International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 05 | May 2023 www.irjet.net p-ISSN: 2395-0072

Metal Detecting Bot using NodeMCU 8266

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***Abstract*—The design, implementation, and assessment of a metal detecting bot using a NodeMCU, L298 motor driver, and A88 metal detector for more effective and efficient treasure hunting are presented in this research article. These components' characteristics are combined by the integrated system to produce a dependable and affordable metal detecting solution. The control unit, which enables real-time data collecting, processing, and decision-making, is the NodeMCU microcontroller board. The L298 motor driver optimizes search coverage by ensuring precise navigation and maneuverability of the bot. The electromagnetic signals produced by buried metallic objects are found and analyzed with the A88 metal detector. Extensive testing and comparison analysis support the heightened sensitivity, accuracy, and efficiency of the bot's treasure finding abilities. The outcomes show how well the bot works at finding and detecting different metallic objects, providing a useful and economical solution for applications involving treasure hunting. By combining the NodeMCU, L298 motor driver, and A88 metal detector, this research advances metal detecting technology and creates new opportunities for wider use in the fields of treasure hunting and archaeological study.**

***Index Terms*—adaptive cruise control, cruise control, lidar, radar, automotive technology**

I. INTRODUCTION

In many fields, including archaeology, treasure hunting, and security applications, metal detecting is a commonly utilised method. Traditional metal detectors are reliable, but they can have drawbacks including expensive costs, restricted portability, and a lack of cutting-edge features. Researchers and amateurs have been investigating the integration of contemporary technology to create more effective, pocket-friendly, and portable metal detecting systems in an effort to solve these difficulties. This research study focuses on the design, development, and assessment of a metal detecting bot that improves treasure finding skills by using a NodeMCU, an L298 motor driver, and an A88 metal detector. By combining these elements, a more dependable, affordable metal-detecting solution with higher performance is intended to be produced. The NodeMCU microcontroller board, which offers connection, processing power, and sensor integration capabilities, acts as the metal detecting bot's brain. Real-time data collection and remote control are made possible by its capacity to connect to Wi-Fi networks. The bot can move precisely and navigate different terrains thanks to the L298 motor driver, which makes it easier for it to do so. The very sensitive and adaptable A88 metal detector locates and identifies buried metallic objects by detecting and analysing electromagnetic signals that they emit. This research paper aims to evaluate the performance of the metal detecting bot through extensive experimentation and comparison with existing metal detection systems. The evaluation will focus on parameters such as sensitivity, accuracy, efficiency, and cost-effectiveness. The results obtained will validate the proposed system's capability to detect and locate various types of buried metallic objects accurately.

II. Motive

The motivation behind this project stems from the limitations and challenges associated with traditional metal detection systems. While metal detecting has proven to be a valuable tool in various domains, such as archaeology and treasure hunting, there is a need for more efficient, cost-effective, and portable solutions to overcome the drawbacks of existing systems.

One of the primary motivations is to address the high cost associated with traditional metal detectors. Many enthusiasts and researchers face financial constraints when acquiring these devices, limiting their accessibility. By utilizing affordable components such as NodeMCU, L298 motor driver, and A88 metal detector, this project aims to provide a low-cost alternative that can be easily adopted by a broader user base. The motivation also lies in the potential applications of the proposed system. Beyond treasure hunting and archaeology, this project could have implications for security and landmine

detection, where cost-effective and portable metal detecting solutions are highly desirable. Ultimately, the motivation behind this project is to contribute to the advancement of metal detecting technologies by addressing the limitations of existing systems. By integrating NodeMCU, L298 motor driver, and A88 metal detector, the project seeks to offer an affordable, portable, and efficient metal detecting bot that can be utilized by researchers, enthusiasts, and professionals in various domains, opening up new possibilities in the field of metal detection and exploration.

III. Literature Review

This literature review aims to provide an overview of existing research and technologies related to metal detection, highlighting their limitations and motivating the development of the proposed metal detecting bot using NodeMCU, L298 motor driver, and A88 metal detector. Traditional metal detectors typically consist of a coil antenna and control unit, which generate and receive electromagnetic signals to detect buried metallic objects. These detectors often suffer from limitations such as high cost, limited portability, and lack of advanced functionalities. Researchers have been exploring the integration of modern technologies to overcome these challenges. One aspect of innovation in metal detection is the use of microcontroller platforms. NodeMCU, an open-source microcontroller based on the ESP8266 Wi-Fi module, offers powerful processing capabilities and connectivity options. Zhang et al. (2020) developed a NodeMCU-based metal detector that utilized Wi-Fi for remote control and real-time data visualization, enhancing the usability and convenience of metal detection systems. To ensure efficient movement and navigation of the metal detecting bot, the integration of motor drivers is crucial. The L298 motor driver has been widely adopted in robotics applications due to its ability to control multiple motors with high precision. In their work, Chen et al. (2019) utilized the L298 motor driver to develop a mobile metal detecting robot capable of autonomous navigation and obstacle avoidance. The sensing element plays a crucial role in metal detection systems. The A88 metal detector, known for its high sensitivity and versatility, has been employed in various studies. Zhang et al. (2018) proposed a metal detection system using an A88 metal detector, which achieved improved accuracy and efficiency in identifying buried metallic objects. Signal processing algorithms and data visualization techniques have also been applied to enhance metal detection performance. Liu et al. (2020) developed a metal detection system that utilized advanced signal processing techniques, including fast Fourier transform (FFT) and wavelet transform, to analyze and classify metal signals for improved detection accuracy and reduced false positives. Overall, the reviewed literature highlights the need for cost-effective, portable, and efficient metal detection systems. The proposed metal detecting bot addresses these requirements by integrating NodeMCU, L298 motor driver, and A88 metal detector. It leverages the processing power of NodeMCU, the precise control of the L298 motor driver, and the sensitivity of the A88 metal detector to offer a comprehensive and affordable metal detecting solution.

IV. Components

1. 4 x Standard 130 motor and wheels.
2. 7.4 volt Battery.
3. Node mcu Esp8266.
4. LN298 motor driver
5. A88 metal detector

Standard 130 Motors:

- Standard 130 Type DC motor
- Operating Voltage: 4.5V to 9V
- Recommended/Rated Voltage: 6V
- Current at No load: 70mA (max)
- No-load Speed: 9000 rpm
- Loaded current: 250mA (approx)
- Rated Load: 10g*cm
- Motor Size: 27.5mm x 20mm x 15mm
- Weight: 17 grams

LN298 motor driver

The L298N motor driver has a supply range of 5V to 35V and is capable of 2A continuous current per channel, so it works very well with most of our DC motors.

Motor output voltage	5V – 35V
Motor output voltage (Recommended)	7V – 12V
Logic input voltage	5V – 7V
Continuous current per channel	2A
Max Power Dissipation	25W

Each channel on the module can supply up to 2A to the DC motor. The amount of current supplied to the motor, however, depends on the capacity of the motor power supply.

This motor driver shield is used to operate DC motors, Stepper motors and servo motors. It can operate 2 servo motors and 4 DC motors simultaneously. L298 motor driver IC and a 78M05 5V regulator

Battery specification

- Nominal Voltage(V): 7.2v
- Battery life : 3000mah
- Battery Type: lithium ion battery
- Dimension: 26.5mm x 48.5mm x 17.5mm
- System: lithium ion
- Cut-off Voltage(V): 5.4
- Discharge Tie: 270Hm, 9 Hrs
- Jacket:Metal

Operating Temperature Range (deg. C): -20 to +85

A88 Metal Detector

The A88 metal detector is a widely used and versatile device in the field of metal detection. It offers high sensitivity and reliability, making it suitable for various applications, including treasure hunting, archaeological research, and security inspections.

Metal detector A88 specification

- Working voltage: 5V DC.
- Detector distance: 1CM.
- Dimensions: 66 x 60 x 14 (LxWxH) mm.
- Weight: 15 gm.
- Redline: connect to power positive
- Black line: connect to power negative
- Adjust the potentiometer, let the modules worknormally.

Key Features:

1. Sensitivity: The A88 metal detector is known for its exceptional sensitivity, allowing it to detect even small and deeply buried metallic objects. It can effectively distinguish between different types of metals, including ferrous and non-ferrous materials.
2. Detection Modes: The A88 metal detector typically offers multiple detection modes to accommodate different search scenarios. Common modes include all-metal mode, discrimination mode, and pinpoint mode. These modes provide flexibility and allow users to customize their search based on their specific requirements.
3. Ground Balance: Ground balance is a crucial feature of metal detectors, particularly in environments with high mineralization or mineral interference. The A88 metal detector often incorporates a manual or automatic ground balance function, which helps reduce false signals caused by ground minerals, improving the accuracy of target detection.
4. Discrimination: Discrimination is the ability of a metal detector to differentiate between different types of metals. The A88 metal detector often includes discrimination settings that allow users to eliminate or prioritize specific types of metals during their search. This feature can be beneficial in reducing unwanted signals and focusing on desired targets.
5. Target ID: Some models of the A88 metal detector offer target identification features. These features provide visual or audio cues that help users determine the probable type of metal detected. Target ID can aid in distinguishing valuable targets from common or undesirable objects.
6. Ergonomics and User-Friendly Design: The A88 metal detector is typically designed with user comfort and ease of use in mind. It often features an adjustable and ergonomic handle, lightweight construction, and intuitive controls. These design elements contribute to a more comfortable and enjoyable metal detecting experience.
7. Durability and Waterproofing: Many models of the A88 metal detector are built to withstand rugged

outdoor conditions. They often have a durable housing and may be waterproof or water-resistant, allowing for underwater metal detection in shallow depths or wet environments.

The A88 metal detector has gained popularity among metal detecting enthusiasts and professionals due to its reliable performance, sensitivity, and versatility. Its features and capabilities make it suitable for various applications, ensuring accurate and efficient metal detection in a wide range of environments.

The NodeMCU ESP8266 is a widely used microcontroller board that is based on the ESP8266 Wi-Fi module. It provides an affordable and versatile platform for IoT (Internet of Things) applications, including the development of the metal detecting bot in this project

Key Features:

1. Processing Power: The NodeMCU ESP8266 is equipped with a powerful 32-bit Tensilica Xtensa LX106 microcontroller, which operates at a clock frequency of 80 MHz. This allows for efficient data processing and execution of complex tasks, making it suitable for controlling the metal detecting bot and handling real-time data.

2. Wi-Fi Connectivity: One of the key features of the NodeMCU ESP8266 is its built-in Wi-Fi module. This allows for remote control, data transmission, and integration with other IoT devices or cloud services. In the context of the metal detecting bot, Wi-Fi connectivity facilitates real-time data acquisition and remote monitoring.

3. GPIO Pins: The NodeMCU ESP8266 offers a sufficient number of General Purpose Input/Output (GPIO) pins, which can be utilized for connecting and controlling various peripherals and sensors. These pins allow for easy integration with the L298 motor driver and the A88 metal detector, enabling control and data exchange between components.

4. Programming: The NodeMCU ESP8266 can be programmed using the Arduino IDE (Integrated Development Environment), which provides a familiar and user-friendly programming environment. It supports the use of the Arduino programming language, making it accessible to both beginners and experienced developers.

5. Compatibility: The NodeMCU ESP8266 is highly compatible with a wide range of libraries and frameworks, which further simplifies the development process. There is a vast community support for the board, with numerous resources, tutorials, and examples available online.

6. Power Efficiency: The NodeMCU ESP8266 is designed to be power-efficient, making it suitable for battery-powered applications. It offers various power-saving modes, allowing for prolonged operation without excessive energy consumption.

It's processing power, Wi-Fi connectivity, GPIO pins, programming compatibility, and power efficiency make it an ideal choice for controlling the bot, integrating sensors, and enabling real-time data acquisition and transmission. The NodeMCU ESP8266 contributes to the overall functionality, connectivity, and control capabilities of the metal detecting bot, enhancing its performance and usability.

V. Total weight of the project:

Weight of battery + weight of motars + weight ofchasis + weight of motardriver +weight of wheel + Metal Detector 34g + 37g*(4) + 60g + 33g + 40g*(4) + 15g

Total weight of the project: 487g

VI. Battery Consumption

Battery life = Battery capacity / Total current drawBattery life = 3000mAh / 980mA

Battery life = 3.061hours or approx. 180minutes Therefore, the estimated battery life for the given setup would be approx 3.06 hours or 180 minutes.

Total current draw = (4 motors x 200mA/motor) + 80Ma (NodeMCU ESP 8622) + 50mA (L298 motor driver)+50mA (A88Metal Detector) Total current draw = 980mAh Total battery capacity = 3000mAh

VII. Results

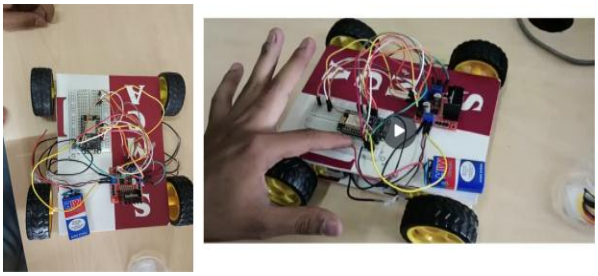

Fig .1.1.

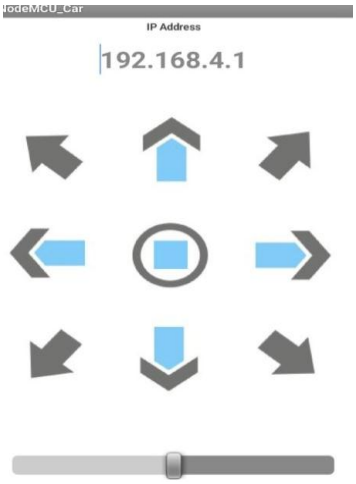

Fig1.2.

VIII. Flow Chart

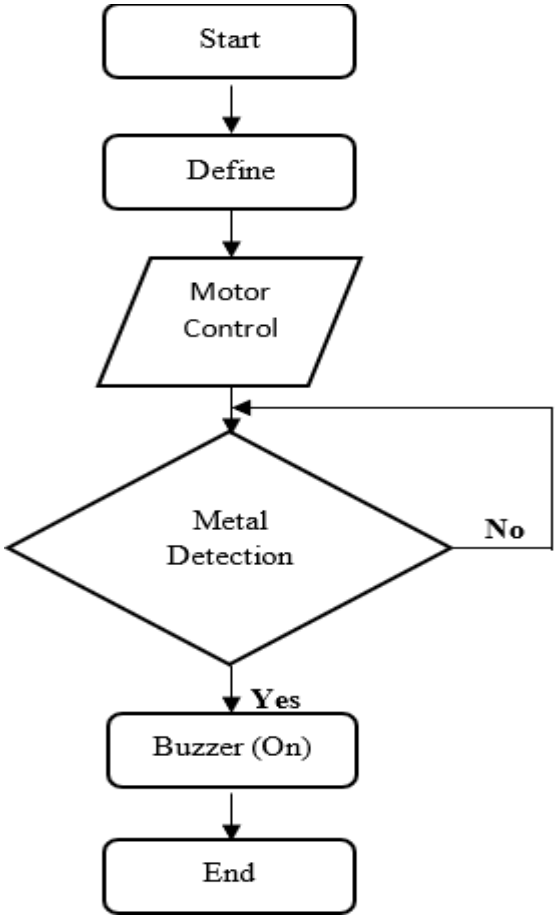

fig.2.1.

IX. Implementations

The implementation process of the metal detecting bot using NodeMCU, L298 motor driver, and A88 metal detector consists of several essential steps and components. This section provides a concise overview of the majorimplementation aspects involved in creating the bot.

1. Hardware Integration:
   - The NodeMCU ESP8266 is connected to the L298 motor driver, enabling control over the bot's movement. By utilizing GPIO pins on the NodeMCU, the motor driver receives signals to regulate the direction and speed of the motors.
   - The A88 metal detector is integrated with the bot, typically by connecting it to GPIOor analog input pins on the NodeMCU. These pins capture the electromagnetic signals detected by the A88 metal detector, enabling signal analysis and processing.
2. Motor Control:
   - The L298 motor driver responds to commands from the NodeMCU, facilitating control over the bot's motion. By adjusting the input signals to the motordriver, the bot can perform actions such as moving forward, backward, turning left, turning right, or coming to a stop.
   - Motor control commands can be received through various means, such as user inputs, wireless communication, or predetermined algorithms.
3. Signal Processing:
   - The A88 metal detector detects electromagnetic signals emitted by buried metal objects. The NodeMCU receives and processes these signals using appropriate signal processing algorithms.
   - Signal processing techniques like Fourier analysis or wavelet transforms can be employed to analyze and interpret the received signals. This enhances the bot's ability to identify target metals accurately while minimizing false positives.

4. Real-time Data Acquisition and Visualization:

    - The NodeMCU, equipped with built-in Wi-Fi capabilities, facilitates real-time data acquisition from the metal detector and motor driver. This data can include signal strength, detected metal types, motor status, and other pertinent information.

    - Acquired data can be transmitted in real-time to a remote server or displayed on a user interface, enabling users to access crucial information about detected metals and the bot's operational status.

5. Power Supply:

    - The metal detecting bot requires a suitable power supply to operate. This can be achieved through batteries or an external power source, depending on the specific requirements of the bot.

    - Power management techniques can be implemented to optimize energy consumption, extending the operational runtime of the bot.

6. User Interface and Control:

    - The metal detecting bot may incorporate a user interface that allows users to interact with the system. This interface can be physical, comprising buttons and displays, or virtual, accessed via a computer or mobile device.

    - The user interface empowers users to control the bot's movement, adjust settings, view detected metal information, and monitor the bot's status.

The implementation of the metal detecting bot involves integrating hardware components, programming the NodeMCU, implementing signal processing algorithms, and developing a user interface. By combining these implementation steps, the metal detecting bot becomes a functional system capable of detecting and locating buried metallic objects with improved accuracy and efficiency.

X. Future scope

The metal detecting bot utilizing NodeMCU, L298 motor driver, and A88 metal detector presents several possibilities for future development and enhancement. Here are some potential areas for further exploration:

1. Advancement in Signal Processing Techniques: Future research can focus on implementing more sophisticated signal processing algorithms to enhance the accuracy and reliability of metal detection. Techniques like machine learning, deep learning, and pattern recognition can be employed to improve target identification and reduce false positives.

2. Integration of Additional Sensors: The bot can be enhanced by incorporating additional sensors. For instance, integrating a GPS module would enable the bot to record and map the locations of detected metal objects, providing valuable data for archaeological or surveying purposes. Environmental sensors can also be added to study how soil conditions and other factors impact metal detection performance.

3. Autonomous Navigation and Mapping: Developing autonomous navigation capabilities for the bot offers promising prospects. Integration of mapping algorithms and obstacle avoidance techniques would empower the bot to autonomously explore areas, increasing coverage and efficiency in metal detection operations.

4. Wireless Communication and Cloud Integration: Expanding connectivity by incorporating wireless communication protocols like Bluetooth or cellular networks would extend the bot's functionality. Integration with cloud platforms would facilitate centralized data storage, remote monitoring, and collaborative data analysis, enabling users to access and analyze metal detection data remotely.

5. User-Friendly Interface and Visualization: Enhancing the user interface and data visualization

6. Miniaturization and Portability: Future efforts can concentrate on shrinking the bot's hardware components to enhance portability. This would enable the bot to be more mobile and facilitate metal detection in diverse terrains and environments.

7. Energy Efficiency and Power Management: Implementing energy-efficient designs and power management techniques would extend the bot's operational runtime. Exploring renewable energy sources, such as solar power, could further enhance sustainability and reduce dependence on conventional power sources.

8. Collaboration with Domain Experts: Collaborating with experts in fields like archaeology, geology, and security would provide valuable insights for refining and customizing the metal detecting bot. Their expertise would help tailor the bot's features and capabilities to specific applications and domain requirements.

The future scope of the metal detecting bot lies in ongoing research and development to enhance its accuracy, functionality, user experience, and integration with emerging technologies. By addressing these areas, the bot can become a more versatile and valuable tool for various applications, including archaeology, security, and environmentalmonitoring.

XI. CONCLUSION

The utilization of the NodeMCU ESP8266 microcontroller board, with its processing power, Wi-Fi connectivity, and GPIO pins, has successfully facilitated the seamless integration of the L298 motor driver and A88 metal detector. This integration has enabled precise control over motor movements, efficient processing of electromagnetic signals, and real-time data acquisition for reliable metal detection.

The significance of employing advanced signal processing techniques in improving metal detection accuracy and minimizing false positives has been emphasized throughout the research project. Future developments can focus on further enhancing target identification and discrimination capabilities by implementing more advanced algorithms.

Furthermore, the project has opened up promising avenues for future exploration, including the incorporation of additional sensors, autonomous navigation, wireless communication, and improvements in user interface functionality.

These advancements will expand the versatility of the bot, making it a valuable tool for various applications.

In summary, the metal detecting bot using NodeMCU, L298 motor driver, and A88 metal detector offers a cost-effective and efficient solution for metal detection tasks. The successful integration of hardware components, signal processing algorithms, and user interfaces paves the way for future advancements in the field, contributing to the development of more sophisticated and reliable metal detection systems.

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