IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SCORPONIOD THE ASSISTANT BOT

Dr. Nitin Dhawas[1], Professor, Electronics and Telecommunication,
Nutan Maharashtra Institute of Engineering and Technology, Talegaon, Pune
Yash Chopade[2], Student, Electronics and Telecommunication,
Nutan Maharashtra Institute of Engineering and Technology, Talegaon, Pune
Abhilash Shinde[3], Student, Electronics and Telecommunication,
Nutan Maharashtra Institute of Engineering and Technology, Talegaon, Pune
Aishwarya Chaudhari[4], Student, Electronics and Telecommunication,
Nutan Maharashtra Institute of Engineering and Technology, Talegaon, Pune

Abstract

The Scorponiod Bot is a state-of-the-art robotic rover that boasts a mechanical arm, providing human-like flexibility in a range of environments. Its standout feature is its ability to memorize and autonomously replicate movements. The bot is split into two key sections: a robotic arm and an omnidirectional rover. The 5-axis robotic arm can be wirelessly controlled and programmed, while the omnidirectional rover, thanks to its unique mecanum wheels, can move in any direction. The arm's movements can be manually controlled using an app, with a "Save" button allowing for the recording and automatic repetition of steps. The arm, which has five degrees of freedom, utilizes MG996R servos for the waist, shoulder, and elbow, and SG90 micro servos for the wrist roll, wrist pitch, and gripper. The rover's movements are controlled by an Arduino MEGA board, with each wheel attached to a DC motor for precise control.

Keywords:

Robotic-arm, microcontroller, robotic-rover, mecanum wheels.

1. INTRODUCTION

The Scorponiod bot stands as a testament to the ingenuity of modern robotics, seamlessly blending cutting-edge technology with the versatility of human-like arm capabilities. At its core, this robotic marvel comprises two primary components: a sophisticated 4-axis robotic arm and an agile all-directional Rover, each designed to fulfill distinct yet complementary functions.

Central to the Scorponiod's functionality is its meticulously engineered robotic arm, boasting an impressive array of features tailored to mimic the dexterity of human arms. With five degrees of freedom, this marvel of engineering leverages the precision of MG996R servos for pivotal movements at the waist, shoulder, and elbow. Complementing these larger servos are the nimble SG90 micro servos, which handle the subtleties of wrist roll, wrist pitch, and gripper actions with finesse.

What truly sets the Scorponiod apart is its intuitive interface, facilitated by an accompanying app that puts the power of control directly into the hands of its users. Through this seamlessly integrated platform, operators can effortlessly manipulate the robotic arm's movements, whether manually or wirelessly, allowing for precise adjustments tailored to the task at hand. Moreover, the app empowers users to save key positions for automatic replication, streamlining repetitive processes and enhancing operational efficiency. With additional functionalities such as the ability to pause or reset operations, the app ensures seamless management of tasks, providing users with unprecedented levels of control and flexibility.

Beyond its impressive mechanical prowess, the Scorponiod's versatility shines through its adaptable end effector, or robotic hand. Tailored to meet the demands of a wide array of applications, this customizable component can be outfitted with specialized tools, ranging from welding apparatus to gripping mechanisms and even spinning devices. Such versatility ensures that the Scorponiod remains relevant across diverse fields, from the rugged terrain of space exploration to the precision-driven environments of automotive assembly lines.

In the realm of space exploration, the Scorponiod emerges as a formidable ally, capable of navigating challenging terrains with ease while executing intricate tasks with surgical precision. Whether assisting in the maintenance of space stations or conducting vital repairs on distant planets, its robust design and advanced functionalities make it an indispensable asset to space agencies across the globe.

Similarly, in the realm of automotive assembly, the Scorponiod's prowess shines through, revolutionizing traditional manufacturing processes with its unmatched precision and efficiency. From intricate welding operations to delicate component handling, its adaptable robotic arm proves instrumental in streamlining production workflows and optimizing output quality.

2. OBJECTIVE

The Scorponiod Bot project represents an innovative initiative aimed at developing and assembling a versatile robotic system. This system will combine a 5-axis robotic arm and an all-directional rover to achieve exceptional mobility and agility, with the ultimate goal of performing complex tasks efficiently across various terrains.

A key focus of the project lies in creating a multi-axis robotic arm that offers extensive flexibility and maneuverability. With five axes of movement, this arm will be able to navigate diverse spatial orientations, allowing it to reach and manipulate objects in challenging environments. Ensuring the arm's mechanical and electrical design is robust and reliable will be essential for its performance in real-world applications.

Complementing the robotic arm, the Scorponiod Bot will feature an all-directional rover platform, further enhancing its mobility and adaptability. Equipped with advanced mecanum wheels, this rover will effortlessly move in any direction, overcoming obstacles and traversing rough terrain encountered during missions. The integration of the robotic arm and rover platform will empower the Scorponiod Bot to navigate diverse landscapes with agility and efficiency.

The Scorponiod Bot project will involve several stages, including mechanical and electrical design, coding, and thorough testing to evaluate the robot's capabilities. Each aspect of the robot will be carefully planned and executed to ensure smooth integration and excellent performance. Coding tasks will focus on developing algorithms for motion planning, object recognition, and autonomous navigation, enabling the robot to operate independently and effectively.

The ultimate goal of the Scorponiod Bot project is to create a fully functional robotic system suitable for deployment in various scenarios. Whether it's scientific research, exploration missions, or hazardous environments where human presence is risky, the Scorponiod Bot aims to offer a versatile solution. By harnessing advanced robotics technology, the project aims to push the boundaries of robotics, opening up new opportunities for exploration and innovation.

3. METHODOLOGY

In the paper authored by Badereddine Fares and Haifa Souifi (2021), an autonomous robot tailored for industrial tasks is introduced. The robot utilizes four distinctive wheels to ensure smooth movement and is equipped with a Fanuc robot along with advanced sensors such as Lidar and a camera for navigation within indoor environments. Its capabilities include independent map creation, obstacle avoidance, and object recognition. Mathematical models for the robot's motion are also presented, validated through computer simulations [1].

Regarding the work by Kanin Piemngam and Itthisek Nilkhamhang (2019), it discusses the development of an autonomous mobile robot platform featuring Mecanum wheels [7].

Hua Yang's paper from 2019 focuses on the LWH-Arm, a prototype of an 8-DoF lightweight humanoid robot arm. The main objective of this study is to achieve a high degree of freedom in the arm. In addition to the 7-DoF arm, a 1-DoF end effector is attached to simulate a human hand. The LWH-Arm is designed to mimic the movement patterns of a real human arm, boasting a low cost and lightweight build. However, the study notes limitations in terms of accuracy and stability [5].

Ehsan Malayjerdi's paper from 2018 delves into the self-tuning fuzzy PID control of a four-Mecanum wheel omnidirectional mobile platform. The focus is on addressing issues such as vibration and slip associated with Mecanum wheels. The study formulates kinematic mathematical models for proper robot control and utilizes encoders to mitigate slip. Detailed explanations of fuzzy PID controllers are provided to ensure accurate motion control of the Mecanum wheeled robot [8].

3.1 Steps to Implement

To implement the Scorponiod Bot project described in the provided abstract, you can follow these steps:

1. Define Project Scope and Requirement: Clearly define the objectives and requirements of the Scorponiod Bot project. Determine the functionalities and features you want the robot to have, such as autonomous navigation, object manipulation, and temperature sensing.
2. Design the Robotic Arm: Design a 5-axis robotic arm capable of providing human-like dexterity. Select appropriate servos for each axis based on torque and precision requirements. Use CAD software to design the mechanical components of the arm.
3. Select and Integrate Sensors: Choose sensors such as Lidar for navigation and a camera for object recognition. Integrate these sensors into the robotic arm and rover platform.
4. Implement Wireless Control: Use appropriate communication protocols to enable wireless control of the robotic arm. Implement a user interface (such as an app) for controlling the arm's movements manually.
5. Develop Movement Recording and Playback Feature: Create algorithms to record and store the movements of the robotic arm. Implement functionality to automatically repeat recorded movements. Include options to pause, reset, or delete recorded movements.
6. Design and Build the All-Directional Rover: Design a rover platform equipped with mecanum-wheels for omnidirectional movement. Select motors and controllers suitable for driving the rover. Integrate the rover platform with the robotic arm and sensors.
7. Select Microcontroller and Components: Choose a microcontroller board such as Arduino Mega for controlling the robot's components. Select additional components such as transistors, temperature sensors (e.g., LM35), fans, and servo motors.
8. Develop Control Algorithms: Develop control algorithms for autonomous navigation, obstacle avoidance, and temperature regulation. Implement PID control for precise movement and temperature control.
9. Test and Debug: Conduct comprehensive testing of each component and subsystem.
10. Debug any issues encountered during testing. Verify that the robot performs as expected in various scenarios.

3.2 Flowchart and Algorithms:

The below flowchart depicts illustrating a serial read process. It begins with the condition of whether serial data is available. If true, it proceeds to check whether a specific character is received. Depending on the outcome, it branches into various actions, including running functions or loops. This flow continues based on different conditions, ultimately resulting in executing specific tasks based on the serial data received.

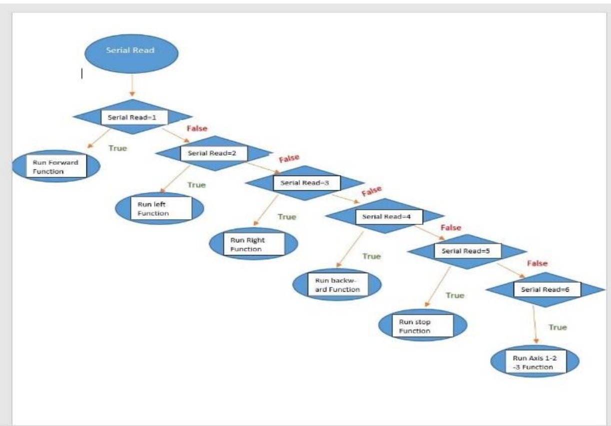

Fig.1: Flowchart

3.3 Component Description:

1. ARDUINO UNO: The Arduino Uno is a microcontroller board featuring the ATmega328P microcontroller from Microchip. It provides digital and analog input/output (I/O) capabilities, allowing connections to various extension boards and peripherals.
2. LM35 SENSOR: The LM35 is a temperature sensor with an integrated analog output that measures temperature in degrees Celsius. It offers high precision without requiring external calibration or trimming.
3. BC547 TRANSISTOR: The BC547 is an NPN transistor utilized for amplification and switching purposes. It operates such that when the base pin is low, the collector and emitter remain open (reverse bias), and when a signal is applied to the base pin, the collector and emitter become connected (forward bias).
4. 12V DC FAN: A 12V DC fan utilizes an internal arrangement of magnets with differing polarities within a coil. When current flows through the coil, a magnetic field is generated, inducing torque that rotates the motor.
5. SG 90 SERVO MOTOR: The SG90 Micro Servo Motor is a compact and lightweight servo motor with high torque output. It can rotate up to 180 degrees (90 degrees in each direction) and operates similarly to standard servos but in a smaller form factor.

3.3 System Architecture

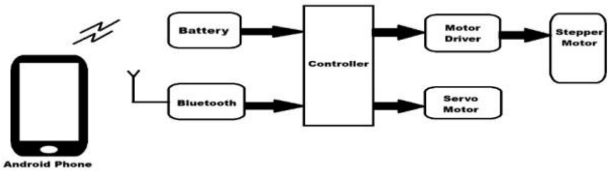

Fig.2: Architecture

The LM 35 sensors sends the temperature readings to the Micro-Controller (Arduino), when the temperature exceeded the particular temperature (set in Arduino) then the micro-controller sends the commands to the output devices connected to it, to turn on the Fan and rotate the servo motor for cooling the elements which are assembled on the breadboard.

3.4 Working

The Arduino is the heart of system. It accepts inputs from the temperature sensor. The LM 35 sensors sense the temperature and if it exceeded the limit of the temperature which is set in the micro-controller then the micro-controller commands to the output devices connected to it, to regulate the temperature of elements which are connected on the breadboard for the testing purpose, by turning on the fan for the cooling of those elements which are mounted on the breadboard. In this way according to the designed program the working of the system takes place automatically without any manual controls.

4. RESULTS & DISCUSSION

In this paper we have used lm35 sensor for sensing the change in temperature and the operating range of sensor is between 55°C to 150°C. When the temperature is exceeded the limit, of the temperature which is set in the micro-controller then the micro-controller sends a command to the output devices connected to it, to regulate the temperature of elements which are connected on the breadboard for the testing purpose, by turning on the fan for the cooling of those elements which are mounted on the breadboard. When the temperature exceeded the limit, the fan gets turn on and when the temperature is maintained or when the temperature is in limited range then the fan gets turn off. In this way we have built the portable automatic cooling system for breadboard component testing.

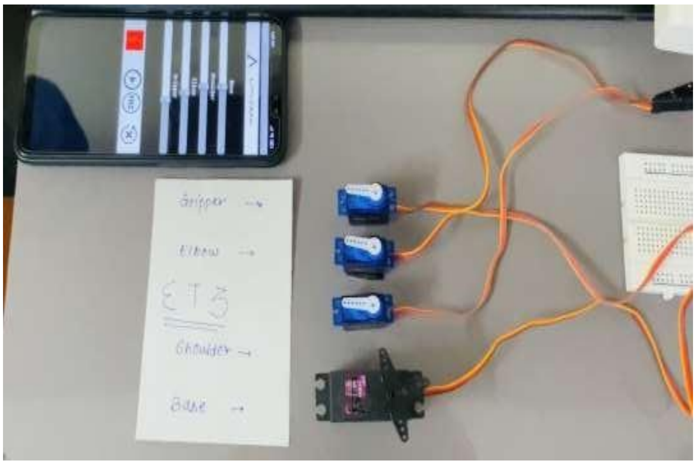

Fig.3: Result Before command

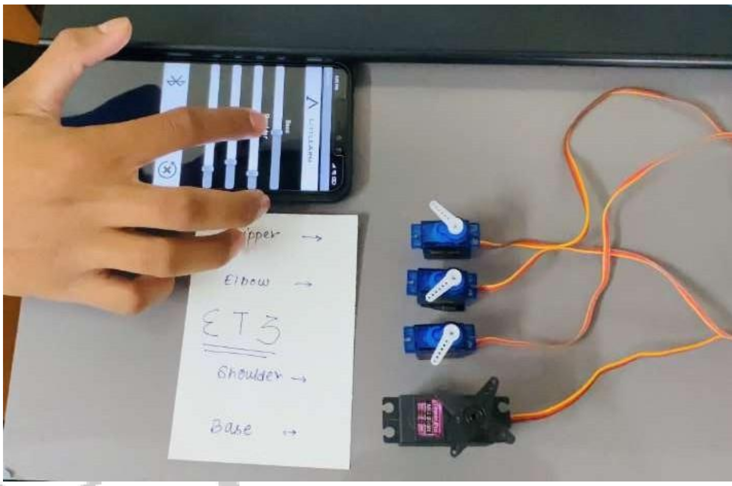

Fig.4: Result After command

4.1 Key Findings:

1. Versatile Robotic System:
The Scorponiod Bot integrates a 5-axis robotic arm and an all-directional rover, providing versatility for various tasks and environments.

2. Human-Like Dexterity:
The robotic arm of the Scorponiod Bot offers human-like dexterity, allowing it to perform intricate tasks with precision.

3. Wireless Control and Programming:
The robotic arm can be wirelessly controlled and programmed, enabling convenient operation and automation of tasks.

4. Automated Movement Repetition:
One of the standout features of the Scorponiod Bot is its ability to store and automatically repeat recorded movements, enhancing efficiency and productivity.

5. Integration of Mecanum Wheels:
The all-directional rover utilizes mecanum wheels, enabling it to move in any direction with ease and agility, enhancing mobility and adaptability.

6. Component Selection and Integration:
Key components such as Arduino boards, temperature sensors (LM35), transistors (BC547), DC fans, and servo motors (SG90) are carefully selected and integrated into the system to fulfill specific functionalities.

7. Real-Time Temperature Regulation:
The Scorponiod Bot incorporates temperature sensing and regulation capabilities, allowing it to adjust cooling mechanisms based on real-time temperature readings.

8. Potential Applications:
The Scorponiod Bot project opens up possibilities for applications in various fields such as industrial automation, scientific research, exploration missions, and hazardous environments where human presence is limited or risky.

9. Interdisciplinary Collaboration:
The project involves expertise from various disciplines including robotics, electronics, programming, and mechanical engineering, highlighting the importance of interdisciplinary collaboration in complex projects.

10. Future Directions:
There is potential for further enhancements and modifications to the Scorponiod Bot, such as adding additional sensors, improving control algorithms, and exploring new applications and use cases in different industries.

4.2 Implementation challenges:

1. Mechanical Design Complexity:
Designing and building a robust and precise 5-axis robotic arm with human-like dexterity can be challenging due to the complexity of mechanical design and assembly.

2. Integration of Components:
Integrating various components such as sensors, actuators, microcontrollers, and communication modules into the robotic arm and rover platform while ensuring compatibility and optimal performance poses a significant challenge.

3. Wireless Control and Communication:
Implementing reliable wireless control and communication protocols for remote operation and programming of the robotic arm introduces challenges related to signal interference, latency, and stability.

4. Autonomous Navigation:
Developing algorithms for autonomous navigation of the rover platform, including obstacle detection, path planning, and localization, presents challenges in ensuring accurate and safe movement in diverse environments.

5. Movement Recording and Playback:
Implementing a robust system for recording and automatically repeating movements of the robotic arm introduces challenges related to data storage, synchronization, and accuracy.

6. Sensor Integration and Calibration:
Integrating sensors such as Lidar, cameras, and temperature sensors into the system requires precise calibration and alignment to ensure accurate perception and measurement.

7. Control and Stability:
Achieving precise control and stability of the robotic arm and rover platform, especially during dynamic movements and interactions with the environment, poses challenges in algorithm development and feedback control.

8. Power Management:
Efficient power management and distribution to ensure adequate power supply to all components, especially in mobile applications where energy consumption is critical, present challenges in system design and optimization.

9. Testing and Validation:
Conducting comprehensive testing and validation of the Scorponiod Bot in various operating conditions and scenarios is essential but poses challenges in ensuring thoroughness and accuracy of results.

10. Interdisciplinary Collaboration:
Facilitating effective collaboration between experts from different disciplines such as robotics, electronics, software engineering, and mechanical engineering introduces challenges in communication, coordination, and integration of diverse expertise and perspectives.

4.3 Discussion Points:
1. Functionalities and Features:
Outline the functionalities and features of the Scorponiod Bot, including its ability to perform autonomous navigation, object manipulation, temperature sensing, and movement recording and playback. Discuss how these features contribute to the overall versatility and utility of the robot in various applications.

2. Technology and Components:
Provide an overview of the technologies and components used in the Scorponiod Bot, such as Arduino microcontrollers, sensors (e.g., LM35 temperature sensor), transistors, DC fans, and servo motors. Discuss the rationale behind selecting specific components and the challenges encountered during their integration and implementation.

3. Control and Navigation Algorithms:
Describe the control and navigation algorithms developed for the Scorponiod Bot, including algorithms for wireless control, autonomous navigation, obstacle avoidance, and movement recording/playback. Discuss the computational challenges, algorithmic complexity, and real-world performance of these algorithms.

4. Wireless Control and Communication:
Explore the implementation of wireless control and communication protocols for remote operation and programming of the robotic arm. Discuss the challenges and solutions related to signal stability, latency, and interference in wireless communication.

5. LIMITATION

1.Short Range: Due to Bluetooth connectivity the range of operation is limited

2.less Stability: Due to cheap servo's the arm movement shakes or gets jitter

3.Imprecise: The automatic movements might not be that precise because of slipping of the wheels

6. FUTURE IMPLEMENTATION

The addition of camera, sensors, and improved communication techniques opens up a plethora of future scopes across various industries and applications. Here are some potential scenarios:

- Healthcare: In hospitals and clinics, cameras and sensors can be utilized for remote patient monitoring, ensuring timely intervention and personalized care. Improved communication techniques can enable faster transmission of medical data between healthcare professionals and patients, facilitating telemedicine and telehealth services.

- Manufacturing: In manufacturing plants, cameras and sensors can be deployed for quality control, predictive maintenance, and process optimization. Real-time communication between machines can streamline production processes and minimize downtime, leading to increased productivity and cost savings.

- Agriculture: Cameras and sensors mounted on drones or agricultural machinery can provide valuable insights into crop health, soil moisture levels, and pest infestations. Improved communication techniques can enable farmers to receive this data in real-time, allowing for timely decision-making and precision farming practices.

- Environmental Monitoring: Cameras and sensors deployed in natural environments can help monitor wildlife populations, track deforestation, and detect environmental hazards such as pollution or wildfires. Improved communication techniques can facilitate data sharing between researchers and organizations, leading to better conservation efforts and environmental management.

- Security and Surveillance: Enhanced cameras and sensors combined with
- improved communication techniques can bolster security systems in public spaces, airports, and critical infrastructure facilities. Real-time data transmission and analysis can enable rapid response to security threats, enhancing overall safety and security.

7. CONCLUSION

In conclusion, the Scorponiod Bot project introduces a groundbreaking robotic system combining a versatile 5-axis robotic arm with an agile all-directional rover. With features such as wireless control, autonomous navigation, and movement recording/playback, the Scorponiod Bot showcases the potential of robotics technology in various industries. While facing challenges like mechanical complexity and integration issues, the project sets the stage for future advancements in robotics, promising enhanced efficiency and versatility across multiple applications.

8. REFERENCES

[1] Badereddine Fares (2021) “Omnidirectional Platform for Autonomous Mobile Industrial Robot” Date of conference: 29-31 October 2021

[2] Ayres RU, Miller SM (1981) the Impact of Robotics on the Workforce and Workplace. Carnegie Mellon University Report, Australia pp 60-66.

[3] Karel C (1923) Rossum`s Universal Robot, English version by P. Selver and N. Playfaff, New York: Doubleday, Page and Company, pp-52-60.

[4] Mechatronics systems Fundamentals by Rolf Isermann Springer – John Wiley & Sons Inc., U.S.A. pp. 60-66.

[5] Yang H (2019) Design and Development of the LWH-Arm: A Lightweight Humanoid Robot Arm with Eight Degrees of Freedom.

[6] Rosenblatt R (1982) ―The Robot Revolution. Editorial Research Reports, pp. 347364.

[7] Piemngam k, Nikhamhang I (2019) Development of Autonomous Mobile Robot Platform with Mecannum wheels.

[8] Malayjerdi E (2018) Self-tuning Fuzzy PID Control of a Four-Mecanum Wheel Omnidirectional Mobile Platform.

[9] S. V. Joshi and R. D. Kanphade, "Deep Learning Based Person Authentication Using Hand Radiographs: A Forensic Approach," in IEEE Access, vol. 8, pp. 95424-95434, 2020.

[10] Joshi, S.V., Kanphade, R.D. (2020). Forensic Approach of Human Identification Using Dual Cross Pattern of Hand Radiographs. In: Abraham, A., Cherukuri, A., Melin, P., Gandhi, N. (eds) Intelligent Systems Design and Applications. ISDA 2018 2018. Advances in Intelligent Systems and Computing, vol 941. Springer, Cham.

[11] Anuradha D. Thakare, Rohini S Hanchate. Introducing Hybrid model for Data Clustering using K-Harmonic Means and Gravitational Search Algorithms. International Journal of Computer Applications. 88, 17 (February 2014), 17-23.

[12] Hanchate, R., & Anadan, R. (2023). Medical Image Encryption Using Hybrid Adaptive Elliptic Curve Cryptography and Logistic Map-Based DNA Sequence in IoT Environment. IETE Journal of Research,1-16

[13] Prof. Pritam Ahire, Akanksha Kale, Kajal Pasalkar, Sneha Gujar, Nikita Gadhave, "ECG MONITORING SYSTEM", International Journal of Creative Research Thoughts (IJCRT), ISSN:2320-2882, Volume.9, Issue 3, pp.407-412, March 2021.

[14] LSTM based stock price prediction, P Ahire, H Lad, S Parekh, S Kabrawala - International Journal of Creative Research Thoughts, 2021.