, RSSI (Received Signal Strength Indicator) values were measured using XCTU software; signal strength decreased with distance.[18].

Rakesh Kumar Godi et al, this system provides safety in road by quickly detecting accidents and alerting emergency contacts. A system based on the ESP32 microcontroller instead of the already present two-wheeler, Raspberry Pi-based safety systems with less power consumption, compact size, and cost is considered. Such an accident-detecting system is realized by mounting flex and MEMS sensors outside a vehicle. When an accident occurs and the detected frequencies exceed a programmed level, the ESP32 will collect GPS data and sends out messages containing location information to the emergency contacts of the registered driver through the Wi-Fi and Bluetooth incorporated in it. This prompt communication can alleviate deaths by ensuring a quicker responding emergency.[19].

S Kumar Reddy Mallidi et al, the proposed Smart Vehicle Monitoring System (SVMS) is an IoT-based solution that can be used to enhance the functionality in the detection, prevention, and monitoring of theft of accidents. With rising vehicle usage and associated accidents, traditional static measures are no more adequate. SVMS integrates RPi with sensors, camera, and GPS for remote monitoring and control over the vehicle. This system makes use of machine learning-based image classification to assess the severity level of accidents.

Upon detecting an accident, the system evaluates its severity and promptly notifies the authorities. The integrated GPS continuously tracks the vehicle’s location, aiding in accident response and theft prevention. The system has shown promising results in accurately detecting accidents, assessing severity, and tracking vehicle locations effectively.[20].

III. METHODOLOGY

This line follower robot is one embedded to autonomously follow a predefined path in an industrial environment and allows remote control of its speed using the Blynk app. At present, it's monitoring the speed of the robot in the time it's set; if that speed goes above 30 units (something like cm/s or RPM, depending on the unit measurement), a warning message will be broadcast to the user via the Blynk app.

This will enable the monitoring and regulation of actual occurrences in real-time to prevent any unsafe operation at any critical industrial site.

A. Hardware Implementation

Sl. No	Component
1	ESP32
2	IR SENSOR
3	GSM MODULE
4	MOTOR DRIVER MODULE L2987
5	DC MOTOR
6	ROBOT CHASSIS
7	WHEEL

Table 1. List of Component

This vehicle module, as shown in fig.1, uses ESP32 as the central processing unit, which integrates input from several IR sensors mounted at different points of the vehicle to monitor its surroundings. In this setup, these IR sensors shall be mounted on locations such as front, left, and right, and will determine its line- following ability, as well as any form of obstacle detection.

ESP32: The central core of the system, an ESP32 receives inputs from the IR sensors and controls the locomotion of the robot. Connected to the motor module, adjusts the speed and direction of the wheels. Further, ESP32 enables wireless communication using its Wi-Fi module provided with the board for connecting to the Blynk app application that enables real-time control and monitoring of speed and other parameters.

The IR Sensors: Three are the number of IR sensors used for detection of lines and obstacles, as shown in the diagram. The data received by sensors is transferred to ESP32, which calculates the proper type of movement and speed adjustment needed by the vehicle. They ensure proper guidance for the robot along set paths and safe operation within its environment.

GSM Module: This module is for communication over mobile networks. It is also a means for sending warnings or real-time data regarding the status of the vehicle in question-for example, when the robot exceeds a certain speed threshold. It runs in parallel with the IoT connection, offering full remote monitoring and control.

Motor Module-L298N: It will connect the ESP32 to the motors which will accordingly transmit their movements further to the vehicle's wheels. The ESP32 would send a command to modify the motor's speed and direction to modify the vehicle's movement. All such inputs from the ESP32 side will be upgraded dynamically by considering the surroundings of the robot, be it the IR sensor or the user commands from the Blynk app.

DC Motors: These motors are attached on the left and right sides of the car. This attachment helps a car to move. The speed of the motor is controlled by a motor module with the help of an ESP32 which controls the motor turn of speed and speed. This motor is quite crucial for the implement movement of the instructions for the vehicle to follow the correct path and correct speed.

IoT Cloud Connectivity: The vehicle is also connected to the IoT cloud, which allows for live data logging and monitoring through the Blynk app or other IoT platforms. This feature enhances the use of the vehicle for industrial purposes, as remote control and monitoring are a concern with robots.

B. Software Implementation

The core function of the Blynk app is to facilitate the interaction needed by users, where the operators can set speed, monitor performance, and receive alerts through GSM and IoT connections. The feedback loop between the vehicle and the app ensures real-time adjustments that will allow one to have precise control and efficient operation.

Fig.2 As can be seen through, the user module is a kind of interface that a user has controlled over a robot remotely. It basically consists of a mobile device and the Blynk IoT application, which is one of the core platforms through which command and monitor status of operational in the robot's real time.

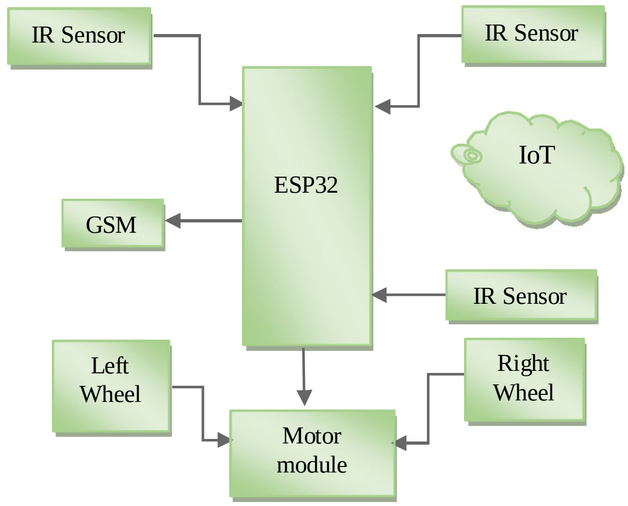


Fig 1. Methodology of Vehicle Module

Mobile Device: It is the control centre for the user. Being installed with the Blynk IoT application, they can access it remotely via their mobile device in controlling the robot. The users can set up several desired speeds, control the direction of the robot by viewing sensor readings, and even receive alerts or notifications.

Blynk IoT Application. The application is a friendly user interface communicating with the ESP32 module inside the robot through Wi-Fi. Characteristic: it provides real-time control and monitoring, thus offering a user the possibility to both control and check up on his work in real time.

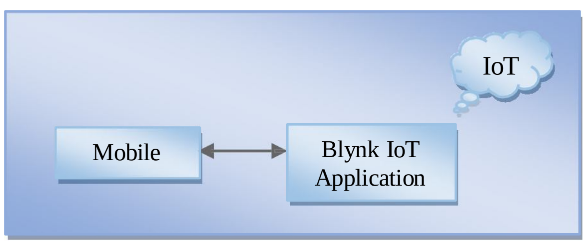


Fig 2. User Module

.

Mobile Device: It is the control centre for the user. Being installed with the Blynk IoT application, they can access it remotely via their mobile device in controlling the robot. The users can set up several desired speeds, control the direction of the robot by viewing sensor readings, and even receive alerts or notifications.

Blynk IoT Application. The application is a friendly user interface communicating with the ESP32 module inside the robot through Wi-Fi. Characteristic: it provides real-time control and monitoring, thus offering a user the possibility to both control and check up on his work in real time. Set Speed for Robot: User can enter a set speed that he wants the robot to achieve remotely. This speed is then transmitted to the ESP32, which can then relay the motor speed commands.

Monitor Speed and Status: The app continuously displays working parameters for the robot-such as speed and sensor status. Real-time feedback ensures that the user is in tune with the behaviour of the robot.

Receive Notification: An important app feature is the display of a notification when the speed of the robot goes above the threshold defined in advanced. For example, in this case, it might be 30 units. Such notifications will thus act as reminders so the users take swift corrective action if the robot moves unsafely or out of bounds.

IoT Cloud: An IoT Blynk cloud application connects the robot using an IoT cloud to communicate using the user's mobile device with the ESP32, which controls the robot. It ensures real-time exchange of data, thus providing continuous monitoring and control over the behaviour of the robot.

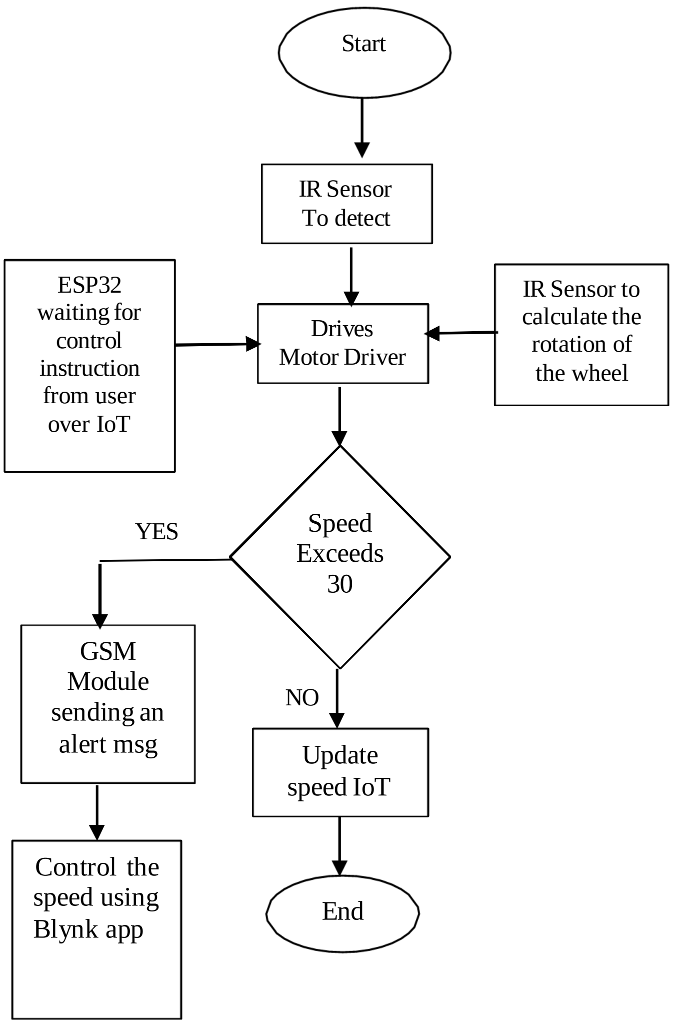
International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

C. Notification System (Speed > 30)

Speed Monitor: This is a module inside the ESP32. It constantly monitors the speed of the robot, keeps track of the current speed and compares with threshold limits such as 30 cm/s or RPM, and provides the module with safety and efficiency in its functions. When the speed of the robot goes beyond the limit, it turns on the warning system of the monitor and sends a signal to the Blynk application by reporting that the robot is moving at unsafe speed, so corrective measures are undertaken.

This system will alert the user once the speed of the robot surpasses the predefined threshold value of 30. In the Blynk application, the alarm will be transferred. Optionally, a buzzer or an LED indicator can be added on the robot to send local warnings. However, it can then take corrective actions either by controlling its speed or by stopping the robot. It further gives an on-site warning through the local buzzer or LED.

Fig.3. Line-Follower with Speed Control Flow chart



D. System Integration and Testing

Once both the hardware and the software are set, upload the code into the ESP32 and begin testing the connections. For this, the application from Blynk is used to watch remotely through and control the speed of the robot. First, make sure that all parts including sensors, motors, and modules for communication are working properly. The system can be checked totally by placing the robot on a path and setting the speed via an application. ESP32 ensures that the speed adjustment is done in real-time and it follows the line. The alert mechanism notifies users when the set speed limit is breached thus improving its industrial application where remote monitoring and control are of great importance. Testing: Try out testing of the robot on a surface with a visible line to prove that it will follow the given path.

Step 8: Adjust the speed using the Blynk app and verify if this is complying with the set conditions to ensure that the motors do move. Notify the user so the robot does not cross the set limits for the allowed speed limit. Lastly, test other features that you might have added such as a GPS module and an ultrasonic sensor to fully implement the project. This application, developed in this project, is going to make the industrial automation easy to set up because it can easily control and operate the robotic systems from a distance in a safe manner.

E. Industrial Application Significance

1) Distributed Speed Control : The robot speed at the industrial site is constantly monitored and adjusted in real time by the operators without the need for their presence. The system is therefore very flexible and adaptable to the diverse needs of an operation.
2) Safety Alerts: The system will ensure that the robot does not cross the permissible limits in terms of speed so that no potential hazard arising from such fast moving industrial operations is tolerated.
3) Real-Time Monitoring : With the seamless integration of Blynk app, supervisors and operators can monitor robot performance in real-time for smooth and efficient operation.
4) Versatility: The robot can be used on various applications in different industries, such as a typical assembly line, warehouse, and transportation system, where precise speed control is required.

IV. RESULTS AND DISCUSSION

The line follower robot successfully follows the black line using the IR sensor. As the robot moves along the defined path, the first IR sensor detects the black line and feeds data into the ESP32, thus giving it precise navigation. As can be seen in fig.4, the robot was tested for accuracy as it followed the line under different lighting conditions and surfaces. The IR sensor itself worked well in following the line, ensuring smooth and undedicated navigation. The Blynk App real-time speed controlling capability enabled the It should have an operator to adjust the speed through remote control. This flexibility is essential for use in industries, where task completion time may be based on requirements according to the operational needs.

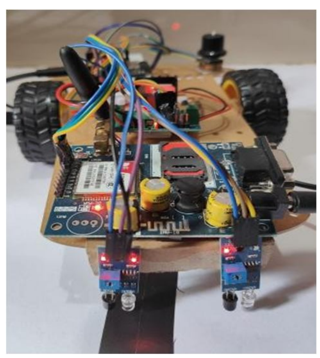


Fig 4. Robot following the black line on the floor

The second IR sensor was successfully used to detect the rotation of the robot's wheels by identifying strips placed on the wheels. This sensor provided crucial data for calculating the robot's speed.

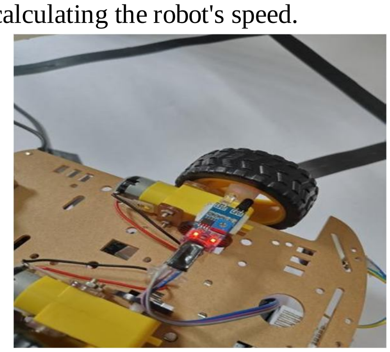


Fig 5. The robot's wheel with strips that the IR sensor detects to calculate speed.

The fig.5 describing the detecting the intervals between the wheel's rotations, the ESP32 could calculate the robot's speed in real-time. This data was essential for both speed monitoring and triggering alerts when the robot exceeded the set threshold (30 units). The precise calculation of speed using the IR sensor ensures that the robot operates safely within desired limits, and any deviations in speed can be quickly identified.

The robot's ability to autonomously follow lines and adjust speed based on real-time feedback has significant applications in industrial automation. Tasks such as material transport and assembly line operations can benefit from the robot's adaptability and remote-control features.

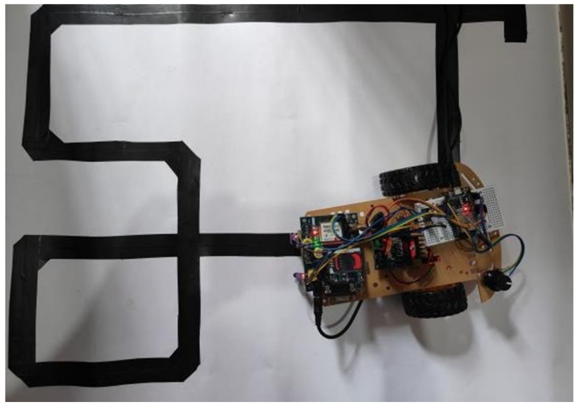


Fig 6. Robot in a warehouse-like environment, demonstrating its potential industrial use case.

As show in the fig.6 in warehouses, the robot could transport materials along predefined paths, and operators could change the speed based on task urgency. This adaptability would allow industrial workflows to become more flexible and efficient. The GSM-based alert system ensures that operations remain safe by notifying the operator of speed violations, which can then be rectified promptly through the Blynk app.

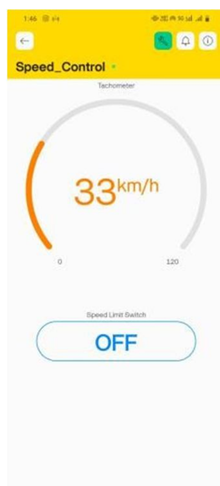


Fig 7. Speed Monitoring Display.

This goes to complement the real-time interface of control and monitoring through the Blynk application for the line-following robot so that the operators can ascertain proper functioning in industrial conditions. As shown in fig.7, the app provides for the actual speed of the robot in real time. In industrial applications, this is an important factor since the speed at which a robot must operate falls well within predetermined limits to ensure safe operation. There is a "Limit Speed" button that the manager or supervisor may activate to bring the robot's speed back within a safe range. The button sends a command to the robot to limit its speed to below the 30-unit threshold. This feature puts in the system the ability to easily adjust the working parameters of the robot quickly, thereby adding a layer of control safety.

Fig 8. Limit Speed Button.

Once the “Limit Speed” button is activated and the robot's speed drops below the 30-unit threshold, a green confirmation message— "Speed Limited to Safe Level"—appears. This message reassures the operator that the robot is now functioning within safe limits, reducing any operational risks associated with overspeed.

V. CONCLUSION

The line follower robot speed control developed using the Blynk app was done in an efficient and scalable way concerning industrial automation. Their components, such as ESP32 microcontrollers, IR sensors, motor drivers, and the speed regulator, form a system that ensures navigation along a predefined path while remotely controlling and monitoring speeds. Integration with the Blynk app is done to enhance the rate of user interaction with the robot. It is possible to change the speed of the robot in real-time and alert the user when it is operating beyond a predetermined safe speed limit, improving the safety aspect in operations.

This paper establishes the potentiality of using the technologies on IoT and robotics in the scope of industrial applications. It shows that these may turn out to be versatile but effective tools to manage automated processes. For such applications that are of industrial nature, including varying speeds and instant alerting when thresholds are breached, remote control, and safety features, it is very apt that the robot be used. In general, this project integrates hardware with the software to produce a reliable and intelligent robotic system to meet the needs of industries.

VI. FUTURE WORK

This elementary system of the line follower robot with using Blynk app for speed control puts in the basis of industrial automation but with lots of opportunities further direction-to be improved: route navigation of the robot. The robot, by integrating such more advanced algorithms like machine learning or computer vision, could dynamically detect lines and better avoid certain obstacles while also planning optimal paths in rather complex or unpredictable industrial environments. This would improve its adaptability and functionality. Long-term deployment also requires optimization of power consumption in the robot. Better battery management systems combined with renewable sources of energy, such as solar-powered robots, would increase the uptime of the operation of the robot, thus making it sustainable for continuous use in industry. Ensuring such a robot is designed to meet all safety standards, durability requirements, and reliability expectations in industry would make it more applicable since such a robot would function in the widest range of industrial environments, meeting extreme safety and performance requirements.

REFERNECES

[1] H. C. T., S. Nagaraju, B. N. Varma, K. K. M., M. S. and M. K.V., "IoT based Vehicle Over-Speed Detection and Accident Avoidance System," 2021 International Conference on Disruptive Technologies for Multi-Disciplinary Research and Applications (CENTCON), Bengaluru, India, 2021, pp. 112-117, doi: 10.1109/CENTCON52345.2021.9688241.

[2] Chang, Kuo-Chi, et al. "Arduino line follower using fuzzy logic control." International Conference on Advanced Machine Learning Technologies and Applications. Cham: Springer International Publishing, 2022.

[3] Kabir, Md & Sarker, Md & Hossain, Tomal & Jahan Jerin, Israt & Ali, Md. (2021). Design and Implementation of Automatic Line Follower Robot for Assistance of COVID-19 Patients. 10.1007/978-981-16-6605-6.

[4] M. Pakdaman and M. M. Sanaatiyan, "Design and Implementation of Line Follower Robot," 2009 Second International Conference on Computer and Electrical Engineering, Dubai, United Arab Emirates, 2009, pp. 585-590, doi: 10.1109/ICCEE.2009.43.

[5] R. K. Godi, S. Agarwal and G. Shailaja, "Develoment of an Accident Detection System Using IoT and Blynk Application," 2023 International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS), Erode, India, 2023, pp. 1412-1419, doi: 10.1109/ICSSAS57918.2023.10331852.

[6] S. M. Malik, M. A. Iqbal, Z. Hassan, T. Tauqeer, R. Hafiz and U. Nasir, "Automated over speeding detection and reporting system," 2014 16th International Power Electronics and Motion Control Conference and Exposition, Antalya, Turkey, 2014, pp. 1104-1109, doi: 10.1109/EPEPEMC.2014.6980657.

[7] H. H. Qasim et al., "Enhancing Weather Monitoring: A Comprehensive Study Utilizing IoT, ESP32, Sensor Integration, and Blynk Platform," 2024 IEEE 10th International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA), Bandung, Indonesia, 2024, pp. 156-161, doi: 10.1109/ICSIMA62563.2024.10675553.

[8] Sandra, I. Syafalni, N. Sutisna and T. Adiono, "Design and Implementation of Line Follower for Adaptive Headlight," 2023 International Conference on Electrical Engineering and Informatics (ICEEI), Bandung, Indonesia, 2023, pp. 1-5, doi: 10.1109/ICEEI59426.2023.10346679.

[9] Pornpanomchai, C., & Kongkittisan, K. (2009). Vehicle speed detection system. In ICSIPA09 - 2009 IEEE International Conference on Signal and Image Processing Applications, Conference Proceedings (pp. 135-139). Article 5478629 (ICSIPA09 - 2009 IEEE International Conference on Signal and Image Processing Applications, Conference Proceedings). https://doi.org/10.1109/ICSIPA.2009.5478629

[10] Shirmohammadi, Shervin, and Fahimeh Baghbani. "Design and Implementation of a Line Follower Robot." 2024 10th International Conference on Artificial Intelligence and Robotics (QICAR). IEEE, 2024.

[11] P. Valsalan and P. Surendran, "Implementation of an Emergency Indicating Line Follower and Obstacle Avoiding Robot," 2019 16th International Multi-Conference on Systems, Signals & Devices (SSD), Istanbul, Turkey

[12] S. Tayal, H. P. G. Rao, S. Bhardwaj and H. Aggarwal, "Line Follower Robot: Design and Hardware Application," 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), Noida, India, 2020, pp. 10-13, doi: 10.1109/ICRITO48877.2020.9197968

[13] S. Saadatmand, S. Azizi, M. Kavousi and D. Wunsch, "Autonomous Control of a Line Follower Robot Using a Q- Learning Controller," 2020 10th Annual Computing and Communication Workshop and Conference (CCWC), Las Vegas, NV, USA, 2020, pp. 0556-0561,doi: 10.1109/CCWC47524.2020.9031160

[14] M. Pakdaman, M. M. Sanaatiyan and M. R. Ghahroudi, "A line follower robot from design to implementation: Technical issues and problems," 2010 The 2nd International Conference on Computer and Automation Engineering (ICCAE), Singapore, 2010, pp. 5-9, doi: 10.1109/ICCAE.2010.5451881.

[15] V. Pandey, B. Behera, A. Yadav, A. Dubey, A. Barai and S. Agrawal, "Design and Development of IoT Based Collision Alert System Using Blynk and Arduino," 2024 International Conference on Advances in Computing Research on Science Engineering and Technology (ACROSET), Indore, India, 2024, pp. 1-6, doi: 10.1109/ACROSET62108.2024.10743475.

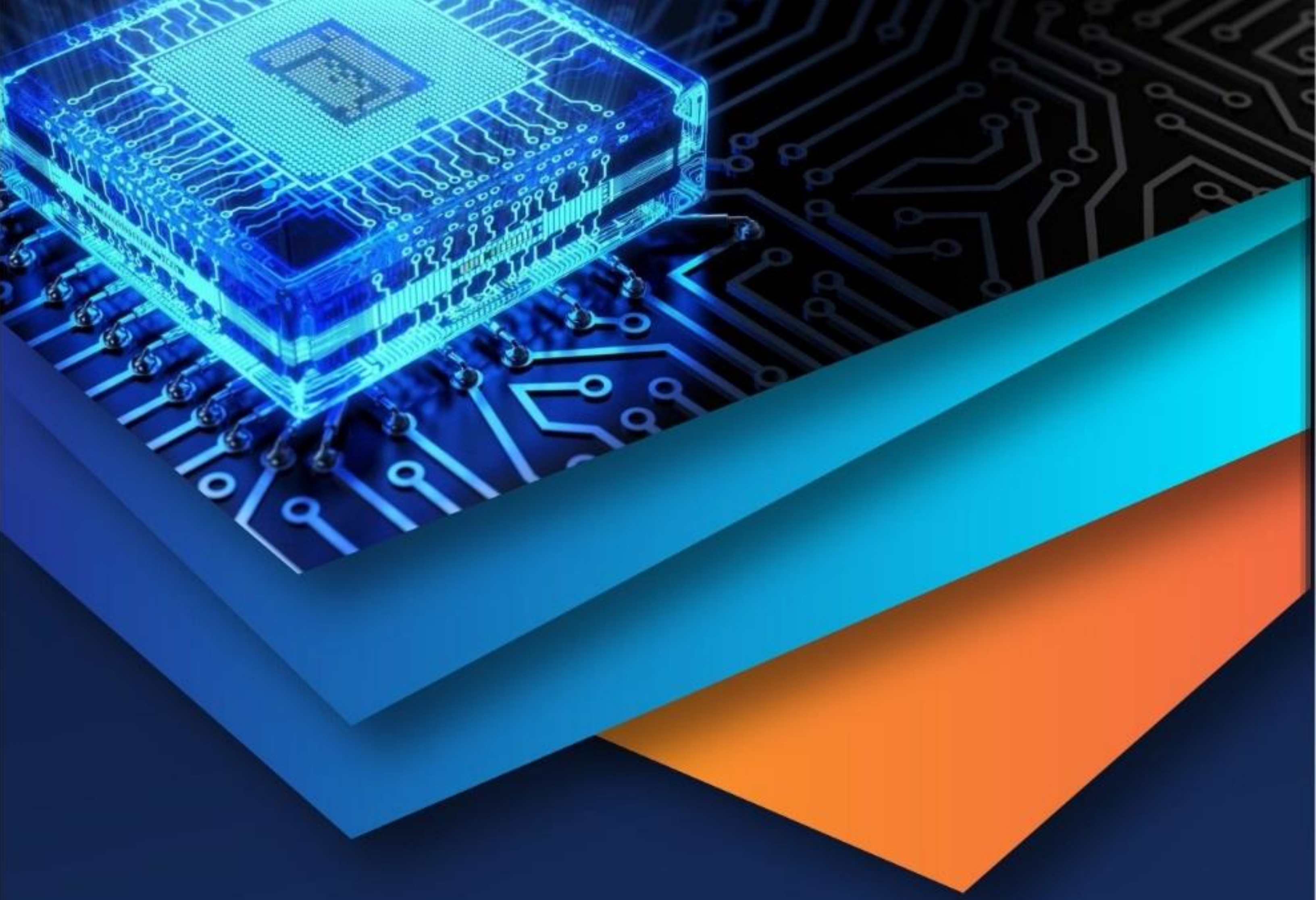
[16] W. N. W. Muhamad, S. A. b. Razali, N. A. Wahab, M. M. Azreen, S. S. Sarnin and N. F. Naim, "Smart Bike Monitoring System for Cyclist via Internet of Things (IoT)," 2020 IEEE 5th International Symposium on Telecommunication Technologies (ISTT), Shah Alam, Malaysia, 2020, pp. 168-173, doi: 10.1109/ISTT50966.2020.9279377.

[17] Azidin, Farid Arafat, Muhamad Sofian Ahmad Zamri, and Zulkarnain Zainudin. "Enhancing Road Safety: A Smart Speed Detection System Using IoT Technology." Journal of Telecommunication, Electronic and Computer Engineering (JTEC) 15.4 (2023): 27-32.

[18] S. Kokare, R. Shastri and S. Kolhar, "Line Follower with Obstacle Information System Using ZigBee," 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), Pune, India, 2018, pp. 1-5, doi: 10.1109/ICCUBEA.2018.8697470.

[19] Godi, Rakesh & Agarwal, Swathi & Shailaja, G.. (2023). Develoment of an Accident Detection System Using IoT and Blynk Application. 1412-1419. 10.1109/ICSSAS57918.2023.10331852.

[20] Mallidi, S Kumar Reddy. (2018). IOT BASED SMART VEHICLE MONITORING SYSTEM. International Journal of Advanced Research in Computer Science. 9. 738-741. 10.26483/ijarcs.v9i2.5870.



10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

SJIFactor
TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY