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DESIGNING A CRYPTIC COLORATIONAL ROBOT FOR REAL-TIME MILITARY OPERATIONS

Mr. Prasanna G
Assistant Professor
Department of Computer Science and Engineering,
GMIT Bharathinagar, Maddur taluk, Mandya District, Karnataka, India

Chaithanya Swaroop M S
Department of Computer Science and Engineering,
GMIT Bharathi Nagar, Maddur taluk, Mandya District, Karnataka, India

Ganavi A R
Department of Computer Science and Engineering,
GMIT Bharathinagar, Maddur taluk, Mandya District, Karnataka, India

Mohammed Usman
Department of Computer Science and Engineering,
GMIT Bharathinagar, Maddur taluk, Mandya District, Karnataka, India

Tejashwini S
Department of Computer Science and Engineering,
GMIT Bharathinagar, Maddur taluk, Mandya District, Karnataka, India

Abstract* - *The nation has invested significant money in the defense sector in the modern period to protect the border security troops and implement advanced security measures. Camouflage is critical in various missions such as invading other military sites, protecting human lives, and gathering information about other military facilities such as construction, equipment, and weapons employed. The robot is outfitted with adaptive camouflage technology, which allows it to blend in with its environment. This feature improves stealth and lowers the danger of detection by enemy forces. Military personnel can remotely operate and control the robot via a secure network interface. From a safe distance, operators can view real-time video feeds, sensor data, and control the robot's movements and functions. The system consists of a Raspberry Pi camera attached to a vehicle; it is a 360' rotational Wi-Fi camera for surveillance, allowing us to monitor the entire operation and record movies and photographs. The major goal is to replace human losses in terrorist attacks or military operations, as well as to build and develop army robots that can be operated on cell phones and commanded remotely [1].

Keywords* - *ESP32, Camouflage, Metal detector, IP Camera, PIR Sensor, Color Sensor, RFID, FIRE AND GAS Sensor.

I. INTRODUCTION

The Internet of Things-based multipurpose camouflage military robot is a cutting-edge technical marvel developed to improve military operations in a variety of conditions. This robot, which is equipped with cutting-edge IoT capabilities, effortlessly connects with a network of interconnected devices to capture and transmit real-time data, giving commanders with essential situational awareness. Its major function is camouflage, which allows the robot to change its appearance to match the environment, making it almost invisible to opponent detection systems [2]. The multifunctional military robot has a wide range of functions in addition to its camouflage skills. Furthermore, depending on the mission objectives, the robot is outfitted with a variety of modular attachments that allow it to perform a variety of duties such as surveillance, target acquisition, and even limited combat engagements. It can conduct reconnaissance missions, gather important intelligence, and safely and instantly transmit data back to command centers. The robot, which is equipped with powerful sensors and imaging technology, can detect enemy movements, identify potential dangers, and convey real-time information to military people, delivering a considerable tactical advantage.

To achieve these goals, we employed an LED with uniform colors diffused in it that is attached to sensors that can precisely determine the color from the surrounding ground. On the other hand, we developed a system that can receive and implement information from a smart phone in order to operate motor drives that can drive a robot in the desired direction. We also included a spy camera to record real-time data in the form of video and photos [3]. It is equipped with a Wi-Fi connection and can be operated as needed.

II. OBJECTIVE

The fundamental goal of a camouflage military robot is concealment and stealth. By blending in with the environment, the robot hopes to evade visual identification and remain unknown by the opponent. Another goal of camouflage military robots is to be able to operate in a variety of situations. They are built to adapt to a variety of habitats, including forests, deserts, urban regions, and aquatic conditions [4]. The use of camouflage robots can help military personnel mitigate risks. These robots can be dispatched ahead of time to analyses unsafe or hostile areas, lowering the risk to human life. Camouflage robots are essential for undertaking clandestine activities.

III. RESEARCH OBJECTIVES

- Camouflage robots can navigate through complex urban settings, blend into the surroundings, and provide situational awareness to troops. They can detect threats, gather intelligence, and support forces.
- Camouflage robots can support counterterrorism efforts and law enforcement operations.
- It will provide us a tactical advantage in hostage situations or on unfriendly terrain.

IV. PROPOSED SYTEM

The main goal of this paper is to create and develop an army robot that is run by a smartphone and commanded by a remote. In addition, the COLOR sensor can be used to duplicate the COLOR of the ground surface where the robot is travelling around the path, allowing it to be disguised from the outside world [5]. To achieve these goals, we employed an LED with uniform COLORS diffused in it that is attached to sensors that can precisely determine the COLOR from the surrounding ground. On the other hand, we developed a system that can receive and implement information from a smart phone in order to operate motor drives that can drive a robot in the desired direction. We also included a spy camera to record real-time data in the form of video and photos. It is equipped with a Wi-Fi connection and can be operated as needed. We can move the camera around to get the information we need.

V. METHODOLOGY AND DESIGN

The networked things, typically wireless sensors and actuators, comprise Stage 1 of IoT architecture. Sensor data gathering systems and analog-to-digital data conversion are included in Stage 2. In Stage 3, edge IT systems preprocess data before it is sent to the data center or cloud. Finally, data is analyzed, managed, and stored on typical back-end data center systems in Stage 4. The sensor/actuator state is clearly the domain of operations technology (OT) professionals [6]. Stage 2 is the same. IT normally controls stages 3 and 4, while edge IT processing may be located at a remote site or closer to the data center. The dashed vertical line labelled "the edge" represents the conventional line of separation between OT and IT tasks, however it is becoming increasingly blurred. Here's a closer look at each.

Figure 1: Block Diagram

A. Everything from traditional industrial equipment to robotic camera systems, water-level detectors, air quality sensors, accelerometers, and heart rate monitors is covered in the sensing/actuating stage. like the IoT's reach is fast expanding, thanks in part to low-power wireless sensor network technologies like Power over Ethernet, which allow devices on a connected LAN to run without an A/C power source. Some data processing can occur in each of the four stages of IoT architecture. While you can process data at the sensor, the amount of computing power available on each IoT device limits what you can accomplish.

B. The data from the sensors is initially analogue. That data must be consolidated and translated into digital streams for downstream processing. These data aggregation and conversion functions are carried out by data acquisition systems (DAS). The DAS connects to the sensor network [7], gathers outputs, and converts analogue to digital. The Internet gateway collects aggregated and digitized data and routes it to Stage 3 systems for additional processing through Wi-Fi, wired LANs, or the Internet. Stage 2 systems are frequently located near sensors and actuators.

C. Edge IT processing systems can be found in distant offices or other outlying areas, but they are typically found in data centers. Mores, it's better to have systems at the edge capable of performing analytics as a method to minimize the facility or place where the sensors live closer to the sensors, such as in a wiring closet. Because IoT data can quickly consume network capacity and overwhelm your data center, the demand on fundamental IT infrastructure is increased. If you only had one giant data pipe travelling to the data center, you would require massive capacity.

D. Data that requires more in-depth processing and does not require median feedback is routed to physical data centres or cloud-based systems, where more capable IT scans analyse, manage, and securely store the data. When you wait until the data reaches Stage 4, it takes longer to acquire findings, but you may perform a more in-depth analysis and integrate your sensor data with data from other sources for deeper insights. Stage 4 processing can take done on-premises, in the cloud, or in a hybrid cloud system [8] .

VI. IMPLEMENTATION

Stage 1 (Sensors / Actuators): An "IoT" device should be outfitted with sensors and actuators, allowing it to emit, accept, and process signals.
Stage 2 (Data Acquisition System): The data from the sensors is initially analogue and must be gathered and converted into digital streams for subsequent processing. These data gathering and conversion functions are carried out by data capture systems.
Edge Analytics (Stage 3): After IoT data has been digitized and aggregated, it may require additional processing before entering the data center, which is where Edge Analytics comes in. Data that requires further in-depth processing is routed to physical data centers or cloud-based systems in [9].

Stage 4 (Cloud Analytics): The entire system is powered by a power supply comprising dual 12V batteries, which are used to power all components such as the ESP32, IP camera, Drive Motors, and LED. Before putting the system to use, it should be authenticated. This can be done with an RFID reader module, which uses radio waves to deliver signals that activate the tag. Once the system is activated, the authorized user can use the Blynk application to control the entire system's operation.

The Blynk programmed provides a user interface for controlling the movement of the robot, allowing the user to control and obtain information from several sensors in any given field [10]. Metal detectors, flame detectors and gas detectors were employed in this case to identify the needed items in the field.

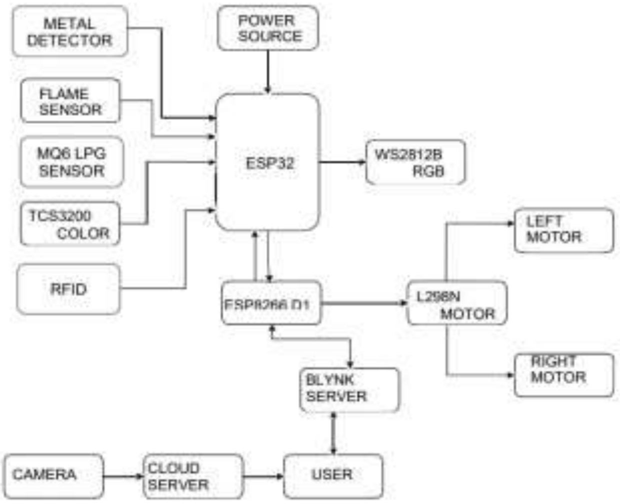

Figure 2: System Architecture

Accordance with the major moto of this project, we have introduced camouflage by introducing color changing feature using LED displays as input from color sensor. The ESP32 module is linked to all of the sensors and the motor driver module, allowing it to communicate and perform the activity as instructed. The ESP32 has the advantage of having its own Wi-Fi module. The system features a separate connection and application for 24/7 video surveillance [14].

VII. MEASUREMENTS AND RESULTS

Step 1: Initialization Turn on the robot and link it to the appropriate networks for IoT connectivity. Set the sensors, actuators, and communication modules to active.
Step 2: Gathering Sensor Data can be read from a variety of sensors, including cameras, infrared sensors, motion sensors, and environmental sensors.
Step 3: Image Processing and Analysis - Using computer vision techniques, process the acquired visual data.
Determine the locations, sizes, and other important attributes of objects [12].
Step 4: Making a Decision Make judgements about the robot's activities based on the analyzed data. Determine whether camouflage is necessary and choose appropriate camouflage designs based on the environment.
Step 5: Enable Camouflage Turn on the camouflage device, which may include color-changing panels, screens, or other materials.
Step 6: Navigation and Movement Use the actuators on the robot to move and navigate through the environment. Avoid obstacles and remain stealthy if necessary.
Step 7: Reporting and Communication Establish contact with the military installation or command center. Transmit pertinent data, such as sensor readings, pictures, and the state of the robot. Provide real-time information on the mission's progress and any threats discovered.
Step 8: Task Execution Perform duties such as reconnaissance, surveillance, or other assigned actions based on the mission objectives. Use the robot's other features, such as weaponry systems and communication relay capabilities [11].
Step 9: Ongoing Monitoring and Adjustment Monitor the surroundings, sensor readings, and mission objectives in real time. Adapt the camouflage patterns or other actions to changing conditions [13].

A. MODULES

ESP32: The ESP32 is a strong, general Wi-Fi + Bluetooth + BLE MCU module that targets a wide range of applications, from low-power sensor networks to the most demanding activities like voice encoding, music streaming, and MP3 decoding. The ESP32-D0WDQ6 chip is at the heart of this module.

Figure 3: ESP32

METAL DETECTOR SENSOR: Metal detector sensors are devices that detect the presence of metal items. It operates by creating a magnetic field and then monitoring any disruptions in that field induced by metallic objects nearby.

Figure 4: Metal Detector Sensor

FLAME SENSOR: This module can detect flames or wavelengths in the 760 nm to 1100 nm light source range. Small plate output interfaces and single-chip solutions can be directly linked to a microcomputer's IO port. To avoid high temperature damage to the sensor, maintain the sensor and flame at a specific distance.

Figure 5: Flame Sensor

LPG GAS SESNOR: The MQ-6 Gas sensor detects and measures gases such as LPG and butane. High sensitivity to LPG, isobutane, propane, and other hydrocarbons small sensitivity to alcohol, smoking, and other substances Quick response, Long and stable life, A straightforward driving circuit. It operates on 5V and is hence the most often utilized.

Figure 6: LPG Gas Sensor

TCS3200 COLOR SENSOR: TCS3200 Colour Sensor is an all-in-one colour detector that includes a TAOS TCS3200 RGB sensor chip and four white LEDs. The TCS3200 can identify and quantify an almost infinite number of visible colours. The TCS3200 is equipped with an array of photodetectors, each with a red, green, or blue filter, or no filter (clear). Single-Supply (2.7V to 5.5V) operation.

Figure 7: TCS3200 Color Sensor

EM-18 RFID READER: The EM-18 RFID Reader module, which operates at 125kHz, is a low-cost solution for your RFID-based application. The Reader module includes an on-chip antenna and can be powered by a 5V power supply.

Figure 8: EM 18 RFID Reader

L298N DUAL H BRIDGE MOTOR DRIVER MODULE: Based on the widely famous L298 Dual H-Bridge Motor Driver Integrated Circuit, this dual bidirectional motor driver allows you to control two motors of up to 2A each in both directions effortlessly and independently.

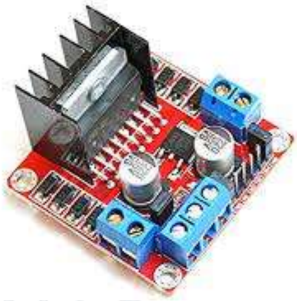

Figure 9: L298N Dual H Bridge Motor Driver Module

WS2812B RGB LED: The WS2812B is an intelligent control LED light source in which the control circuit and RGB chip are merged in a 5050 package. It has a precise internal oscillator and a 12V voltage programmable constant current control component that ensures the pixel point light colour height is consistent.

Figure 10: WA2812B RCG LED

Table 1: Test Cases

Test Case	Description	Precondition	Test Steps	Expected Results
TC_01:RFID Sign Up	A user should beable to Register intosystem by providing authentic information. Registration authenticationRFID Card	The User should have an Blynk Application	1. Navigate to Blynk signup page application. 2. It Authenticate all the required for fields along with user's manual	An authentication link should appear in the user's Blynk Application inbox. A message should be generated. That notifies login attempt
TC_02:RFID Login Failure	Any unauthorized and unauthentic user must not able to login into	The RFID user nameand password available	1. Navigate toBlynk login page. 2. Enter the un-authenticated RFID username and password	Expected Result: A message shouldbe generated that notifies login attempt failure.
TC_03:RFID Login Success	Any Authentic and authorized user should be able to login into		1.Navigate to Blynk login page. 2. Enter the authentic RFID username and password.	A message of successful login and Blynk Application dashboard fort the user should be displayed.

B. Snapshots

I. FRONT VIEW

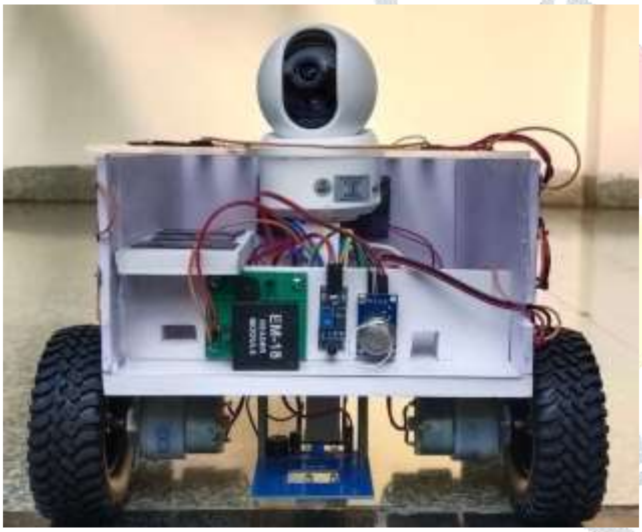

Figure 11: Front-view of the military robot

CONCLUSION

Finally, the IoT-based multipurpose camouflage military robot represents a game-changing advancement in military technology. This robot's integration with IoT technologies provides it with a variety of sophisticated features that improve its battlefield effectiveness. The camouflage function of the robot allows it to blend in with its environment, providing strategic benefits in reconnaissance and covert operations. Furthermore, its versatility allows it to carry out a variety of activities such as surveillance, target identification, and even combat operations. The robot's connection to the IoT network allows for real-time data transfer and remote operation, facilitating effective coordination with other military assets and improving commanders' situational awareness.

Overall, this IoT-based multifunctional camouflage military robot is a significant leap in military robotics, providing a diverse and effective tool for soldiers.

FUTURE IMPROVEMENTS

to IoT-based multipurpose camouflage military robots are possible. concentrate on increasing their intelligence and adaptability. To begin with, including powerful machine learning algorithms and artificial intelligence skills can improve the robot's ability to learn. It must analyze and interpret its surroundings. This would allow the robot to make autonomous judgments based on real-time data, which would improve its situational awareness and response skills. Incorporating modern sensor technologies such as thermal imaging, LIDAR, and radar can also improve the robot's perception and detection abilities, allowing it to work efficiently in a variety of terrains and weather situations.

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