Design, Fabrication and Control of Quadruped Robot for Elderly People Assistance

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Abstract—The design, development, and implementation of a quadruped robot tailored to address the unique needs of elderly individuals. As the global population continues to age, there is a growing need for innovative technologies that can improve the quality of life for senior citizens. Our quadruped robot serves as a versatile solution, offering features such as voice assistance, fall detection, and support with daily tasks, all within a single platform. Fall detection and emergency alerts are crucial components of our robot, ensuring the safety of elderly individuals who are living on their own. To accomplish this, our robot is equipped with advanced sensors and computer vision technology, which allows it to accurately identify when a person has fallen. In the event of a fall, the robot can take action independently by initiating an emergency alert. Our aim with this project is to enhance the well-being and security of elderly individuals by providing them with a reliable and multifunctional robotic companion. This device can offer assistance with various daily tasks and, more importantly, can come to the rescue when a fall occurs, ensuring that seniors can continue to live independently with peace of mind.

Indexed Terms – Robot, Quadruped Robot, Elderly Individuals, Aging Population

1. INTRODUCTION

The design, fabrication, and control of quadruped robots for elderly people's assistance represent a cutting-edge area of robotics that aims to improve the quality of life for the aging population. As societies across the globe experience demographic shifts towards an older population, there is a growing need for innovative technologies that can provide support and companionship to elderly individuals. First and foremost, their design, which mimics the natural movement of animals with four legs, grants them excellent stability and maneuverability. This means that quadruped robots can navigate a wide range of environments, from indoor spaces to outdoor terrains, with relative ease. This adaptability is crucial for assisting elderly individuals who may live in diverse settings, from urban apartments to rural areas. They assist with monitoring health parameters such as heart rate, temperature, or falls, which is particularly valuable in providing timely care to the elderly. Another significant advantage of these robots is their ability to provide companionship and social interaction. Loneliness and social isolation are common issues among the elderly, and quadruped robots can offer a source of companionship and engagement. They can converse with the elderly, remind them of medication schedules, and even play games or provide entertainment. This project will enhance the independence of the elderly.

II. LITERATURE REVIEW

[1] T. McGeer ‘‘Passive dynamic walking’’. Int. J. Rob. Res. 9, 2 (March 1990), pp. 62-82. [31] Anand Kumar Mishra, “Design, Simulation, Fabrication and Planning of Bio-Inspired Quadruped Robot”, 2014 May Incorporation of multidisciplinary design approach, CAD modelling, kinematic, and dynamic analysis, as well as finite element analysis in the development of the robots.

[2] Estremera, Joaquin, and Kenneth J. Waldron. "Leg Thrust Control for Stabilization of Dynamic Gaits in a Quadruped Robot." In Romansy 16, 2006, pp. 213-220. Springer Vienna The paper focuses on regulating and stabilizing running quadruped robots by controlling parameters such as leg touchdown angles, hip torques, and leg thrust.

III. THEORY OF PROBLEM

A. PROBLEM DEFINITION

As the global population ages, there is a growing concern about the increasing number of elderly individuals facing loneliness and social isolation. The problem to be addressed is how to mitigate the negative impact of these social issues on the well-being of older people and provide them with meaningful social connections and interactions.

B. AIM OF THE PROJECT

This paper focuses on the design, development, and control of a quadruped robot tailored for elderly assistance. The primary goal is to enhance the quality of life for aging individuals by providing mobility support, fall detection, medication management, social interaction, and environmental assistance. The project addresses the unique needs of elderly users, emphasizing user-friendly interfaces, adaptability, safety, and cost-effectiveness. Ethical considerations are paramount, ensuring privacy and user autonomy. Furthermore, this research explores the integration of healthcare systems and conducts user studies to measure the acceptance and satisfaction of elderly individuals, with the ultimate aim of promoting independence and well-being for our aging population.

C. Flow chart

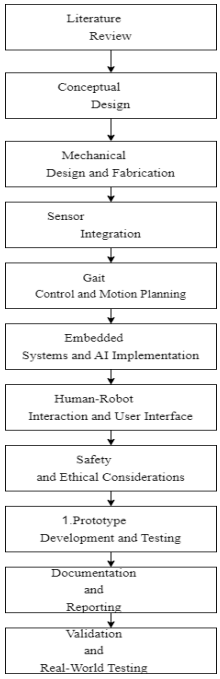

Fig: 1 Flow chart

Quadruped robots, with their four legs, provide a stable and balanced platform. This stability is crucial when assisting elderly individuals who may have mobility issues or may require physical support. The four-legged design allows for smooth and stable locomotion, making it easier for the robot to navigate through various environments and provide the necessary support for walking.

Quadruped robots are highly versatile and can traverse a wide range of terrains, both indoors and outdoors. This versatility is vital when assisting the elderly, as they may need support in different environments, such as in their homes, in parks, or on city streets. The design of a quadruped robot is inspired by the locomotion of animals, which can make interaction with it feel more natural for elderly users. The way it moves and responds can be more intuitive and less intimidating than other types of robots, fostering a comfortable and friendly interaction. The four-legged design of the robot provides an ideal platform for offering physical assistance to the elderly. It can help them with tasks like standing up, walking, and maintaining balance, which are common challenges for older individuals. Fall Detection and Emergency Response: Quadruped robots can be equipped with sensors and algorithms that can detect falls or other emergencies. Their stable design allows for accurate detection of sudden changes in position, enabling rapid emergency alerts and assistance.

IV. IMPLEMENTATION AND WORKS

A. OPENCV

OpenCV, which stands for "Open Source Computer Vision Library," can be a valuable component of a vision system for a quadruped robot. Here's how OpenCV can be utilized in such a system:

B. Object Detection and Tracking:

OpenCV provides tools for object detection and tracking. In a quadruped robot, this can be used to identify and track objects or obstacles in its environment, allowing the robot to navigate safely and avoid collisions.

C. Image Processing:

OpenCV offers a wide range of image processing functions. These can be used to enhance the visual data received by the robot's cameras, improving its ability to perceive its surroundings.

D. Pattern Recognition:
OpenCV includes features for pattern recognition and feature matching. Quadruped robots can use these capabilities to recognize specific objects, markers, or patterns in their environment, which can be useful for tasks like localization or interacting with objects.

E. Depth Sensing:
OpenCV can be integrated with depth sensors like LiDAR or depth cameras to create 3D point clouds or depth maps. This information is invaluable for understanding the robot's surroundings and detecting variations in terrain height.

F. Simultaneous Localization and Mapping (SLAM): OpenCV can be employed to implement SLAM algorithms, which help the robot create maps of its environment while simultaneously determining its own position within that map. This is crucial for autonomous navigation.

G. Face and Object Recognition:
OpenCV's facial recognition capabilities can be used to identify individuals or recognize specific objects, which can be important in human-robot interaction scenarios.

H. Human Gesture Recognition:
OpenCV can be utilized to recognize and interpret human gestures or body movements, allowing the robot to respond to user commands or gestures effectively.

I. Real-Time Image Processing:
OpenCV's real-time image processing capabilities can be used to perform tasks such as tracking lines on the floor, following predefined paths, or maintaining balance in challenging terrain.

J. Camera Calibration:
OpenCV provides tools for camera calibration, which is crucial for ensuring accurate perception and measurement within the robot's visual field.

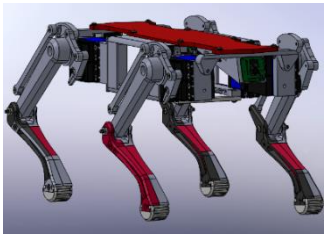

Fig 2 :Design of quadruped robot in solid works

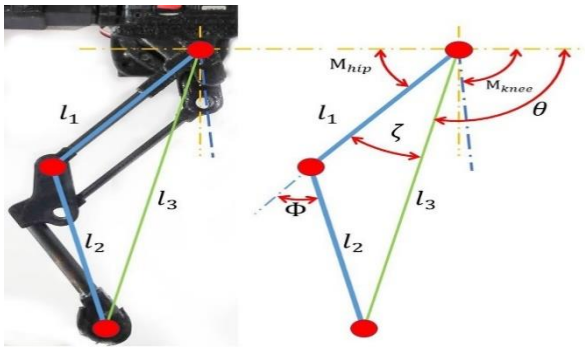

Fig 3: Use of inverse kinematics

NODE-RED is a user-friendly software designed to streamline the development of IoT (Internet of Things) applications and automation processes. It employs an intuitive, visual approach, allowing users to effortlessly connect various devices and services through a drag-and-drop interface. This approach makes it accessible and comprehensible, even for individuals who aren't proficient in programming. With Node-RED, users can seamlessly integrate sensors, devices, and online services to create personalized workflows. Think of it as assembling a digital jigsaw puzzle – you select the pieces and link them together to achieve your desired outcomes. This software excels in diverse tasks, empowering users to automate processes, gather data, and manage smart devices without the need for extensive coding. As such, it serves as a valuable tool in the realm of automation and IoT projects.

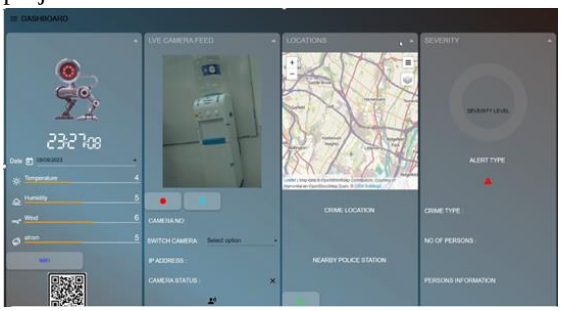

Fig 4: Node red dashboard

Servo motors and drivers play a vital role in the operation and control of quadruped robots.

Leg Movement and Actuation:
Servo motors are commonly used to control the movement of the robot's legs. Each leg typically comprises multiple servo motors responsible for joint movements, including bending, extending, and rotating. The precise control offered by servo motors

allows for coordinated and smooth leg movements, essential for stable and efficient locomotion.

Gait Control:
Quadruped robots employ different walking gaits for various tasks and terrains. Servo motors and drivers are crucial in orchestrating these gaits, as they control the timing, speed, and coordination of leg movements. This results in efficient and adaptable locomotion, making the robot capable of navigating diverse environments.

Balance and Stability:
Servo motors are employed to maintain the robot's balance and stability during movement. They continuously make real-time adjustments to the robot's posture, ensuring it remains upright and prevents falls or mishaps. This is particularly important in applications where the robot needs to traverse uneven or challenging terrains.

RASPBERRPI CAMERA

The camera allows the robot to identify obstacles, barriers, or hazards in its path. It can use this information to plan safe routes and avoid collisions. To recognize specific objects or patterns. This is particularly useful in scenarios where the robot needs to interact with or manipulate objects in its surroundings. The camera can contribute to the robot's navigation capabilities by capturing images that help create maps of its environment. These maps can be used for localization and path planning.

CONCLUSION

Our comprehensive study focusing on the use of a quadruped robot to assist the elderly population has provided a wealth of insights, unveiling both the positive aspects and areas for further refinement. The following points offer a more detailed discussion of the findings:

ADVANTAGES

The adoption of quadruped robots for elderly assistance offers several advantages:
Enhanced Mobility: Quadruped robots can navigate a wide range of environments, including uneven surfaces and tight spaces, enabling elderly users to access places that might otherwise be challenging. Fall Prevention: With their advanced sensors and agility, quadruped robots can swiftly respond to instability and prevent falls, reducing the risk of injuries. 24/7 Support: These robots can provide continuous assistance and companionship, alleviating the need for constant human supervision and care. Customization: Quadruped robots can be tailored to individual needs, offering personalized assistance based on user preferences and requirements. Physical and Mental Stimulation: Interacting with a robotic companion can provide mental stimulation and cognitive engagement, potentially slowing down cognitive decline in elderly individuals. Relief for Caregivers: Quadruped robots can ease the workload of caregivers by handling routine tasks and offering respite, allowing caregivers to focus on more complex aspects of care.

Data Collection: These robots can gather data on user behaviour, health metrics, and living conditions, providing valuable insights for healthcare professionals and family members.

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