ROCKER BOGIE ROBOT

Y. Neeraj Kumar[1], P. Gayathri[2], P. Rohit Reddy[3], M. Kiran[4], P. Sravani[5], Mrs. B. N. S. Rani[6]
[1,2,3,4,5]U.G. Students, [6] Assistant Professor
Department of ECE, N. S. Raju Institute of Technology, Sontyam, Visakhapatnam, A.P, India

ABSTRACT

The Rocker Bogie Robot is a versatile solution designed to navigate challenging environments such as disaster zones, hazardous terrains, military contexts, and mining sites. It integrates advanced components for optimal performance across diverse applications. At its core is the NodeMCU, serving as the brain to control and coordinate operations seamlessly, facilitating real-time data acquisition and decision-making. The locomotion system, driven by six geared motors and L293D drivers, ensures enhanced maneuverability and traction across surfaces. Equipped with a Zebronics Smart Cam 100, the robot offers advanced features like automation, WiFi connectivity, and two-way audio communication. Its multi-functional design enables applications like search and rescue missions, exploration of hazardous environments, military reconnaissance, and mining operations. The integration of state-of-the-art components enhances its effectiveness, resilience, and adaptability, making it invaluable for disaster response, exploration, and industrial tasks.

Keywords: Rocker Bogie Robot, Hazardous terrain navigation, Military reconnaissance, Mining operations, NodeMCU microcontroller, Geared motors, L293D drivers, Zebronics Smart Cam 100, Search and rescue missions, Exploration Industrial applications.

I. INTRODUCTION

In response to the increasing occurrences of natural disasters, environmental challenges, and difficult terrains, the necessity for adaptable and efficient robotic systems has become apparent. This project is dedicated to crafting a versatile rocker bogie robot capable of addressing a wide array of challenges encountered in disaster response, exploration endeavors, military applications, and mining activities. The incorporation of a rocker bogie suspension system stands as a cornerstone of the robot's design, allowing for superior mobility and stability even across rough and uneven terrain. Drawing inspiration from NASA's successful employment of similar systems in their Mars rovers, this mechanism equips the robot to navigate obstacles and debris frequently encountered in disaster areas and hazardous environments. At the heart of the robot's operation lies an advanced control system, driven by the NodeMCU microcontroller. This integration ensures robust and adaptable control, enabling both remote operation and autonomous functionality. To facilitate precise motion control in demanding conditions, the robot employs six geared motors alongside accompanying L293D drivers. Additionally, the inclusion of a Zebronics Smart Cam 100 enhances the robot's capabilities with features such as automation, WiFi connectivity, motion detection, and two-way audio communication, thereby augmenting its situational awareness and facilitating real-time data gathering and communication with operators or personnel. The overarching goal of this project is to showcase the versatility and effectiveness of the proposed rocker bogie robot across various applications, including search and rescue missions, hazardous environment exploration, military reconnaissance and surveillance tasks, and support in mining operations. By leveraging state-of-the-art components and features, the robot is poised to emerge as an invaluable asset for disaster response teams, exploration missions, and industrial applications, ultimately contributing to safer and more efficient operations in challenging environments.

II. LITERATURE SURVEY

The literature survey encompasses a diverse range of studies focusing on various aspects of robotics design and functionality, particularly emphasizing stair-climbing mechanisms and mobility systems. Sinha and Sinha (2018) delve into the intricate details of the "Design of Stair-Climbing Rocker-Bogie Mechanism," providing a deep understanding of the engineering principles involved in creating such systems [1]. Meanwhile, N. Yadav, B. Bhardwaj, and S. Bhardwaj (2015) undertook a feasibility study regarding the implementation of

Rocker-Bogie Suspension Systems in front-loading vehicles, highlighting the potential advantages and challenges associated with this technology [2].

Bruzzone and Quaglia (2012) offer a comprehensive review of locomotion systems for ground mobile robots operating in unstructured environments. Their work provides valuable insights into the evolution of mobility systems, the challenges faced, and the technological advancements achieved over time [3]. Asalekar et al. (2017) contribute practical insights with their research on the "Design and Fabrication of Staircase Climbing Robot," demonstrating the real-world implementation of such systems and their performance in navigating complex terrains [4].

Harrington and Voorhees (2004) draw from their experiences in aerospace engineering to discuss the unique challenges encountered in designing Rocker-Bogie Suspensions for Mars rovers. Their work sheds light on the rigorous engineering processes and considerations required for space exploration missions [5]. Y. L. Maske, S. V. Patil, S. Deshmukh (2015) contribute to the literature with their study on modeling and simulating stair-climbing robots equipped with rocker-bogie mechanisms. By employing simulation techniques, they provide valuable insights into the behavior and performance of such robots in various scenarios [6].

Sasaki and Suzuki (2018) introduce an innovative active rotary-legs mechanism for stair-climbing mobility vehicles, showcasing advancements in mobility technologies [7]. N. J. Baishya, B. Bhattacharya, H. Ogai, and K. Tatsumi (2021) offer an analysis and design perspective on minimalist step-climbing robots, exploring potential optimizations and efficiencies in their construction and operation [8]. Y. Kim, J. Kim, H. S. Kim, and T. Seo (2019) propose a Curved-Spoke Tri-Wheel Mechanism for Fast Stair-Climbing, presenting novel approaches to address mobility challenges efficiently [9].

Lastly, X. Chen, L. Mao, Y. Zhao, and F. Gao (2021) contributes to the advancement of robotics with their research on Stair Climbing Capability-Based Dimensional Synthesis for Multi-legged Robots. By focusing on dimensional synthesis, their work aims to optimize the design of multi-legged robots for effective stair-climbing capabilities [10]. Together, these studies provide a comprehensive overview of the state-of-the-art in stair-climbing robotics, offering valuable insights for researchers and engineers seeking to develop innovative solutions for navigating challenging terrains

III. EXISTING SYSTEM

The Arduino board serves as the central processing unit for controlling the movement of the robot. It receives commands and instructions from the user or an external controller and generates corresponding signals to drive the DC motors. Six DC motors are used to drive the wheels of the rocker-bogie robot. These motors are typically equipped with gearboxes to reduce speed and increase torque, providing sufficient power to propel the robot over various terrains. Motor drivers such as H-bridge modules or motor driver ICs are used to interface the Arduino with the DC motors. These drivers provide the necessary power amplification and control signals to drive the motors in both directions (forward and reverse) at variable speeds.

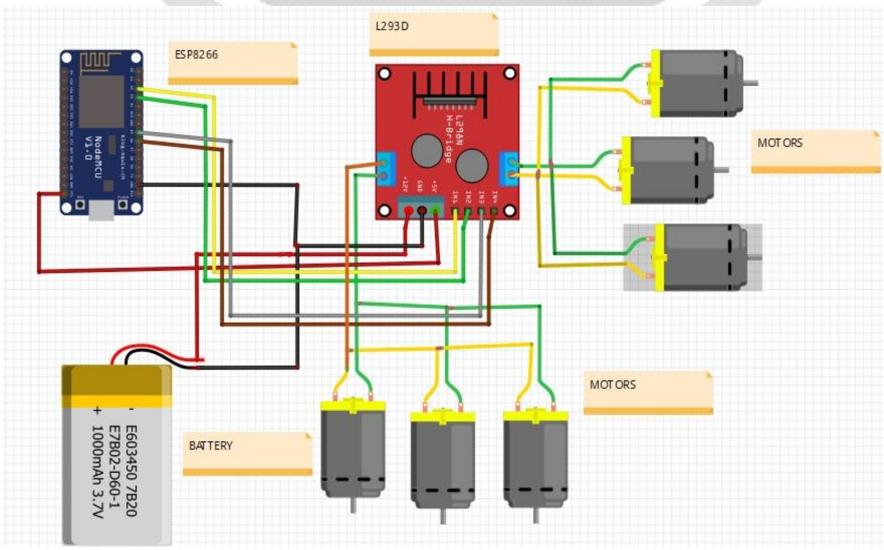

Fig 1: Circuit Diagram of Rocker-Bogie Robot

IV. PROPOSED SYSTEM

The proposed system introduces several enhancements to the Rocker Bogie Robot. Alongside the motor drivers, it incorporates a NodeMCU for expanded connectivity options. Additionally, the inclusion of a Zebronics Smartcam 100 introduces advanced features such as automation, WiFi connectivity, remote monitoring, motion detection, day/night mode, live streaming, micro SD card storage, and two-way audio communication. These enhancements not only improve the robot's functionality but also offer capabilities for remote operation, data collection, and situational awareness, making it more versatile and suitable for a wider range of applications, including search and rescue missions, exploration in hazardous environments, military operations, and mining activities.

Fig 2: Rocker Bogie System

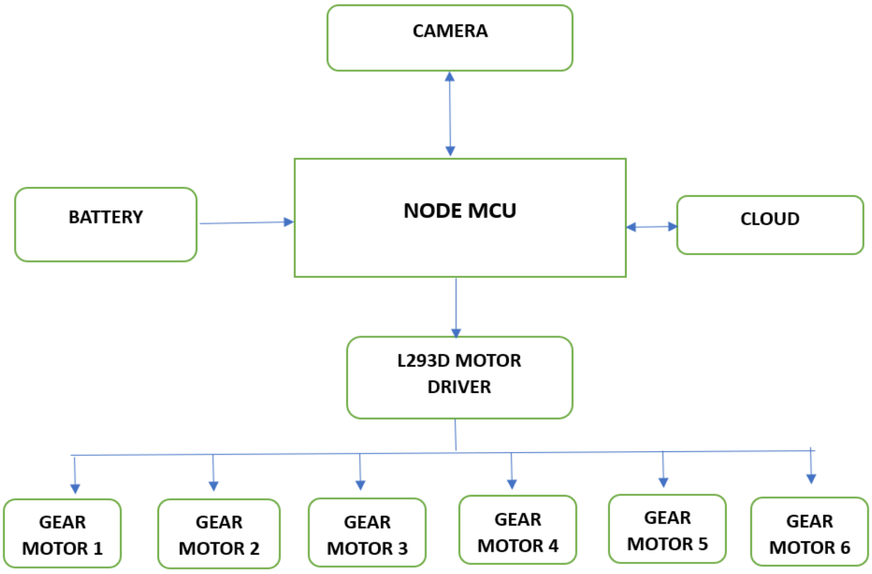

Fig 3: Block Diagram of Rocker Bogie Robot

The Rocker Bogie Robot is a versatile and robust platform designed for a multitude of critical applications such as search and rescue missions, exploration in hazardous environments, military operations, and mining activities. At its core, the robot integrates several key components to enable its functionality and effectiveness in diverse scenarios. Firstly, the NodeMCU serves as the central control unit, orchestrating the robot's movements and operations. It receives instructions from external sources or user inputs and translates them into commands for the various subsystems of the robot. Driving the locomotion of the robot are six geared motors, each equipped with wheels to provide stability and traction across different terrains. These motors work in tandem to propel the robot forward, backward, and sideways, allowing it to navigate through challenging environments with ease. To regulate the power and direction of the geared motors, the L293D motor driver acts as an intermediary between the NodeMCU and the motors. It amplifies control signals from the microcontroller and ensures precise control over the motor's speed and direction, enhancing the robot's maneuverability and responsiveness. Additionally, the integration of the Zebronics Smartcam 100 enhances the robot's capabilities by providing real-time surveillance and monitoring capabilities. Equipped with features such as WiFi connectivity, advanced motion detection, and live streaming, the smart camera enables remote monitoring of the robot's surroundings, facilitating situational awareness and decision-making during operations.

In essence, the Rocker Bogie Robot operates by receiving commands from the NodeMCU, which orchestrates the movement of the geared motors via the L293D driver. Simultaneously, the Zebronics Smartcam 100 captures vital visual data, allowing operators to monitor the robot's progress and surroundings in real-time. This integrated system empowers the robot to excel in its designated tasks, whether it's navigating disaster zones, exploring hazardous environments, conducting military operations, or undertaking mining activities.

V. HARDWARE REQUIREMENTS:

(a) NODEMCU ESP8266

NodeMCU is an open-source firmware and development kit that facilitates the development of IoT (Internet of Things) applications. It is based on the ESP8266 Wi-Fi module and integrates GPIO, PWM, I2C, and other digital interfaces, making it suitable for a wide range of IoT projects. NodeMCU allows developers to program in Lua scripting language or using the Arduino IDE, providing flexibility and ease of use. With built-in Wi-Fi connectivity, NodeMCU enables devices to connect to the internet and communicate with other devices or cloud services. Its small form factor and low cost make it popular for prototyping and DIY projects, including home automation, sensor networks, and remote monitoring systems. Additionally, NodeMCU supports over-the-air (OTA) firmware updates, allowing for seamless maintenance and updates of deployed IoT devices. Overall, NodeMCU serves as a versatile platform for building connected IoT applications with ease.

(b) ZEBRONICS SMART CAM 100

The Zebronics Smart Cam 100 is a versatile smart home automation camera designed to provide advanced surveillance and monitoring capabilities. With its high-quality video capture, WiFi connectivity, and remote monitoring features, users can keep an eye on their property from anywhere, at any time. Equipped with advanced motion detection and day/night mode, the camera ensures reliable surveillance even in low-light conditions. Additionally, its live streaming capabilities and two-way audio functionality enable remote interaction with individuals near the camera. With a micro SD card slot for local storage and built-in automation features, the Zebronics Smart Cam 100 offers comprehensive security and peace of mind for home and commercial applications.

(c) DC GEAR MOTOR

A DC gear motor is a type of electric motor that incorporates a gear system to provide precise control over speed and torque. These motors are commonly used in various applications requiring controlled motion, such as robotics, automotive systems, and industrial machinery. The gear system consists of gears of different sizes, which mesh together to transmit power from the motor shaft to the output shaft. This gearing arrangement allows the motor to produce higher torque output while reducing the speed of rotation. DC gear motors are available in different sizes and configurations to suit specific requirements, and they offer efficient and reliable operation for a wide range of applications.

(d) L293D Driver

The L293D is a popular motor driver integrated circuit (IC) used to control the direction and speed of DC motors. It is designed to drive small to medium-sized DC motors with a maximum voltage rating of 36 volts and a maximum current rating of 600 mA per channel (1.2 A peak). The IC contains two H-bridge circuits, each capable of driving one DC motor bidirectionally, allowing the motor to move forward or backward depending on the input signals. Additionally, the L293D includes built-in protection diodes to prevent damage from back EMF generated by the motor during operation. It is commonly used in robotics, mechatronics, and other electronic projects requiring motor control.

(e) Battery

The 12V battery used in the Rocker Bogie Robot is a rechargeable sealed lead-acid battery with a capacity of 1300mAh. It is designed for applications such as UPS systems, toys, solar panels, and do-it-yourself projects. The battery cell composition is lead-acid, offering reliable performance and durability. With a voltage of 12 volts and a capacity of 1300mAh, it provides sufficient power to drive the motors and other electronic components of the robot. The battery is maintenance-free and features a strong ABS body for added durability. It measures 97 x 45 x 53 mm (L x W x H) and weighs 0.1 kilograms, making it compact and lightweight for easy installation. The battery is rechargeable after each use, ensuring long-term usability and reliability. It is an essential component of the Rocker Bogie Robot, providing the necessary power to support its operations in various environments.

(f) PVC Pipe & Elbow's

The PVC pipe and elbows used in the Rocker Bogie Robot serve as the main structural framework for the chassis and body of the robot. PVC, or polyvinyl chloride, is a lightweight, durable, and cost-effective material commonly used in construction and engineering projects. In the context of the Rocker Bogie Robot, PVC pipes and elbows are used to create a rigid yet flexible structure that can withstand the rigors of challenging terrains and environments. The pipes are typically cut to specific lengths and joined together using elbows to form the desired shape of the robot's chassis. This modular construction allows for easy assembly and customization of the robot's size and configuration. Additionally, PVC pipes are corrosion-resistant and can withstand exposure to water, making them suitable for outdoor and harsh environments where the robot may operate.

VI. SOFTWARE TOOLS

1. **Arduino IDE:** The Arduino IDE is an integrated development environment (IDE) for writing and uploading code to Arduino boards. It's used to program the ESP8266 microcontroller board to handle tasks like image processing, communication with the sensor, and data storage.
2. **Arduino IoT Cloud:** Arduino IoT Cloud is a platform provided by Arduino that enables users to easily build IoT (Internet of Things) applications and connect their Arduino devices to the cloud. It provides a simple and intuitive interface for creating projects, connecting devices, and managing data remotely.

VII. FUTURE ENHANCEMENTS

Future enhancements for the Rocker Bogie Robot could include:

1. **Autonomous Navigation:** Implementing advanced navigation algorithms and sensors to enable autonomous movement and obstacle avoidance, enhancing its capabilities for independent operations in challenging terrains.
2. **Improved Sensor Integration:** Integrating additional sensors such as LiDAR (Light Detection and Ranging), infrared sensors, or environmental sensors to provide more comprehensive data for environmental mapping and analysis.
3. **Enhanced Communication:** Upgrading communication capabilities to support long-range communication technologies like satellite communication or mesh networks, ensuring robust connectivity in remote and disaster-affected areas.
4. **Payload Flexibility:** Designing modular payload systems to accommodate different mission-specific equipment, such as medical supplies for disaster response or specialized tools for mining applications.
5. **AI and Machine Learning:** Implementing artificial intelligence (AI) and machine learning (ML) algorithms for real-time data analysis, decision-making, and adaptive behavior in dynamic environments.

VIII. RESULT

The Rocker Bogie Robot, integrated with NodeMCU for control, six geared motors, L293D motor driver, and Zebronics Smartcam 100, delivers robust performance across various applications. It excels in disaster response scenarios, exploration missions in hazardous environments, military operations, and mining activities.

The NodeMCU effectively manages the movement of the robot, coordinating the six geared motors through the L293D driver. The Zebronics Smartcam 100 enhances operational efficiency by providing real-time monitoring, advanced motion detection, and live streaming capabilities. This integrated system ensures reliable performance and situational awareness in demanding environments.

IX. CONCLUSION

In conclusion, the integration of the Zebronics Smart Cam 100 with the existing Arduino-based rocker bogie robot enhances its functionality by providing live video streaming capabilities. This addition allows users to remotely monitor the robot's surroundings in real-time, improving situational awareness and navigation during operation. By mounting the camera module securely onto the robot's chassis and developing the necessary software interfaces, users can view live video footage transmitted wirelessly from the robot to a compatible receiving device. The benefits of live video streaming contribute to the overall effectiveness and usability of the rocker-bogie robot in various applications, including search and rescue operations, environmental monitoring, and exploration missions. Ultimately, the integration of the Zebronics Smart Cam 100 enhances the robot's capabilities and expands its potential for use in diverse scenarios where real-time visual feedback is essential.

X. REFERENCES

[1] Abhaykant Sinha and Reshma Sinha, titled "Design of Stair- Climbing Rocker-Bogie Mechanism", ISSN(Online): 2319-8753, Vol. 7, Issue: 7 July 2018.

[2] N. Yadav, B. Bhardwaj, S. Bhardwaj, "Design analysis of Rocker-Bogie Suspension System and Access the possibility to implement in Front Loading Vehicles", IOSR Journal of Mechanical and Civil Engineering, e-ISSN: 2278-1684, p-ISSN: 2320334X, Volume 12, Issue 3 Ver. III, PP 64-67, May-Jun. 2015

[3] L. Bruzzone and G. Quaglia, "Review article: locomotion systems for ground mobile robots in unstructured environments", Mech. Sci., 3, 49- 62, 2012. DOI:10.5194/ms-3-49-2012.

[4] Akash Asalekar, Akash Chorage, Bhushan Jagdale, Rohit Kusalkar, Shantanu Garud, Vipul Gaikwad, "Design and Fabrication of Staircase Climbing Robot", Volume: 4, Issue: 7, July 2017.

[5] B. D. Harrington and C. Voorhees, "The Challenges of Designing the Rocker-Bogie Suspension for the Mars Exploration Rover", Proceedings of the 37th Aerospace Mechanisms Symposium, Johnson Space Center, page No. 185-1985, May 19-21, 2004.

[6] Y. L. Maske, S. V. Patil, S. Deshmukh, "Modeling and MBD simulation of stairclimbing robot with rocker bogie Mechanism", International Journal of Innovative Research in Technology, 101743, Volume 1 Issue 12, Page no. 267-273,ISSN: 2349-6002, 2015.

[7] Sasaki K and K. S. Suzuki, "Active rotary-legs mechanism for stair-climbing mobility vehicle," IEEE Robot. Autom. Lett., vol. 3, no. 2, pp. 1668-1675, Apr. 2018

[8] N. J. Baishya, B. Bhattacharya, H. Ogai, and K. Tatsumi, "Analysis and Design of a Minimalist Step Climbing Robot," Appl. Sci., vol. 11, no. 15, p. 7044, 2021.

[9] Y. Kim, J. Kim, H. S. Kim and T. Seo, "Curved-Spoke Tri-Wheel Mechanism for Fast Stair-Climbing", IEEE Access, vol. 7, pp. 173766-173773, 2019.

[10] H. Li, C. Qi, X. Chen, L. Mao, Y. Zhao, and F. Gao, "Stair Climbing Capability-Based Dimensional Synthesis for the Multi-legged Robot", IEEE International Conference on Robotics and Automation (ICRA), 2021.