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# SMART QUADRUPED ROBOT

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**Abstract:** Because of their unmatched capacity to adapt to challenging environments and dynamic performance, quadruple robots have become essential components in the fields of automation and robotic engineering. In the primary technical areas of quadruped robots, this paper provides a thorough summary of recent advances in research, with an emphasis on structural design, locomotion planning, and sensory integration. The suggested quadruped robot has parallel legs with two degrees of freedom and a lightweight, modular architecture that is optimised for improved weight reduction and transmission accuracy. The robot's driving end is arranged horizontally, which improves its efficiency and stability. The rotation angles of each actuator are exactly established by means of a rigorous study using inverse kinematics methods, hence enabling smooth and precise motion.

**Keywords**: Robots with quadruples, Design structural, planning for locomotive motion, integration of senses, Reversing kinematics

## I. INTRODUCTION

Quadruped robots are the epitome of robotics innovation; they combine biomimicry with sophisticated engineering concepts to move and function in a variety of demanding conditions. Quadruped robots have attracted a lot of interest in a variety of disciplines, from automation to military surveillance, due to their exceptional capacity to go through challenging terrain with stability and agility. Recent studies have concentrated on improving these robots' dynamic performance, environmental adaptability, and functional capacities; as a result, structural design, locomotion planning, and sensory integration have advanced to unprecedented levels. This research study explores the design and development of a quadruped robot that combines voice recognition, video surveillance, and mobility, going beyond traditional functionalities. Based on the movement skills of giant quadruped mammals and utilising cutting edge technology for sensory perception and control, the suggested robot is a fusion of robotics, biomechanics, and artificial intelligence. An overview of the field of quadruped robotics is given in the introduction, emphasising the importance of human-robot interaction, environmental perception, and mobility. It establishes the framework for investigating the complex technology advancements and design factors that guide the creation of the suggested quadruped robot. This work clarifies the theoretical underpinnings and practical ramifications of combining locomotion, voice recognition, and video surveillance in quadruped robotics through an extensive study of previous research projects and literature..

## II. SYSTEM ARCHITECTURE

In this below figure 1:

- Arduino is used for low-level control chores and Raspberry Pi for high-level processing.
- Power is supplied via an 18650-battery pack with controlled voltage levels.
- 12 Servo Motors (S1 through S12) coupled to digital pins D2 through D13 on the Arduino board regulate leg motions.
- Serial or I2C communication is possible between the Raspberry Pi and Arduino.
- All parts are powered by the battery pack, which supplies enough current directly to the servos.

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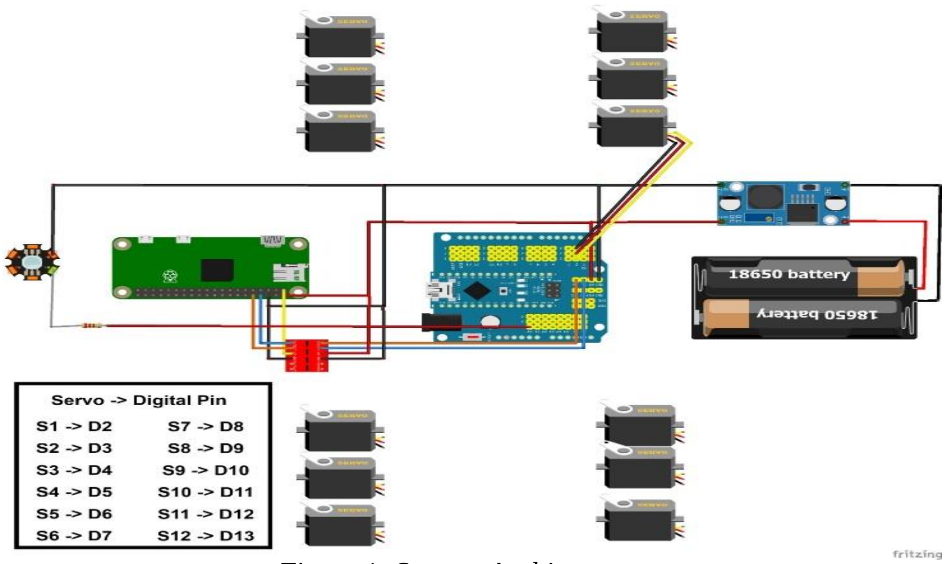


Figure 1: System Architecture

## III. IMPLEMENTAION

This paper describes the quadruped robot's technique with an emphasis on voice activation, movement, and surveillance capabilities. Preprogrammed vocal instructions are used to activate the robot, and a Raspberry Pi processes them to start it working. Twelve servo motors are employed in the locomotion system, which is managed by an Arduino board and is coupled to certain digital pins (S1 -> D2, S2 -> D3,..., S12 -> D13). With this arrangement, the robot's legs can move precisely, allowing it to turn, walk, and successfully traverse obstacles. To improve navigation, an ultrasonic sensor helps even more with obstacle detection. Additionally, the robot has a security camera that is connected to a Raspberry Pi, allowing users to see real-time video through an online interface.

The online interface enables users to remotely control the robot's motions, such as forward, backward, and sideways, in addition to seeing the live video stream. With its sophisticated control mechanisms and real-time monitoring capabilities for several applications, this integrated system guarantees effective and flexible operation. The quadriplegic robot exhibits a high degree of autonomy and user engagement through the use of voice commands and remote access, which qualifies it for a variety of operating contexts.

**The system architecture comprises several components:**

- **Microcontroller Units (MCUs):** Arduino is used for low-level control operations while Raspberry Pi is used for high-level processing.
- **Power Supply**: 18650 batteries are used for power. Power is supplied via a battery pack that is controlled to maintain constant voltage levels.
- **Actuators:** Twelve servo motors (S1 through S12) that are linked to digital pins on the Arduino board (D2 through D13) regulate leg motions.
- **Sensors:** An Arduino is linked to an ultrasonic sensor for obstacle detection.
- **Connectivity:** Serial or I2C communication between an Arduino and Raspberry Pi.
- **Power management:** All parts are powered by the battery pack, which also provides the servos with a direct source of electricity as needed.

**Process**

1. **Hardware Setup:**
   - As shown by the digital pin arrangement (S1 through S12), connect the servos to the Arduino.
   - Attach the camera module, HC-SR04 sensor, Raspberry Pi, and battery.
   - A check for correct power connections and component security should be made.
2. **Google Assistant SDK Integration:**
   - To authorize and authenticate the device, adhere to the approved setup instructions.
   - Install and configure the Raspberry Pi's Google Assistant SDK.
   - Use some example voice commands to confirm the functioning.
3. **Audio Management with Pygame:**
   - On the Raspberry Pi, install the Pygame library.
   - Utilize Pygame's audio modules to implement audio recording and replay.
4. **Natural Language Processing (NLP):**
   - To handle voice instructions, use the Google Assistant SDK.
   - Put certain directives and answers for robot control into action.
   - Assure precise execution of diverse spoken directives.
5. **System Control Functions:**
   - Provide Python routines for camera and servo control.
   - With Google Assistant SDK, you can integrate these features with voice commands.
   - Verify that orders like "move forward" and "start surveillance" are being carried out as intended.
6. **GUI Development with Tkinter:**
   - Use Tkinter to create an intuitive user interface.
   - Activate the response display, control buttons, and voice command input.
   - Make sure the interface has a good visual appeal and is responsive.
7. **Web Access for Surveillance:**
   - Install Flask or another web server on the Raspberry Pi.
   - Create a webpage with robot controls and a camera feed to stream.
   - Make that the surveillance system works and can be accessed remotely.

## IV. FUTURE SCOPE

1. **Superior Natural Language Processing (NLP):**

   - For the robot to comprehend natural language inquiries better and respond to them more accurately, use sophisticated NLP approaches.

2. **Boost the Integration of Applications:**

   - Integrate the robot with more services and apps from third parties so that consumers may utilize voice commands to accomplish a wider range of activities.

3. **Machine Learning Consolidation:**

   - To improve its reactions over time, teach the robot to learn from user interactions. Customize the user experience by implementing machine learning techniques.

4. **Voice Computation:**

   - A more engaging contact may be had by integrating text-to-speech technology, which will allow the robot to react verbally.

  

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5. **Interoperability Across Platforms:**

   - Develop the robot's ability to function on platforms other than the Raspberry Pi, such as smartphones and smart home automation systems.

## V. RESULTS


Its functionality and user experience will be greatly enhanced by putting these improvements into practice for the voice-activated quadriplegic robot with camera-based surveillance and online access. This will guarantee that the robot comprehends natural language inquiries and can appropriately react to them thanks to advanced NLP algorithms. Voice commands may be used by users to do a greater variety of activities as more third-party applications are integrated. While text-to-speech technology will boost user immersion by providing vocal replies, machine learning will allow the robot to learn from interactions and tailor responses. Its usefulness will increase if it can be integrated with mobile devices and smart home systems. Enhancing the robot's usability for those with impairments is possible through accessibility features, and allowing the project to be open-sourced will encourage community involvement, leading to more advancements and breakthroughs.

## VI. CONCLUSION

With the help of a Raspberry Pi for surveillance, an Arduino Nano for movement, voice activation, and online access, our project exhibits a multipurpose robotic platform. We've developed a flexible robot that can follow voice commands, navigate its surroundings, carry out surveillance, and access online resources by fusing various technologies together. With its ease of use, effectiveness, and versatility in a range of situations, the Smart Quadruped Robot exhibits great potential for use in home automation, security, exploration, and remote monitoring applications. If this project's development and refinement continue, robotics, automation, and human-machine interaction may progress, opening up new avenues for the development of intelligent and adaptable robotic systems.

## REFERENCES

[1] Ming Lu, Baorui Jing, Hao Duan, and Guanbin Gao. "Design of a Small Quadruped Robot with Parallel Legs". Hindawi Complexity Vol. 2022, August 2022

[2] B Sandeep and P Tamil Selvan, "Design and Development of an Autonomous Quadruped Robot" IOP Conf. Ser.: Mater. Sci. Eng. 1012 012016, 2021

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[3] Hui Chai, Yibin Li, Rui Song, Guoteng Zhang, Qin Zhang, Song Liu, JinmianHou, Yaxian Xin, Ming Yuan, Guoxuan Zhang, Zhiyuan Yang a, Sumathi, M. “A survey of the development of quadruped robots: Joint configuration, dynamic locomotion control method and mobile manipulation approach” Biomimetic Intelligence and Robotics 100029,2021.

[4] Yi Zheng, Kun Xu, Yaobin Tian, Huichao Deng* and Xilun Ding “Bionic Design and Analysis of a Novel Quadruped Robot with a Multistage Bufer System” Chinese Journal of Mechanical Engineering, 35:32, 2022

[5] Priyaranjan Biswal and Prases K. Mohanty “Development of quadruped walking robots: A review” Ain Shams Engineering Journal, 2020.

[6] Chen, G and Hong, L. “Research on Environment Perception System of Quadruped Robots Based on LiDAR and Vision”. Drones 2023, 7, 329, 2023.

[7] Y. Fan, Z. Pei, C. Wang, M. Li, Z. Tang, Q. Liu “A Review of Quadruped Robots: Structure, Control, and Autonomous Motion” School of Automation Science and Electrical Engineering Beihang University,2300783, 2024.

[8] Ligang Yao, Hao Yu and Zongxing Lu “Design and driving model for the quadruped robot: An elucidating draft” Advances in Mechanical Engineering 2021, Vol. 13(4) 1–14,2021.

[9] Qian Cong, Xiaojie Shi, Ju Wang, Yu Xiong, Bo Su, Wei Xu, Hai Liu, Kuiyue Zhou, Lei Jiang, and Weijun Tian “Stability Study and Simulation of Quadruped Robots with Variable Parameters” Hindawi Applied Bionics and Biomechanics Vol. 2022, 2022.

[10] Omkar Jagdale, Prabhat Kaushal, Tushar Vitole and Ganesh Gaikwad “Quadruped Robot Used for Search and Rescue Operations”, International Journal of Research Publication and Reviews, Vol 4, no 5, pp 6838-6842, May 2023.

 