

DESIGN AND IMPLEMENTATION OF 17 DOF HUMANOID ROBOT TO PERFORM VARIOUS HUMAN MOVEMENTS AND SURVEILLANCE

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ABSTRACT

The "Design and Implementation of a 17 DOF Humanoid Robot for Human Movements and Surveillance" project introduces a versatile humanoid robot that combines both entertainment and security functionalities. This innovative robot is equipped with 17 Degrees of Freedom (DOF), providing it with the flexibility to replicate various human movements and serve as a surveillance tool. The robot's hardware components include servo motors, a custom robot frame, an Arduino microcontroller, NodeMCU, and an ESP32cam module for surveillance capabilities. The ESP32cam allows for real-time video streaming and surveillance. It's designed to enhance security and can be remotely controlled to assist in providing visual feedback through live video feeds. The robot's additional function is to illuminate its surroundings by activating a flashlight, offering assistance in low-light situations. In the realm of human-like movements, the robot is capable of replicating a wide array of actions such as walking, waving, and more. This feature provides an entertaining element and highlights the robot's potential in interactive settings. Moreover, the inclusion of a Passive Infrared (PIR) sensor allows the robot to detect human presence and movement effectively. It can respond to human activity by transmitting alerts, making it suitable for surveillance in homes or offices, or to assist in various security-related applications. The "Design and Implementation of a 17 DOF Humanoid Robot for Human Movements and Surveillance" project merges the realms of robotics and security. By offering entertainment through human-like movements and enhancing security through surveillance capabilities, this project showcases the potential of humanoid robots to serve dual roles in various contexts. As technology advances, these robots could play a significant role in surveillance, entertainment, and assistance in both domestic and industrial settings.

INTRODUCTION

Robotics is a multidisciplinary field at the intersection of computer science, engineering, and mathematics, focusing on the design, construction, operation, and use of robots. Robots are automated machines that can perform tasks autonomously or semi-autonomously, often with some level of artificial intelligence. At its core, robotics encompasses intricate mechanical design, where engineers meticulously craft the physical architecture and mechanisms that empower robots to navigate their surroundings and manipulate objects with precision and finesse. This involves delving into the intricacies of kinematics, which governs the motion of robotic limbs, as well as dynamics, which elucidates the forces and torques exerted during movement. Furthermore, an understanding of materials science is indispensable for selecting the optimal materials to ensure durability, flexibility, and efficiency in robot construction.

Moreover, the electronic circuitry and sensor arrays embedded within robots serve as their sensory organs, enabling them to perceive and interact with the environment. From high-resolution cameras and ultrasonic sensors to sophisticated radar systems and gyroscopes, these sensory inputs provide robots with invaluable data to navigate complex terrains, detect

obstacles, and identify objects of interest.

Programming serves as the linchpin of robotic functionality, endowing robots with the intelligence and autonomy to execute predefined tasks with precision and efficiency. Whether utilizing traditional programming languages like C/C++ or harnessing the power of specialized robotics frameworks such as ROS (Robot Operating System), programmers craft algorithms that dictate every facet of a robot's behavior, from simple movements to complex decision-making processes.

OBJECTIVE OF THE PROJECT

Objective for stage-1: The primary objective of this project is to develop the 17 DOF humanoid Robot with servo motors and PCA controller that performs basic features like walking, exercise.

Objective of stage-2: The objective of stage 2 is to develop the 17 DOF humanoid robot with ESP32cam to enhance security by providing real-time monitoring of an area and to transmit real-time video footage

LITERATURE SURVEY

A literature survey on the design and implementation of 17 DOF humanoid robots would involve reviewing academic papers, conference proceedings, and relevant publications. Look for studies on mechanical design, control algorithms, sensor integration, and real-world applications of such robots. Consider sources from robotics conferences, journals, and reputable research institutions to gather insights into the state-of-the-art techniques, challenges, and advancements in this field.

Investigate how researchers have tackled challenges related to balance, agility, and coordination in these robots. Additionally, examine studies that showcase applications in areas such as human-robot interaction, healthcare, or industry. Summarize key findings and identify emerging trends to gain a comprehensive understanding of the current landscape in 17 DOF humanoid robot development.

ASIMO (Advanced Step in Innovative Mobility) is one of the greatest achievements by HONDA in the field of Humanoid robots. Honda started the development of this robot in the year 1980 and launched ASIMO in 2000. The name was chosen in honor of Isaac Asimov. The evolution of the robot from the beginning to till date can be seen in the figure. ASIMO has a height of 130cm and weighs about 54kg. It can recognize moving objects, surrounding environment, sounds, and faces. It can also understand the gestures and postures portrayed by others. The latest model of this robot achieved the ability to climb stairs and also to run which was a critical task of humanoid research. The recent advancements in the latest model includes the ability to walk, run, run backward, hop on single or two legs continuously. With the implementation of AI, it is capable of having a coordination between visual and auditory sensors to simultaneously recognize a face and voice of a person. NAO was launched in the year 2004 by Aldebaran robotics, a French-based company under the Softbank group. This robot was initially developed for soccer competition at RoboCup Standard Platform League (SPL). NAO is widely used for research and educational purpose in educational institutions and research laboratories all over the globe. NAO was used to teach English to the students of age 3 and 4 whose native language is Dutch Different versions of NAO come with 14, 21, and 25 Degrees of Freedom with a height of 22.6 in and 10.8-inch width. NAO is integrated with a wide range of sensors for its perfect balance and positioning within space. The advancements in the latest model includes the optimization of its hardware with stronger metal gears in joints, soles which help to dampen the noise and friction of footsteps. It also comes with the advanced features of shape and face detection with optimized algorithms with improved distance estimation. More powerful battery system is integrated which is 30% more efficient than the previous generation model. It is packed with a Linux based operating system platform which helps the researches to

understand and further develop the robot. Sophia is a social humanoid robot developed by Hanson Robotics. It was created in the year 2016 and integrated with advanced AI algorithms to behave more like humans. She is capable of displaying more than 60 facial expressions and can make active conversations on predefined topics. In October 2017, Sophia became a Saudi Arabian citizen, the first robot to receive citizenship. It has advanced features to follow faces, maintain eye contact, recognize and capable to process speech and have conversations using natural language processing (NLP). It has AI algorithms that help it to learn constantly to improve the efficiency of its conversations. In all the humanoid robots, Sophia had become a public figure addressing various competitions and news channels like CNBC, Forbes, the New York Times, etc

PROPOSED SYSTEM

A humanoid robot with 17 degrees of freedom (DOF) would likely have a design that allows for a wide range of movements, mimicking human-like actions. Here's a breakdown of key components. Such a system enables the robot to perform complex actions, including walking, grasping objects, and interacting with the environment in a more human-like manner. The control and coordination of these DOFs would involve sophisticated algorithms to ensure smooth and precise movements.

BLOCK DIAGRAM:

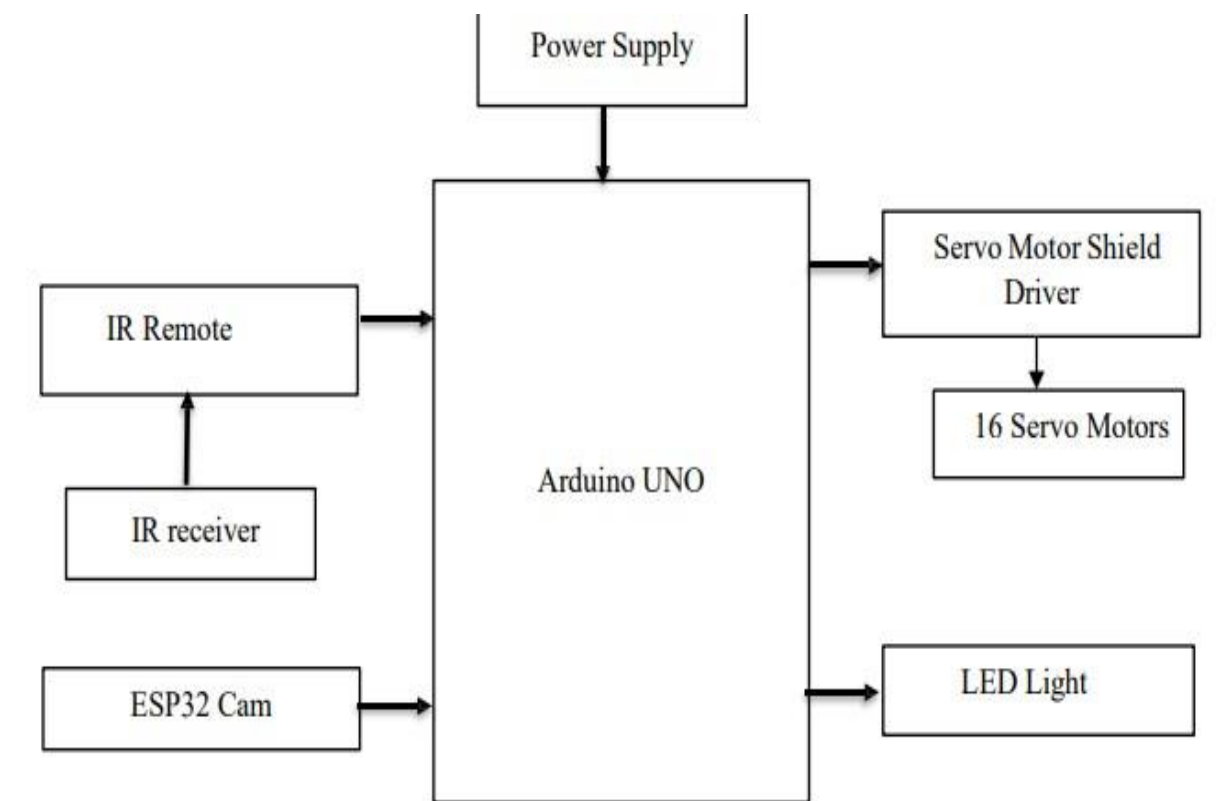


Figure.1 Block Diagram

RESULTS

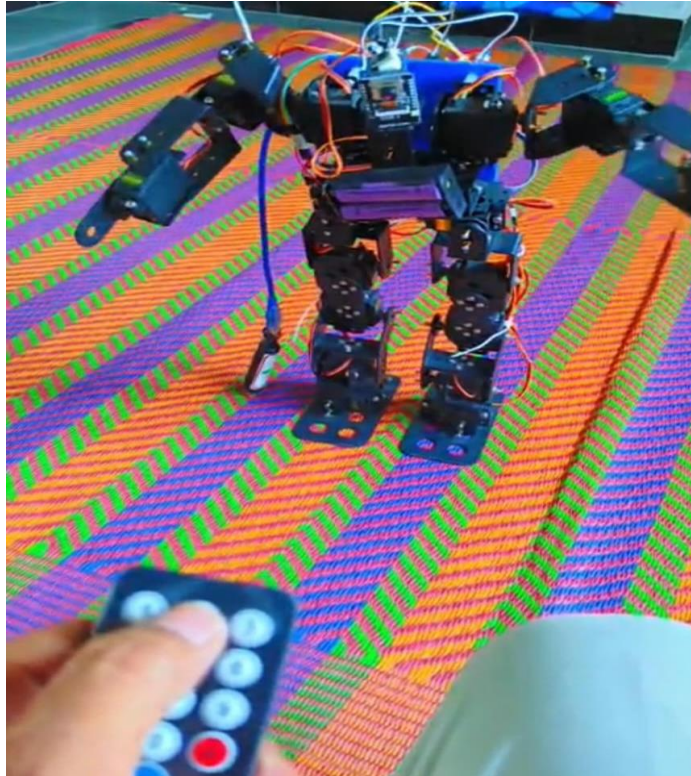


Figure.1 Controlling Robot with IR Remote

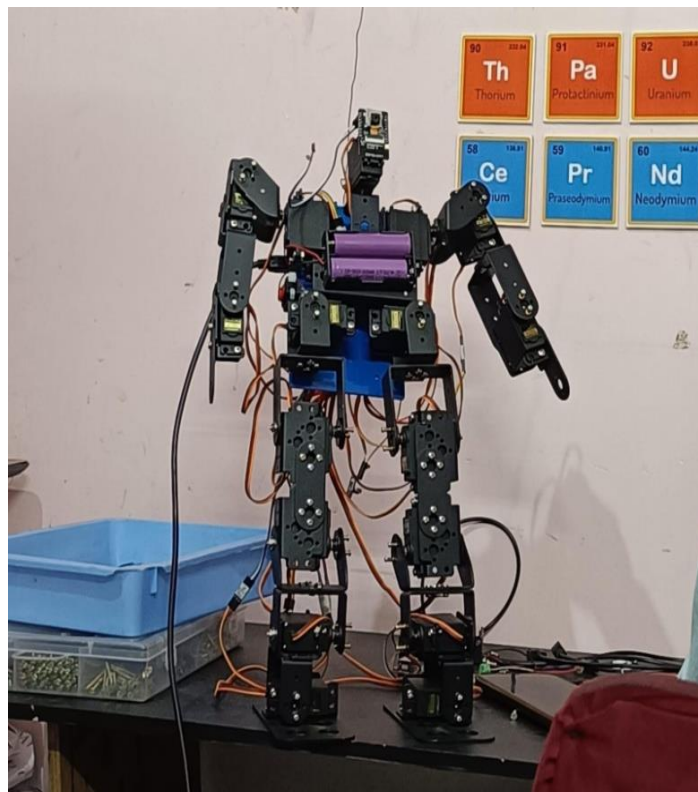


Figure.2 Robot with ESP32 CAM

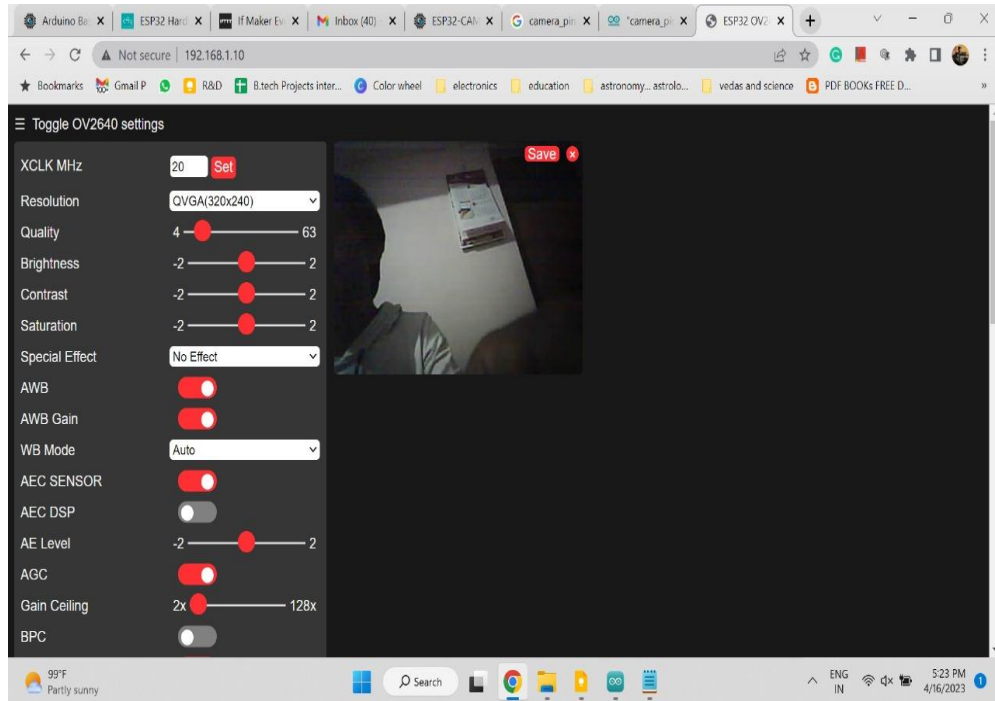


Figure.3 Video footage in the mobile.

ADVANTAGES

- Versatile Humanoid Robot
- Security
- Increased Flexibility
- Enhanced stability
- Complex task execution
- Human-Like Movements

APPLICATIONS

- Research and Development
- Healthcare
- Education
- Entertainment
- Space Exploration
- Service and Hospitality

CONCLUSION

In conclusion, the design and implementation of a 17 Degree of Freedom (DOF) humanoid robot for mimicking various human movements represent a significant achievement in the field of robotics. The intricate combination of mechanical, electronic, and programming elements has resulted in a versatile and dynamic robotic system capable of emulating a wide range of human motions. The successful integration of sensors, actuators, and control algorithms has enabled the humanoid robot to exhibit fluid and lifelike movements, enhancing its ability to interact with the environment in a manner that closely resembles human actions. The comprehensive design process involved careful consideration of biomechanics, kinematics, and ergonomics, ensuring that the robot's motions are both natural and efficient.

Furthermore, the implementation of advanced control strategies, such as inverse kinematics and feedback mechanisms, has played a pivotal role in achieving precise and coordinated movements. These control techniques contribute to the robot's adaptability in responding to

external stimuli, making it well-suited for a variety of applications, including assistance in healthcare, entertainment, and research.

FUTURE SCOPE

The design and successful implementation of a 17 Degree of Freedom (DOF) humanoid robot capable of replicating diverse human movements mark a significant achievement in robotics. As we look towards the future, there are exciting prospects for further advancements in this field. The next steps involve exploring avenues such as enhanced sensor integration for improved environmental perception, the integration of artificial intelligence and machine learning to enable adaptive learning, and a focus on human-robot collaboration to ensure safe and productive interactions. Additionally, miniaturization and portability, along with a shift towards real-world applications in healthcare, disaster response, and hazardous environments, will be pivotal for expanding the practical utility of humanoid robots. Prioritizing energy efficiency, autonomy, and user interface enhancements will further contribute to the seamless integration of these robots into our daily lives. The future holds immense potential for refining and expanding upon the capabilities of humanoid robots, fostering a new era of innovation and collaboration at the intersection of robotics and human interaction.

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