IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

FABRICATION OF SOLAR POWERED SURVEILLANCE ROBOT

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Abstract: The android is a powerful operating system and it supports large number of applications in Smart phones. A growing interest m having smart phones interacting with peripheral devices such as motors, servo and sensors led to the recent creation of electronic interface boards. These applications are more comfortable and advanced for the users. This robot can be controlled with the help an application of Android phones. So main aim of our project is to make a robot vehicle which is controlled by Android application. This robot can move to any place and perform smartly within specified Wi-Fi range. This project is work on radio frequency technology. So, Android application sends the signal to radio frequency receiver which is mounted on robot by using Wi-Fi connection. The robot consists of night vision wireless camera which can transmit images or videos.

Keywords – Surveillance Robot, Solar Energy, Android Application, Wi-Fi, Night Vision Camera.

I. INTRODUCTION:

In recent years, there has been a surge of interest in integrating robotics with renewable energy sources. This trend is driven by the potential to create sustainable and efficient solutions for various applications. One particularly promising area lies in the development of solar-powered surveillance robots.

These robots offer a unique combination of functionalities. Equipped with cameras, sensors, and communication systems, they can autonomously monitor and secure designated areas for extended periods. The key advantage lies in their power source: solar panels. This allows for:

- Prolonged Operation: Solar panels ensure a continuous power supply, eliminating reliance on external power sources and enabling long-term monitoring, particularly beneficial in remote locations.
- Reduced Environmental Impact: By leveraging clean solar energy, these robots minimize their environmental footprint, making them a sustainable choice for surveillance needs.
- All-weather Functionality: The design will be robust enough to handle variations in light, temperature, and terrain, making them suitable for deployment in remote areas with diverse conditions.

This project focuses on the design, development, and fabrication of a solar-powered surveillance robot specifically designed for autonomous monitoring in remote areas. The following sections will detail the scope of the project, encompassing the mechanical design, selection and integration of electronic components, programming of control systems, and testing in simulated and real-world environments.

II. EXISTING SYSTEM:

There are no widely available commercial solar-powered surveillance robots yet. However, ongoing research projects and conceptual designs provide valuable insights for your project.

Research projects like solar-powered mobile robots for border patrol demonstrate the concept of using solar panels for extended operation and remote control for flexibility. Wireless solar robotic vehicles showcase the potential for integrating solar power, wireless communication, and mobility – key elements for a surveillance platform. Additionally, solar-powered reconnaissance robots highlight the benefit of solar for long-term, ground-based surveillance in remote areas.

Another research project focuses on wireless solar robotic vehicles. While the application might differ from yours, it showcases the potential for integrating three key elements for a surveillance platform: solar power, wireless communication, and mobility. This type of robot could be equipped with cameras and sensors for data collection, and the solar panels would ensure continuous operation. The wireless communication system would allow for real-time data transmission to a remote monitoring station, enabling centralized control and analysis.

Finally, research into solar-powered reconnaissance robots explores the use of solar power for robots in long-term, ground-based surveillance missions. This aligns with your project's objective of continuous monitoring in remote locations, where access to power grids might be limited. Solar-powered reconnaissance robots can be particularly useful for monitoring large areas or critical infrastructure in remote regions.

Companies like SMP Robotics offer concepts for solar-powered security robots with features like sun-tracking systems and PTZ cameras. These concepts provide inspiration for functionalities you can incorporate into your design.

III. PROPOSED SYSTEM:

Project aims to build a solar-powered surveillance robot for remote areas. This robot will rely on solar panels for continuous power generation, storing excess energy in a battery for nighttime or low-light situations. A microcontroller will act as the robot's brain, processing data from various sensors and cameras.

The robot will be equipped with a high-resolution camera for visual monitoring, potentially with night vision capabilities. Infrared sensors will enhance object detection in low-light conditions, while proximity sensors will prevent collisions during navigation. Wireless communication will allow for real-time data transmission to a remote monitoring station, keeping operators informed. This design offers a self-sufficient and versatile solution for surveillance needs in remote locations.

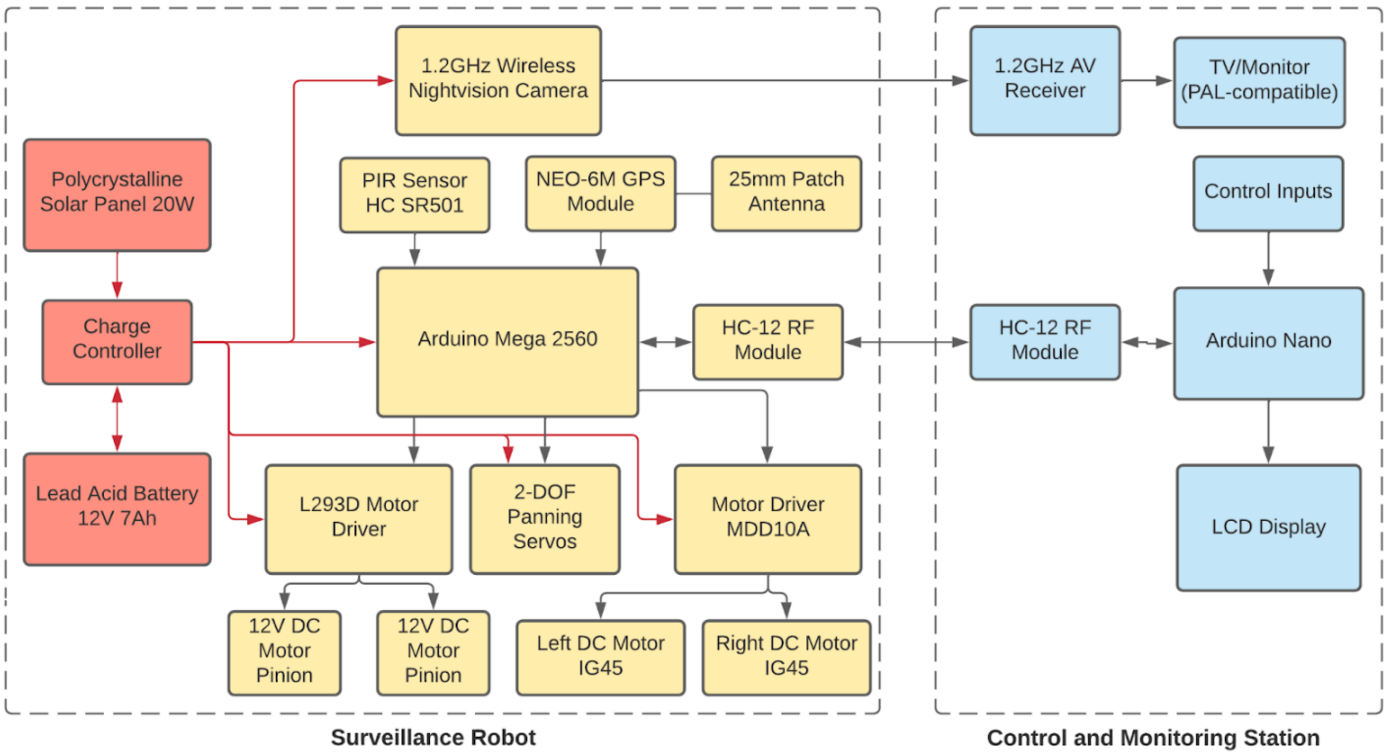

Fig 3.1 Block Diagram

IV. THEORETICAL BACKGROUND:

1. Photovoltaic (PV) Cells and Solar Power Generation:

The core principle behind your robot's power source lies in Photovoltaic (PV) cells. These cells convert sunlight directly into electricity through the photovoltaic effect. The number and type of solar panels chosen will depend on factors like:

Solar Irradiance: The amount of solar radiation available in the target deployment location. Higher irradiance requires fewer panels for the same power generation.

Robot's Power Consumption: The total power required by the robot's components (motors, sensors, cameras) will determine the panel size and quantity needed.

2. Battery Storage and Management:

Rechargeable batteries are crucial for storing excess solar energy generated during the day for use during low-light conditions or emergencies. Understanding battery characteristics like capacity, discharge rate, and lifespan becomes important for optimal system design.

Battery management systems (BMS) can be integrated to regulate charging and discharging cycles, maximizing battery life and preventing damage.

3. Mobile Robot Kinematics and Control

The robot's mobility platform relies on principles of mobile robot kinematics. This field of robotics deals with the motion of robots, considering factors like:

Robot Type: Wheeled or tracked robots have different kinematic models for movement planning.

Degrees of Freedom (DOF): The number of independent movements the robot can perform (e.g., turning, strafing) influences the complexity of the kinematic model.

Control system design plays a vital role. Feedback control systems using sensors like encoders on the motors allow for precise movement and path following.

4. Sensor Technologies for Object Detection and Navigation

Your robot utilizes various sensors for environmental awareness and navigation:

Cameras: Cameras capture visual data of the surroundings, enabling object identification and scene analysis.

Infrared Sensors: These sensors detect heat signatures, allowing object detection in low-light conditions where cameras might struggle.

Proximity Sensors: These sensors detect nearby obstacles, preventing collisions during robot movement.

Sensor fusion techniques can be employed to combine data from multiple sensors for a more comprehensive understanding of the robot's environment.

5. Wireless Communication and Remote Monitoring

Wireless communication technologies like Wi-Fi or cellular networks enable real-time data transmission from the robot to a remote monitoring station. This data can include:

- Visuals: Captured by the camera for live monitoring of the remote area.
- Sensor Readings: Data from infrared and proximity sensors for object detection and obstacle avoidance.
- Robot Status: Information about battery level, motor health, and any operational errors.

V. HARDWARE DESCRIPTION:

1. Power Generation and Management:

Solar Panel: Converts sunlight into electricity to power the robot.

Fig 5.1 Solar Panel

Battery: Stores excess solar energy for operation during low-light conditions.

Fig 5.2 Battery

DC-to-AC Converter: May be needed if some components require AC power. However, most robot components typically operate on DC power.

Fig 5.3 DC to AC Converter

2. Control and Processing:

Arduino or NodeMCU: A microcontroller board that serves as the brain of the robot, processing sensor data and controlling functionalities. Both Arduino and NodeMCU are popular options for hobbyist robotics projects. NodeMCU offers built-in Wi-Fi capabilities, which might be advantageous for wireless communication.

Fig 5.4 Arduino

3. Mobility:

DC Motors: If the robot needs to move, DC motors will provide the driving force. The number of motors and their specifications will depend on the robot's design (wheeled, tracked).

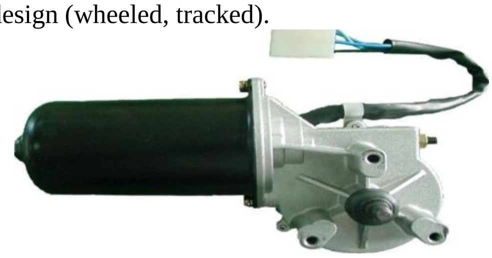

Fig 5.5 DC Motors

4. Sensors:

360 Degree Camera: Captures a panoramic view of the surroundings for comprehensive surveillance.

Fig 5.6 360 Degree Camera

Ultrasonic Sensor: Measures distance to objects, useful for obstacle avoidance during navigation.

Fig 5.7 Ultrasonic Sensor

5. Communication:

Relay: A relay can be used to control the high current of a DC motor if needed, protecting the Arduino/NodeMCU from damage.

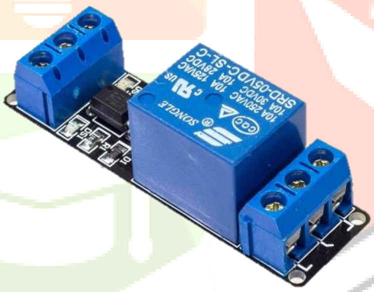

Fig 5.8 Relay

Wireless Module: An additional Wi-Fi or cellular module can be integrated with NodeMCU for enhanced wireless communication capabilities.

Fig 5.9 WI-FI Module

6. Considerations:

Power Management: Matching the solar panel's capacity to the robot's power consumption and battery storage is crucial for ensuring continuous operation.

Sensor Selection: Choose sensors with appropriate ranges and functionalities for your desired surveillance application.

Programming: The Arduino/NodeMCU will need to be programmed with code to control the robot's functionalities, including sensor data acquisition, camera control, and (if applicable) motor movement and obstacle avoidance.

VI. WORKING PRINCIPLE:

Powering the Guardian: Solar Energy and Battery Storage

The robot's heart lies in its sustainable power source: solar panels. These photovoltaic cells, strategically mounted on the robot's body, capture sunlight and convert it into electricity. This harvested energy then gets stored in rechargeable batteries, typically lithium-ion due to their efficiency and long lifespan. The batteries act as a crucial backup, ensuring the robot's operation during low-light conditions like nighttime or shaded areas. This design eliminates dependence on conventional power grids, making the robot ideal for remote deployments.

Mobility and Navigation

The robot utilizes either wheels or tracks for mobility, allowing it to navigate various terrains. Additional features like suspension systems and rugged tires can be incorporated to enhance its adaptability to challenging environments.

Eyes in the Dark: The Surveillance System

The robot's surveillance capabilities are central to its functionality. It's equipped with a night vision camera, employing infrared technology to capture clear images even in low-light conditions. This allows for continuous monitoring irrespective of the time of day. The camera works by converting light information into electrical signals, amplifying them, and processing them to generate a visible image or video feed.

Command and Control: The Human-Machine Interface

The robot boasts a user-friendly interface. DC motors, powered by a lead-acid battery, propel the robot's movement based on remote commands received through an Android interface. Relays act as electronic switches, controlled by the interface, to activate various functions of the robot remotely. This allows for real-time control over the robot's movements and surveillance operations.

The Power of Connectivity: The Internet of Things (IoT)

An integrated IoT module facilitates seamless wireless communication between the robot and the controlling device. This real-time connection enables the transmission of commands and ensures the operator receives a continuous stream of data from the robot.

VII. OUTPUT:

Fig 7.1 Output

VIII. CONCLUSION:

This solar-powered surveillance robot offers a sustainable and efficient solution for remote monitoring needs. Its versatility makes it a valuable tool for a wide range of applications, including:

- Security patrols in remote locations: The robot can be deployed in areas with limited infrastructure or where human presence might be risky. Its covert operation capabilities allow for discreet monitoring without disturbing potential threats.
- Monitoring wildlife populations in sensitive ecosystems: Researchers can use the robot to observe wildlife behavior without causing disruptions. The silent and sustainable operation minimizes the robot's impact on the environment.
- Inspecting critical infrastructure: The robot can be used to inspect pipelines, power lines, or other infrastructure in remote or hazardous locations. The real-time data transmission allows operators to identify and address any potential issues promptly.

Beyond these specific applications, the robot's modular design allows for customization to suit various needs. Additional sensors can expand its data gathering capabilities, while advancements in processing power can enable more complex onboard data analysis. As battery technology continues to develop, the robot's operational range and endurance can be further enhanced. Overall, this solar-powered surveillance robot stands as a testament to the future of intelligent and environmentally conscious surveillance systems. By leveraging the power of renewable energy and automation, these robots offer a sustainable and versatile solution for a wide range of monitoring tasks.

IX. RESULT AND DISCUSSION:

9.1 RESULT:

The project was able to achieve the following benchmark results:

Passive operation time - 12-13 hours

The implemented setup was able to achieve an operation time of 12 hours using the onboard battery which powers the entire surveillance robot and its functionalities. The robot was able to perform continuous surveillance and transmit the obtained data successfully to the control and monitoring station.

Successful data communication between the Surveillance Robot and the Control and Monitoring Station

The GPS data and motion sensing data were received by the Control and monitoring station along with continuous video feed from the onboard night-vision camera of the Surveillance robot. The Surveillance robot successfully performed the tasks of solar panel deployment and locomotion according to the incoming data from the control unit.

Deployment of solar charging using on-board solar panel.

The power section of the surveillance robot is capable of charging the onboard battery within 5 hours of continuous sunlight when the solar panel is deployed. Thus, the long-term operation of the robot is successfully achieved.

Deployment of retractable solar panel deployment mechanism

The solar panel deployment mechanism is implemented using the onboard mechanical components to achieve smooth and dependable sliding which helps in improving stealth of the robot and reducing the size of the surveillance robot.

Deployment of locomotion using high-torque 2-wheel drive system

The robot is able to successfully perform locomotion using its 2-wheel drive system with desired speed and control.

9.2 DISCUSSION:

The proposed system overcomes many challenges faced by conventional reconnaissance systems as it is able to stay inside the enemy territory and perform continuous monitoring and surveillance. The system can be further miniaturized and made energy-efficient to reduce the need for continuous solar charging and improve stealth. The robots can be deployed along with a dedicated satellite communication link that will improve security and range of the surveillance network.

The successful operation of the robotic system powered by solar energy creates a doorway for future developments in Long-term and self-sustainable robotic applications on the field ranging from defence, agriculture and even marine applications. It can be integrated with face recognition technology for detection of previously identified terrorist group members or sympathizers.

X. ACKNOWLEDGEMENT:

Certainly, acknowledging the support and contribution of Paavai College of Engineering, particularly the teaching and non-teaching staff of the Department of Automobile Engineering, is essential. Additionally, expressing gratitude to our parents, friends, and all those who have provided direct or indirect support for this research is imperative.

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