IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 5, May 2022

An Analysis of Humanoid Robot Architecture, Uses, and the Future of the Industry

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ABSTRACT: ***Humanoid robots have captivated humans since the introduction of robotics. They are the physical manifestation of artificial intelligence. While human-like robots work independently in complicated human-populated worlds in science fiction, humanoid robots' capabilities are rather restricted in reality. AUTHOR will cover several exoskeleton technologies and also their significance in rehabilitation in this study. Based on several studies, this objective in rehabilitation seems to be promising. This study emphasizes the necessity for robots to exhibit human-like characteristics, as well as the specialized application of robotics. The last chapter of the magazine discusses human-humanoid control, as well as other technologies such as grabbing force. It also demonstrates the tendency in robotics research toward the construction of humanoid robots employing cogitative systems using artificial intelligence. The magazine concludes with a list of humanoid robot advances to help readers comprehend the depth of growth in the area of humanoid robots and the relevance of humanoid robots in the current and future eras.***

KEYWORDS: ***Body, Humanoid robot, Robot Architecture, Robotic Applications.***

1. INTRODUCTION

A humanoid robot is a programmed machine that can mimic both human activities and appearance. Humanoid research allows scientists to learn more about human form and behavior. Humanoids are currently accessible in a variety of forms, sizes, and capacities depending on their application area, after years of intensive research in this domain. The humanoid has one torso, two legs, two hands, and a head. However, in other applications, partial body portions are intended to do specialized jobs or research, like merely the bottom section of the body to conduct a study on the robot's locomotion [1]. Human-Robot Interaction (HRI) is an exciting yet hard area of study that spans the disciplines of psychology, cognitive science, social sciences, artificial intelligence, computer science, robotics, engineering, and human-computer interaction.

When compared to other robots, they have a more sophisticated structure and design, thus more attention is being focused on this area to enhance the control and design characteristics of humanoids. The humanoid robot can simulate human expressions with its eyes and lips, either via mechanics or a display screen. Aside from studies in this arena, humanoids are being created for usage as assistance robots as well as unclean and risky activities. Humanoid robot applications are widely established in the fields of health care, defense, education, and entertainment. Humanoid robots are also being used in the education sector to help teachers instruct pupils. This motivates students to understand the material more practically and improves their learning ability [2].

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Humanoid robots, by definition, are programmable machines that can mimic humanoid behaviors and physical characteristics. Two of a humanoid robot's primary roles are sensory data collection and manual labor (e.g., lifting, carrying, and repositioning things). Humanoid robots have been studied and developed for years, and currently come in a wide range of sizes, weights, and heights depending on the task at hand [3]. Humanoid robots mimic human behavior, to the extent that they can show emotion via facial expressions like blinking and squinting. They have hands and legs like humans, allowing them to do a variety of jobs, and they can pick up new skills with the help of sensors and technology like artificial intelligence. To sum up, a humanoid robot is a robot that has sensors to sense its surroundings and effectors to do some kind of action.

Physically, humanoid robots are quite close to humans. The goal of humanoid robotics is not to replicate the human form, but rather to build a tool that can facilitate human activity. Humanoids are anticipated to live and function harmoniously with humans in settings designed for them. These robots need to communicate with people because people have social lives. A more accurate understanding of Humanoids may be gained via the use of human body simulation software [4]. Using springs and the oscillating motion of pendulums, a simplistic method of building Humanoids is possible. This method results in robots with straightforward control systems, few moving parts, low power requirements, and low manufacturing costs. Although these robots are capable of walking locomotion, their bizarre construction and design limit their usefulness. Nonetheless, studies are being conducted on creating robots that are very human in appearance and behavior[5].

2. DISCUSSION

Humanoid robot technology has exploded in recent years because of an ever-increasing demand in domains ranging from the battlefield to something as basic as the household. There is more than enough justification for the need for humanoid robots for the simple reason that having a computer among us can assist us in ways that an anticipated person couldn't. Humanoid robots have almost reached the point where they can look, talk, and walk just like people. In a nutshell, they are copies of people, just as the name implies. As the human population ages and birthrates decrease, the longevity of humanoid robots continues to rise [6]. Humanoid robots have emerged as a viable alternative to human laborers in light of the growing need for such workers, and as a result, advances in humanoid robot technology have been made over the last several years and are expected to continue. A humanoid robot should have the fewest defects in its characteristics when compared to a real human being. Some of the most important motions for a humanoid robot to have is the ability to mimic the motion of a human hand.

2.1.Applications of Humanoid Robots in Various Fields:

Humanoid robot technology steadily improves over time. Humanoid robots had hitherto only seen employment in domestic and recreational settings. As technology evolves, however, humanoid robots are increasingly useful in settings as diverse as healthcare, athletics, space exploration, building and manufacturing, and classroom instruction. The following is a discussion of the many applications that have been found for humanoid robots across a range of environments.

2.1.1. Humanoids Robots in Home:

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As early as the 1990s, people could buy robots designed specifically for use in the home. The Electrolux RC70 robot vacuum released in 2001 is an early example of this. Presently, they are used to assist humans in a wide variety of home tasks. This study delves into three of the most prominent domestic robot uses. These days, everyone is so engrossed with their careers that they seldom come home, leaving their houses uninhabited. Since this is the case, they should get a robot to watch over the home while they're gone. So, Japanese scientists designed a mechanism that lets people command their humanoid robots from afar through smartphones or the web [7].

2.1.2. Humanoids Robots in Health care :

There are now many other kinds of robots available for use in the medical field, all of which owe a debt to the original concept of using robots for surgical purposes[8]. Identifies various potential avenues for further study of robots' use in healthcare settings. Examples include surgical robots, robots for laparoscopy and tele-rounding[9], robots to aid in rehabilitation [10], robots to aid caregivers and patients, and robotic applications in dentistry and bio-prosthetics [11]. With further technological development, the potential for even more medical robot uses expands.

Humanoid robots possess human-like characteristics, such as the ability to walk like a biped and converse with others in the same manner that humans do. A humanoid robot may be put to work as a service robot at a hospital, assisting nurses and patients in their day-to-day duties while also facilitating communication between persons in distant locations and those located in the hospital[12]. A common developmental disease is an autism. Many children on the autism spectrum struggle with basic skills such as communication, socialization, and even creative thought. Robots have the potential to serve as a helpful therapeutic aid in this context. Two distinct humanoid robots are currently under development with the express purpose of aiding autistic youngsters. IROMEC and Kinesics and Synchronization in Personal Assistant Robotics (KASPAR) are the names of our two humanoid robots. A mobile robotic platform, IROMEC has a cartoonish figure as its user interface. To put it simply, KASPAR is a little humanoid robot. Children with autism benefit from both types of humanoid robots because they encourage social engagement and the development of language abilities [13].

2.1.3. Humanoids Robots in Entertainment:

Already commonplace in settings like amusement parks and POS kiosks, the film industry is also rapidly expanding its usage of robot extras. A robot equipped with a camera may repeat the same task again and over, such as filming a scene many times or controlling the finely-tuned, repetitive motions required for special effects. Humanoid robots are also gaining traction in the entertainment industry. Humanoid robots are excellent communicators because they can mimic human facial expressions, hand gestures, as well as other body languages. As a result, several humanoid robots are being created for use in the entertainment industry. The dynamic and silky dancing of SDR-4X's performance is the work of a program named SDR Motion Creator. SDR-4X's primary abilities are dance and A Cappella Chorus. Further, SDR4X could recognize users' identities and converse with them through a synthetic voice after learning their names and faces [14].

2.1.4. Humanoid Robots in Sports:

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For robotic sports tournaments, robot machines square off against one another, with the rules and equipment usually modeled after those of real-world sports. Sport is a vital part of the human experience. This is why the idea of a humanoid robot competing in sports is being investigated. In the RoboCup soccer tournament, a humanoid robot's ability to move rapidly and with a high degree of flexibility is a major factor. One of the biggest obstacles to doing so is the inherent risk of instability. You may do this by walking at an incline with your step length adjusted appropriately. For the robot to respond appropriately to different body conditions, a fuzzy algorithm is used to determine the optimal joint angle. With this in mind, the humanoid robot EFuRIO was created. The current (third generation) model can stand upright, move, turn, and kick [15].

2.1.5. Humanoid Robots in Education:

Teaching youngsters on the autism spectrum is greatly aided by the use of humanoid robots. In particular, 'learning by teaching' or caring pedagogical approaches have shown that humanizing the learning experience leads to more student engagement and responsibility. With capacities like seeing humans and their surroundings and reasoning and rationalizing human circumstances and emotions, robots are quickly becoming integral components of the educational ecology. Importantly, these robots also have a physical presence and the ability to engage in multimodal interaction. With their humanlike appearance, humanoid robots open the door to more natural and intuitive interactions between humans and machines by mimicking human body language and social signaling skills[16]. Aside from the uses mentioned above, other researchers have begun to focus on teaching. Robotics, a Korean robot maker, created a humanoid robot named Bioloid. Bioloid is a hobbyist and educational robot kit designed to serve as a teaching aid and give students an interactive learning environment [17].

Although this discipline has benefited from decades of study and progress, there are still many problems that need to be solved. The development of a physical structure and software program to make humanoid robots walk effectively will be the primary challenge in humanoid robotics. These robots can only walk at a very sluggish pace and have trouble adjusting to novel environments. With the use of modern simulation software, this problem may be overcome by creating a digital model and using artificial intelligence (AI) methods like Reinforcement learning to enhance the effectiveness of gait over time [18]. The humanoid may learn the pattern of walking from exposure over time using a learning model called reinforcement learning, which has biological backing. Algorithms in reinforcement learning tend to teach the humanoid robot to understand and grasp the best appropriate sequences for successful travel in much the same way that children learn to walk by understanding their failures.

3. CONCLUSION

To build a platform with sufficient capabilities, humanoid hardware design needs substantial knowledge and expertise in mechatronics. The combination of Artificial Intelligence and Robotics is a potent one that can either overcome existing obstacles or develop new ways to increase the effectiveness of robot performance. Developers from all over the world are coming up with the finest feasible algorithms to solve problems and enhance the performance of humanoids as a result of the growth of open source societies in the research sector. Still more sophisticated research is

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being done to tackle some of the challenges, the primary focus of which is to increase the human-computer interface, the capability to travel across any sort of terrain, and the cost-effectiveness of these solutions. It is anticipated that humanoid robots of the future will have enhanced capabilities for perception. To make sense of the ambiguities that are presented by the sensory information, more sophisticated approaches will be created. Because of the ongoing advancements in computer vision and voice recognition systems, humanoid robots will soon be able to converse more effectively with humans, navigate a wider variety of terrain, and do so at a lower cost.

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