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.2025.71604

Design and Implementation of a Remotely Operated Vehicle for Real-Time Monitoring Application

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Abstract: Efficient surveillance of large-scale commercial warehouses and private properties guarantees asset security, operational lapse, and real-time situational awareness. Conventional surveillance systems often lack mobility and flexibility, which reduces their effectiveness in dynamic environments. This paper discusses the design and implementation of a flexible, low-cost, and energy-efficient Remotely Operated Vehicle (ROV) developed and designed for real-time remote surveillance of spacious commercial premises. The main goal of this project is to facilitate remote monitoring with real-time video streaming, providing an affordable option compared to fixed camera setups and costly autonomous patrol robots. The suggested system uses an STM32F4xx series microcontroller for real-time management, a 2.4 GHz NRF24L01 transceiver for wireless connectivity, and a Python-driven video streaming module combined with an HTML-based control interface reachable over the local network. The power system incorporates a 76 Wh $LiFePO_4$ battery, with stable voltage regulation achieved using LM2596 and AMS1117 modules for different subsystems. The software architecture combines Arduino C, Python, and HTML, allowing effective control, live feed management, and user-friendly access. The system's novelty lies in its hybrid multi-platform design, wireless range, and energy efficiency, tailored for indoor and semi-outdoor commercial environments. Experimental results show that the ROV achieves a stable control range of over 50 meters and continuous operation exceeding 1.5 hours on a single charge. Video streaming performance remains consistent with minimal possible latency, even in warehouse environments with moderate interference. While currently designed for commercial and industrial use, the system's modularity allows future integration of features such as autonomous navigation, object detection, and deployment in hazardous and defence-sensitive environments. In conclusion, the proposed ROV offers a scalable and practical solution for commercial surveillance, contributing towards intelligent, mobile, and energy-efficient monitoring systems.

Keywords: commercial surveillance robot; embedded monitoring system; LiFePO4 battery; STM32 control unit; wireless video streaming.

I. INTRODUCTION

Due to the rising incidence of thefts and unauthorized access particularly in spacious properties such as bungalows, offices, and commercial warehouses modern surveillance systems are becoming increasingly essential. Conventional fixed-position cameras provide restricted coverage, creating vulnerabilities in places with complex layouts or large infrastructure. To address these challenges, this paper presents a Remotely Operated Vehicle (ROV) designed for real-time surveillance in large and unmanned areas. This mobile surveillance solution provides a flexible and an affordable alternative to fixed camera systems and costly autonomous robots. Fitted with cameras and sensors, the ROV can be remotely controlled or function semi-autonomously, delivering live video feedback over a local network. It allows property owners and warehouse managers to oversee their assets remotely, ensuring security assurance even in their absence. The 2022 National Crime Records Bureau (NCRB) reports indicates that India recorded more than 2.5 lakh thefts and 88,000 burglaries, with cities like Delhi experiencing one theft every two minutes. This emphasizes the pressing requirements for more adaptive and smart surveillance strategies.[1][2][3]

The ROV addresses significant limitations of conventional surveillance specifically lack of mobility and restricted viewing angles by incorporating mobility, environmental adaptability, and modularity. The platform uses an STM32 microcontroller for system control, Nordic Semiconductor's NRF24L01 (2.4 GHz) module for long-range wireless communication, and a Python-based video streaming interface that can be accessed via a browser. A 76 Wh LiFePO4 battery provides power, which is regulated via LM2596 and AMS1117 voltage modules to satisfy different subsystem requirements. A telemetry display on the controller offers live system information such as battery level and vehicle positioning, improving user feedback and reliability.

This paper presents the ROV system's design, development, and evaluation, addressing the challenges encountered throughout the process. Furthermore, it explores potential extensions including autonomous navigation, making the system scalable for wider applications, including hazardous and disaster-prone environments.

II. METHODS

Robotics is a technological area focused on the design, construction, operation, and application of robots along with their related control systems, which include sensing, feedback, and information processing. Robotics facilitates task automation, enabling machines to execute operations in hazardous or distant settings, minimize human involvement, and enhance accuracy in areas such as surveillance, security systems, and monitoring activities.[4] A surveillance ROV combines robotics technology with live monitoring and communication, providing an efficient method for remote observation. These vehicles are commonly utilized in sectors such as security, military, environmental surveillance, and industrial evaluations. Here are the main elements of a surveillance ROV setup:

1) *The Form*

- The physical architecture of an ROV is meticulously crafted for mobility and stability, allowing the vehicle to traverse different settings like industrial sites, outdoor spaces, or dangerous regions. The ROV is designed with motors for locomotion and actuators for designated function ns (e.g., camera rotation, sensor triggering). The chassis contains all parts, guaranteeing resilience and efficiency.
- Surveillance ROVs come equipped with camera systems that can capture images or videos in low-light or difficult conditions. Wireless communication modules, such as nRF24L01, offer remote control functionality, allowing operators to obtain live video and sensor information from the vehicle.

2) *The Power Source*

- Typically, powering an ROV requires batteries or rechargeable power systems that provide energy to the motors, sensors, and communication components. The power system must be optimized for efficiency to enhance operational duration, particularly in monitoring situations where the ROV must operate for long durations.
- Effective power management is vital, guaranteeing that communication modules along with other parts such as the camera or sensors obtain the required energy without depleting the battery too rapidly. Energy optimization techniques, such as low-power modes during inactivity, are frequently integrated into the ROV's design.

3) *The Program*

- The behaviour and functionality of the system are determined by the programming of the surveillance ROV. The main component of the system is usually a microcontroller which manages signals from sensors, cameras, and user inputs, and oversees the ROV's movement and monitoring activities.
- The control system might be developed for remote control (RC) functioning. In an RC system, the operator issues commands to the ROV for manoeuvring (e.g., moving forward, backward, turning) and controlling the camera (e.g., panning or zooming).
- Real-time information is handled and sent to the operator through wireless communication. For instance, nRF24L01 modules enable effective long-distance communication between the ROV and the base station, making it possible to transmit video feeds, sensor information, and control commands without depending on the internet.

Integrating wireless communication, embedded systems, and immediate feedback, the surveillance ROV project serves as a notably efficient security and monitoring system. Its use could broaden to include industrial inspections, military monitoring, or search-and-rescue operations where human involvement is restricted or unsafe. The system's versatility and receptiveness render it an invaluable asset for promoting improved security and effectiveness across different sectors.

A. Methodology Details

The methods described here draw from existing research on Robotics and wireless communication technologies, highlighting the innovative integration of these technologies to address modern security and surveillance challenges. The system design incorporates the following key components:

Motor Drivers, Servo Motors, and DC Motors: These components are used for controlling the movement and positioning of the robot, enabling manual control via a joystick. Servo motors are particularly important for precise movements, such as controlling the camera's angle for surveillance.
Camera and Image Processing: The camera captures live video feed, which is processed for real-time monitoring. This is crucial for enhancing surveillance capabilities in manual modes.
Raspberry Pi: The Raspberry Pi serves as the central processing unit, handling image processing, communication, and data transmission. Its compact size and processing power make it an ideal choice for a mobile surveillance system.
Microcontroller (STM32XX series): This microcontroller is responsible for controlling and coordinating the various components of the robot, ensuring seamless interaction between hardware elements and smooth operation.
TOF Sensors: Time-of-Flight (TOF) sensors are integrated into the system for precise distance measurement, enabling obstacle detection and collision avoidance if required in future. This improves the robot's ability to navigate safely in various environments.
2-Axis Joystick: The joystick is used for manual control of the robot's movement, allowing the user to navigate and adjust the camera in real-time. The two-axis design enables intuitive control over both direction and angle.
OLED Display: An OLED display is incorporated into the remote controller to provide real-time telemetry data, such as battery levels, robot status, and communication signals. This ensures that the user has all necessary information at their fingertips for effective operation.

B. Block Diadrams

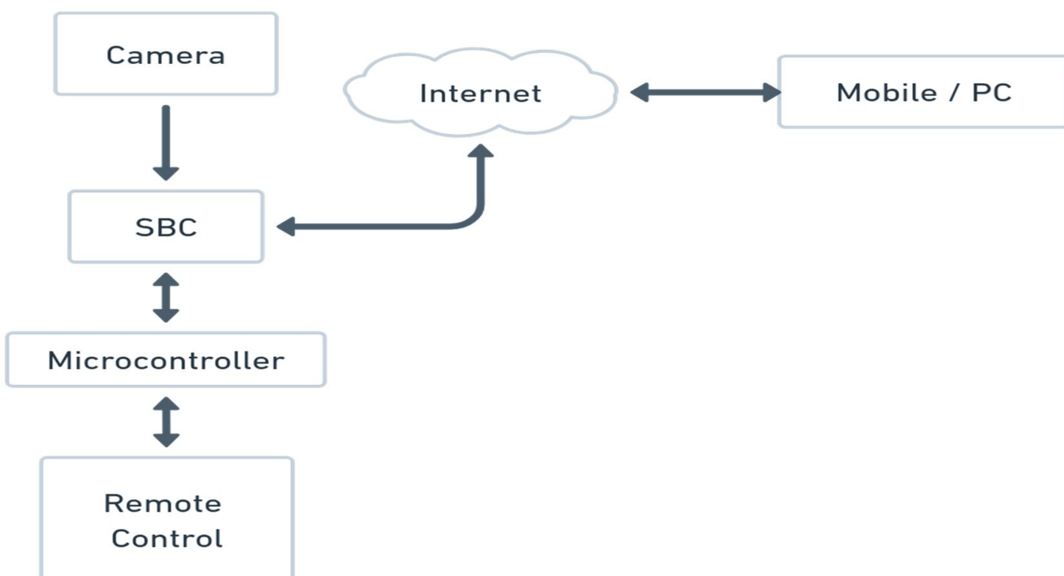

Fig. 1. Overall Block Diagram

The illustration 1 provides a summary of our project. As illustrated in the figure, the video stream from the Camera is supplied to the Single Board Computer (SBC). Next, this video feed will be processed, and then, using the internet, this live video will be streamed, allowing one to view the live stream from a distance. The microcontroller serves as the brain for the ROV. This MCU manages the ROV's movement and navigation while also processing sensor data to enhance the ROV's positioning.

The project can be divided into following basic modules. These are:
- Camera Module
- Control Module
- Sensor Module
- Transceiver Module
- Battery Module

1) Camera Module

The figure 2 displays the ‘Camera Module’. As shown in the figure, the Camera Module comprises the Camera and the SBC. As mentioned previously, the video feed from the Camera is provided to the SBC. Subsequently, this video feed will undergo processing and, via the internet, this live video will be broadcast, permitting viewers to access the live stream remotely.

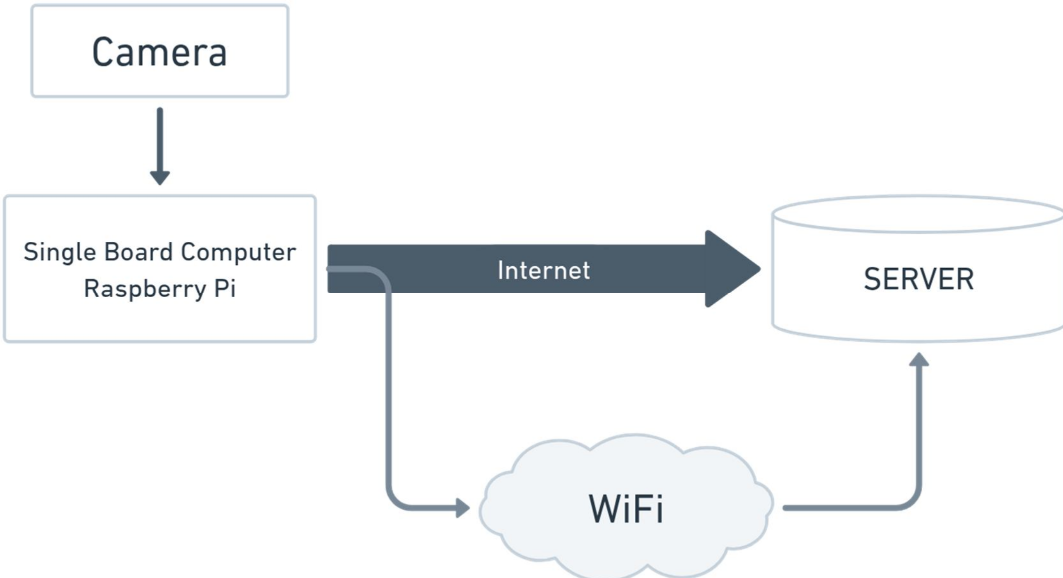

Fig. 2. Block Diagram showing Camera Module

The single-board computer we are utilizing is the Raspberry Pi, which can connect to the internet via Wi-Fi. Therefore, streaming the video would be simple. This figure also shows the working of the module and how the video would be streamed on the Internet.

The Raspberry Pi is a small, cost-effective, and flexible single-board computer mainly created for educational purposes, prototyping, and embedded computing uses.

In contrast to conventional microcontrollers, the Raspberry Pi operates on a complete operating system, usually a Linux-based OS such as Raspberry Pi OS, and accommodates high-level programming languages, networking, multimedia, and general computing functions.

Fitted with a robust processor, integrated memory, USB, HDMI, GPIO connections, and networking capabilities, it provides a strong foundation for creating various applications—from IoT and automation to robotics and computer vision.

The Raspberry Pi was chosen for this project because of its robust processing power, straightforward integration with external devices, and broad software support. It closes the divide between a full-scale computer and a microcontroller, making it perfect for uses that need intricate processing, graphical interfaces, or remote connectivity.[5]

Key features of Raspberry Pi:

- Quad-core ARM Cortex-A72 processor, running at up to 1.5 GHz
- Available in 2 GB, 4 GB, or 8 GB LPDDR4 RAM configurations
- Supports microSD card for OS and storage
- 40-pin GPIO header for interfacing with sensors, modules, and other hardware
- Camera and display interfaces via CSI and DSI connectors
- Supports a wide range of programming environments (Python, C/C++, Node.js, etc.)
- Runs full-fledged Linux OS with access to software packages, libraries, and development tools
- Multiple connectivity options:
    - 4× USB ports (2× USB 3.0, 2× USB 2.0)
    - 2× HDMI outputs (supports dual 4K displays)
    - Gigabit Ethernet, dual-band Wi-Fi, and Bluetooth 5.0

2) Control Module

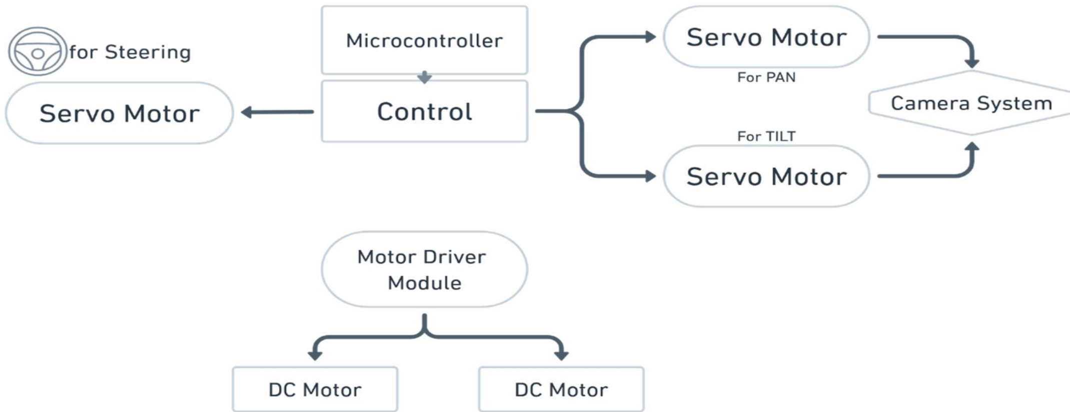

Fig. 3. Block Diagram showing the Microcontroller - Control Module

Figure 3 illustrates the Microcontroller module', specifically the Control Module. As illustrated in the figure, there are several motor drivers, servo motors, and DC motors.

A single servo is designated for controlling the steering of the ROV. Every time the MCU receives a command to steer right or left, it will issue Pulse Width Modulation (PWM) to the servo motor. This PWM signal is utilized to manage the position of the servo motor's shaft, enabling the ROV to execute a turn.

Two more servo motors are designated for the Panning and Tilting of the camera module. Two servos will collaborate so that users can Tilt or Pan the camera. This will enhance the camera's FOV and will be more effective during patrols.

A motor driver module will be utilized to control the two DC motors. It is understood that MCUs are not capable of directly managing DC motors efficiently. DC motors typically need greater current and voltage to function than what a MCU is able to provide. MCUs generally function at logic levels and deliver a restricted current, usually within the range of milliamps. MCUs by themselves are unable to manage the bidirectional current flow required for changing motor direction or to produce adjustable power for speed regulation. Motors can generate back electromotive force (EMF) when halting or reversing, potentially harming the MCU. Therefore, utilizing the motor driver module can resolve most of these problems, preserving both the motor and the MCU.

3) Sensor Module

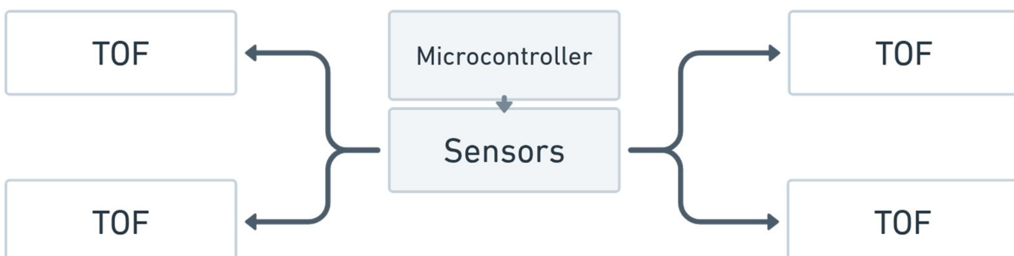

Fig. 4. Block Diagram showing the Microcontroller - Sensor Module

Figure 4 illustrates the Microcontroller Module, specifically the Sensor module. It is evident that our ROV will utilize the Time of Flight (TOF) sensor (VL53L0X).

To effectively identify the closeness of obstacles in the surveillance ROV, the VL53L0X Time-of-Flight (ToF) sensor by STMicroelectronics was employed. In contrast to conventional ultrasonic sensors that rely on sound waves, the VL53L0X gauged the time delay of reflected light pulses by utilizing an infrared laser emitter along with a SPAD (Single Photon Avalanche Diode) detector. This sensor measures the precise duration required for a photon of light to exit the sensor, bounce off an object, and come back — a technique called Time-of-Flight measurement.

This sensor's resistance to surrounding light, quick refresh rate, small size, and high precision on different surfaces make it perfect for surveillance ROVs that need exact navigation and obstacle recognition.[6][7]

Key features of VL53L0X include:
- High Accuracy: It provides high-resolution distance measurements, typically with an accuracy of ±3%.
- Short Measurement Time: The VL53L0X is designed for fast measurements, providing results in under 50 milliseconds.
- Low Power Consumption: The sensor is efficient, consuming only 20mA during measurement and even lower power when idle.
- Compact Size: It is small and lightweight, making it suitable for use in portable and embedded systems.
- Easy Integration: The sensor can be easily interfaced with microcontrollers via I2C communication.

4) Remote Control Module

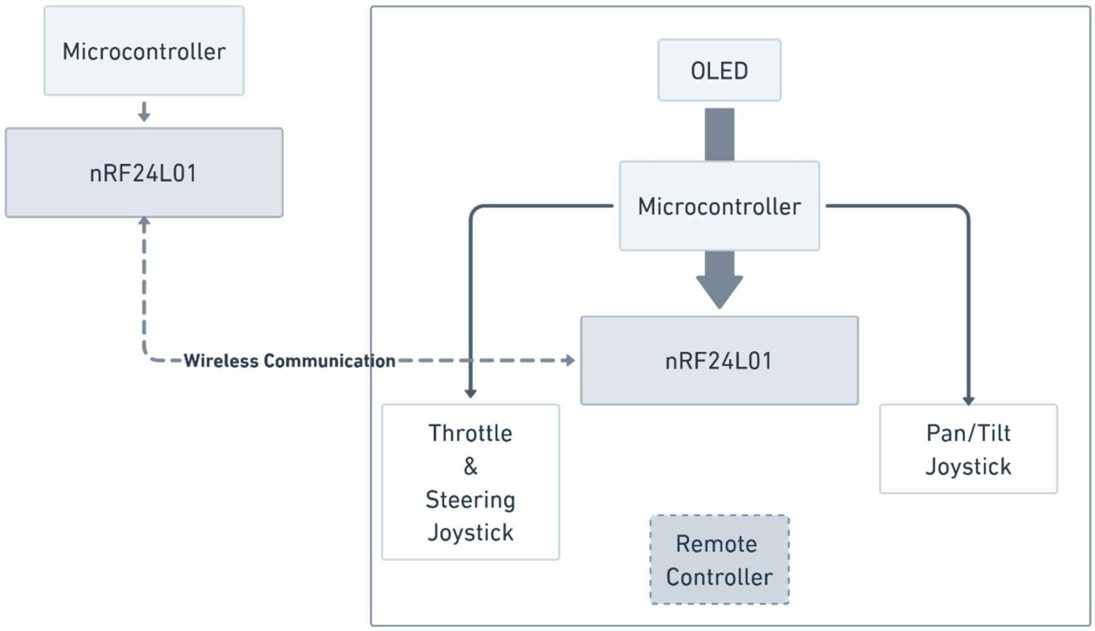

Fig. 5. Block Diagram Showing the Remote-Control Module

The figure 3.11 shows the 'Remote Control Module'. We can clearly see that it contains a microcontroller, NRF24L01 transceiver, an OLED display, and multiple 2 axis joysticks.
The nRF24L01 is a highly integrated, ultra-low power (ULP) 2.4GHz RF transceiver developed by Nordic Semiconductor. Functioning within the 2.4 GHz ISM (Industrial, Scientific, and Medical) band, it allows data rates of up to 2 Mbps and is tailored for wireless applications that necessitate strong communication while consuming little power. Featuring peak RX/TX currents below 14 mA and a broad supply voltage range from 1.9V to 3.6V, the nRF24L01 is especially suitable for devices powered by batteries and energy-efficient embedded systems.[8] [9]
The nRF24L01 module is used along with its adapter board, which includes an onboard 3.3V regulator and decoupling capacitors to ensure stable operation. The adapter allows the module to be powered safely from a 5V supply and also provides better voltage stability during RF transmission, which is crucial since the nRF24L01 is sensitive to voltage drops.
Key features of the NRF24L01:
- Operates in the 2.4 GHz ISM band
- Data rate support of 250 kbps, 1 Mbps, and 2 Mbps
- Ultra-low power consumption:
  - Transmit current: < 14 mA
  - Receive current: < 13.5 mA
  - Power-down mode: < 900 nA
- Supply voltage: 1.9 V to 3.6 V (typically powered at 3.3 V)
- Receiver sensitivity: down to –85 dBm at 2 Mbps, up to –94 dBm at 250 kbps
- SPI interface for high-speed communication with microcontrollers.
- On-chip frequency synthesizer, power amplifier, and modulator/demodulator

- Supports up to 6 data pipes (multi-device communication)
- Features auto-acknowledgment and auto-retransmission
- Short-range in basic configuration (up to 100 meters line-of-sight); can be extended using external antenna variants like NRF24L01+PA+LNA

An OLED display is incorporated into RC to provide real-time telemetry data such as batter level, robot status, etc.
A total of two 2-axis joystick is used in Remote Control. Out of the two joysticks, one is used for manual control of ROV’s movement, allowing users to navigate and the second joystick is used to adjust the camera i.e. panning or tilting the camera.
A microcontroller is a small, energy-efficient, and affordable integrated circuit that operates as a computer on one chip. It is constructed with Metal-Oxide-Semiconductor (MOS) technology and incorporates various crucial components, including a central processing unit (CPU), non-volatile memory (like Flash or ROM) for storing programs, volatile memory (RAM) for temporary data storage, clock circuits, and input/output (I/O) control units.
For this project, the STM32F401 microcontroller was chosen due to its high processing power, rich set of peripherals, and low power consumption. It is part of the STM32 family developed by STMicroelectronics and is based on the ARM Cortex-M4 core, which offers enhanced performance for real-time embedded applications.[10]

Key features of STM32F401 include:
- 32-bit ARM Cortex-M4 processor with Floating Point Unit (FPU), operating at up to 84 MHz
- Low power consumption, suitable for battery-powered applications
- Operating voltage range: 1.7V to 3.6V
- Up to 512 KB of Flash memory and 96 KB of SRAM
- Multiple communication interfaces:
    - USART/UART
    - SPI
    - I2C
    - CAN
- Six 16-bit/32-bit timers and PWM output channels
- 12-bit ADC for analog signal acquisition
- Support for external and internal interrupts for responsive event handling
- On-chip debugging and programming support via SWD (Serial Wire Debug).

5) Power Delivery Module

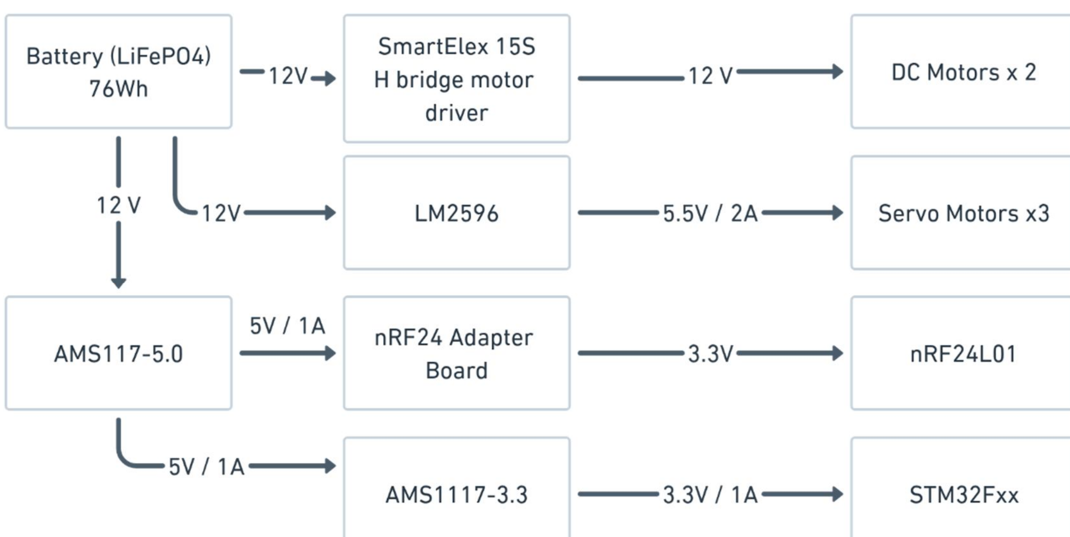

Fig. 6. ROV’s power distribution

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

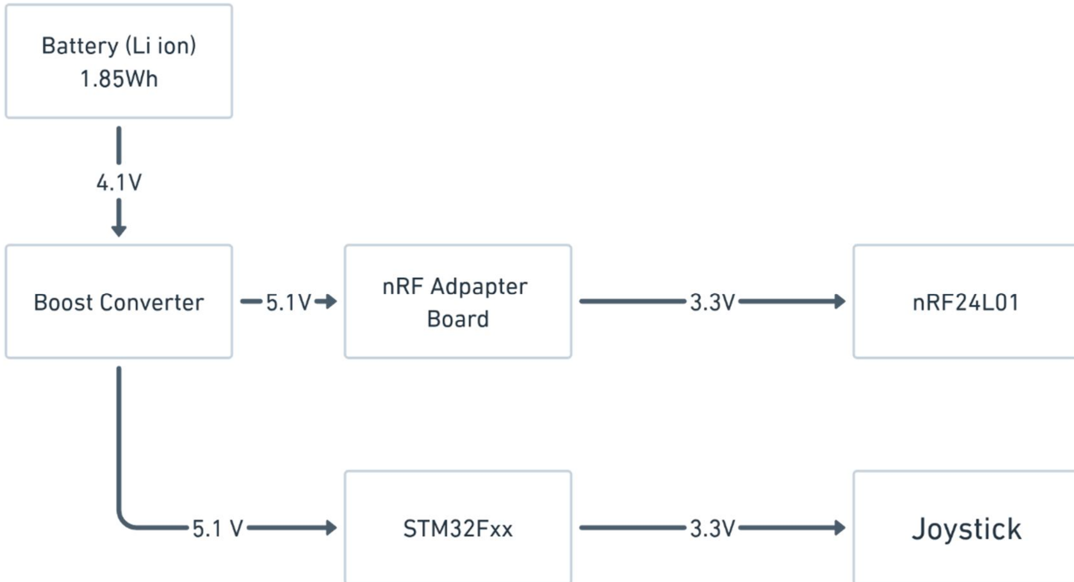

Fig. 7. RC's power distribution

For power distribution in our project, we are utilizing a 76 Wh LiFePO4 battery. Battery cells are configured in a series of 4S. Therefore, the overall voltage is approximately 12.8V. To ensure the battery voltage is suitable for the various modules, we employ different DC-DC converters. In this setup, we are utilizing a LM2596 DC-DC buck converter to reduce the 12.8V from the battery pack to 5.5V for the servo motors. Servo motors typically require a stable and sufficient voltage supply to operate correctly. The LM2596 buck converter effectively reduces the voltage from 12.8V to 5.5V, guaranteeing that the servo motors obtain the appropriate voltage while reducing energy waste. The LM2596 is selected due to its substantial efficiency (usually about 90%), which minimizes heat production and enhances overall battery lifespan, essential in battery-operated devices such as our ROV.[11]

For additional elements in the system that need varying voltage levels, AMS-117 3.3V and AMS-117 5.0V linear regulators are utilized. The AMS-117 3.3V regulator supplies power to components such as the microcontroller and various sensors that function at reduced voltage levels. In a similar manner, the AMS-117 5.0V regulator provides power to devices that need 5V, including specific communication modules and peripheral electronic components.[12]

These linear regulators deliver low noise and stable outputs, guaranteeing smooth functionality for delicate components, despite being less efficient than the LM2596. The trade-off in efficiency is justifiable in these instances because of the comparatively low current demands of these parts. This combined power distribution arrangement utilizing DC-DC converters and LDO regulators guarantees that every module in your system obtains the appropriate and stable voltage for maximum efficiency, while also prolonging the lifespan of your LiFePO4 battery. Along with the voltage regulators and DC-DC converters, we are utilizing a USB fast charging module to supply power to the Raspberry Pi. Given that the Raspberry Pi needs a consistent 5V power source with a notably high current (usually up to 3A during peak operation), the USB fast charging module is perfect for this application. It efficiently steps down the 12.8V from the 76 Wh LiFePO4 battery to 5V, while ensuring sufficient current is provided to avoid undervoltage problems or unanticipated shutdowns. At the transmitter (RC) side, we are using a compact and lightweight 1.85 Wh Li-ion battery to power the controller circuit. Since this battery typically outputs around 4.1 V, we step it up using a 5V 3A BEC (Battery Eliminator Circuit). This BEC ensures a stable 5V output, which is crucial for powering both the nRF24L01 RF module and the STM32F401 microcontroller.[13]

III.RESULTS AND DISCUSSIONS

This section presents the main findings from the deployment of the Surveillance ROV, emphasizing its performance regarding wireless communication, mobility, sensor integration, and power management. The results are examined in relation to the goals established in previous chapters to assess the system's independence, dependability, and scalability. This also contains the CAD models, completed ROV chassis, and assembled prototypes for both the ROV and the remote control (RC) unit. The incorporation of 3D-printed components—like motor mounts and sensor brackets—is also showcased, highlighting the mechanical and functional integrity of the assembly.

The chapter succinctly outlines the code organization and control algorithms implemented for wireless communication, motor management, and sensor data analysis. Furthermore, it discusses the test jigs utilized for validating subsystems such as RF modules, motor drivers, and power converters, confirming that each component satisfied its design criteria prior to complete integration.

A. Related Images

1) Assembled ROV Prototype

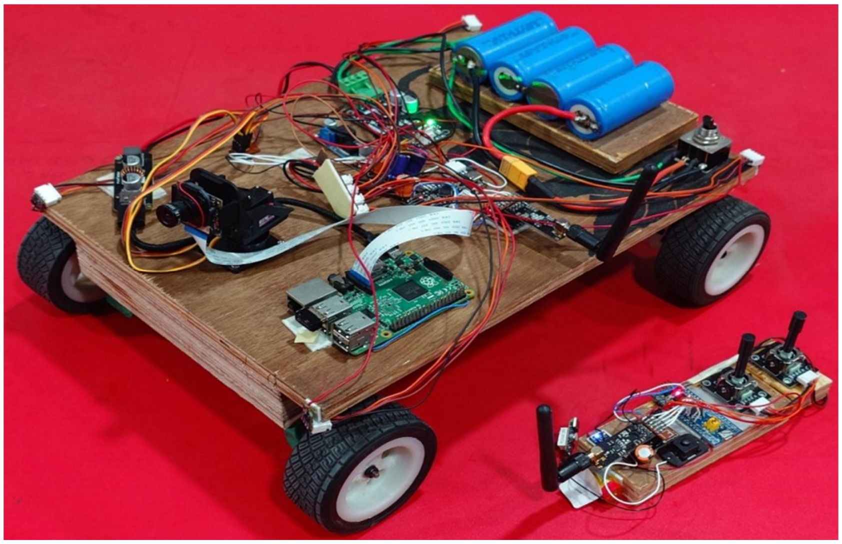

Fig. 8. Assembled ROV and RC

B. Results

The results obtained for tests carried out on power unit is presented in Table 1.

Table 1 Voltage Readings

Module / Component	Voltage
Main Battery (LiFePO4)	12.7V
LM2596 Output	5.1V
AMS117-5.0 Output	5.12V
AMS117-3.3 Output	3.35V
USB Fast Charging Module Output	5.1V
RC Battery (Li ion)	4V
5V / 3A BEC	5.1V

The results obtained for test performed on the remote-control unit are presented in Table 2.

Table 2 Two-axis Joystick readings

Joystick Axis	Direction	Range	Comments
Left Stick – Vertical	Up	0 to 255	Move ROV forward
	Down	0 to -255	Move ROV reverse
Left Stick – Horizontal	Left / Right	45 to 135 degrees	Steering
Right Stick – Vertical	Up / Down	45 to 135 degrees	Tilt camera up/down
Right Stick – Horizontal	Left / Right	0 to 180	Pan camera left/right

C. Discussion of Results

Table 1 shows the outcomes derived from testing the power supply unit of every module of the initiative. These examinations were conducted to confirm that the battery banks of each module provided the specified voltages needed by their connected circuitry, as indicated by the data sheets of the different elements.

Table 2 displays the digital representations of analog voltages sourced from the joystick module, which are directly read by the 12-bit ADC (Analog-to-Digital Converter) of the STM32F4x1xx microcontroller. The ADC can discern 4096 distinct analog levels (0–4095) over a reference voltage of 3.3V, indicating that a voltage of 3.3V equates to a digital value of 4095.

The joystick's X and Y potentiometers provide these analog values, which are utilized to ascertain the user's intent to control. Using set thresholds and directional areas in the ADC readings, the STM32 interprets and assigns them to the appropriate movement commands for the Remotely Operated Vehicle (ROV), including:

- FORWARD
- REVERSE
- LEFT TURN
- RIGHT TURN
- PAN
- TILT

The ROV’s motor and steering systems then carry out these movement commands. This direct mapping from ADC to motion enables real-time, proportional, and accurate control of the remote operated vehicle’s movement according to the joystick's position.

IV. CONCLUSION AND FUTURE SCOPE

A. Conclusion

Existing surveillance systems—ranging from traditional fixed CCTV setups to advanced autonomous patrol robots—exhibit notable limitations in terms of mobility, cost, adaptability, and energy efficiency. Fixed CCTV systems, although reliable for static monitoring, fail to provide flexible coverage in dynamic or spacious environments and are not cost-effective in all use cases. On the other hand, mobile surveillance robots offer flexibility but are often burdened by high costs, complex SLAM-based navigation, and increased power consumption.

In contrast, the proposed ROV surveillance system bridges this gap by integrating:

- Low-cost and efficient hardware: Using an STM32 microcontroller and NRF24L01 transceiver offers real-time control and low-power wireless communication.
- Hybrid control architecture: Python-HTML-based interfaces enable intuitive and low-latency remote control compared to proprietary or closed-loop commercial robot UIs.
- Efficient power system: The 76 Wh $LiFePO_4$ battery, combined with LM2596 and AMS1117 regulators, ensures extended runtime and safety—advantages not commonly found in existing consumer-grade patrol robots.
- Scalability and modularity: The modular design allows easy future integration of autonomous features or AI-based video analytics, unlike many rigid commercial systems.
- Performance tests of the prototype show a stable wireless range of over 50 meters and operation exceeding 1.5 hours, outperforming several Raspberry Pi-based surveillance bots, which often suffer from limited range or power inefficiencies.

B. Future Scope

Moving forward, several key improvements and enhancements will be made to the IoT based surveillance robot to further optimize its performance and expand its capabilities:

- Camera Module Enhancement:

The next phase of development will focus on upgrading the camera module to significantly enhance surveillance capabilities. This includes improving resolution, boosting low-light performance, and integrating advanced image processing techniques for more effective real-time monitoring. Additionally, higher-quality camera sensors will be considered, along with the integration of thermal imaging cameras, enabling the ROV to operate effectively in defence and search-and-rescue scenarios, especially in low-visibility or night-time conditions.

- Chassis Redesign:

The chassis will be reengineered to provide enhanced durability, optimized weight distribution, and improved manoeuvrability. The structural refinements aim to increase the ROV's capability to navigate complex terrains while maintaining stability, especially when equipped with additional sensors or payloads. As part of this redesign, we also plan to incorporate a tank wheel drive mechanism, which will further enhance traction and mobility on uneven or rugged surfaces—making the system more robust for both tactical and industrial applications.

- Improved Wireless Communications:

To improve the reliability, range, and efficiency of communication, we will adopt advanced wireless communication methods and leverage higher bandwidths to reduce interference. Through the investigation of 5G, Wi-Fi 6, or Long Range (LoRa) technologies, we seek to prevent the congestion typically experienced in the busy 2.4GHz band. This will guarantee quicker and more stable data transfer, even in challenging settings, minimizing the chances of signal interference and enhancing the overall efficiency of the ROV. These enhancements will enable improved real-time control, uninterrupted video streaming, and extended operational range, rendering the ROV more appropriate for challenging applications like defence, surveillance, and industrial activities.

- Improved Security and Code Improvement:

As the ROV develops, security will remain a primary concern, particularly in fields like defence or surveillance. We will deploy strong encryption standards and secure communication pathways to block unauthorized entry, guaranteeing that sensitive information and control signals are safeguarded from cyber risks. This involves employing AES encryption for data transmission and utilizing SSL/TLS for secure remote communications.

In addition to security upgrades, we will prioritize enhancing the codebase. By implementing modular programming methods, enhancing memory efficiency, and incorporating error-checking systems, we strive to improve the system's efficiency, reliability, and maintainability. Furthermore, integrating automated testing and code reviews will assist in detecting vulnerabilities and improving the overall functionality of the ROV's software. These measures will guarantee that the ROV functions effectively, even in high-pressure situations, and can be relied upon for essential missions.

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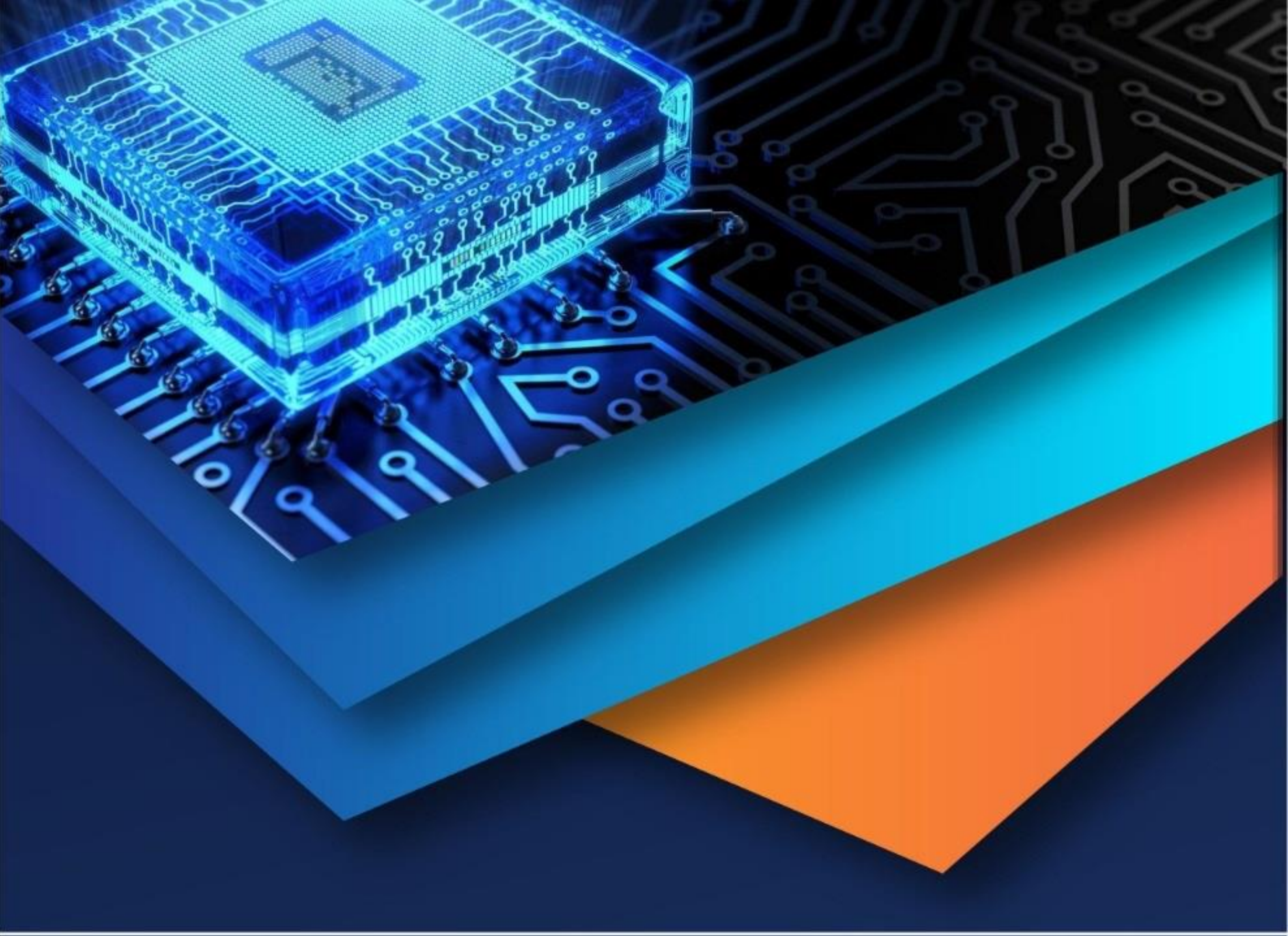

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