



## A Review on the Humanoid Robot and its Impact

<sup>1</sup>Mukhtar Ibrahim Bello, <sup>2</sup>Lawal Mukhtar Ibrahim, <sup>3</sup>Musa Dan-azumi Mohammed, <sup>4</sup>Umar Farouk Musa, <sup>5</sup>Shariff Abdulhamid Mahmoud, <sup>6</sup>Bello Abubakar Imam, <sup>7</sup>Usman Bukar Usman, <sup>8</sup>Mustapha Aliyu Yusuf, <sup>9</sup>Deepak Dasaratha Rao, <sup>10</sup>Muhammad Ahmad Baballe\*

<sup>1,5,6</sup>Department of Computer Science, School of Technology, Kano State Polytechnic, Nigeria.

<sup>2</sup>Department of Electrical and Electronics Engineering, Altinbas University Istanbul, Turkey.

<sup>3</sup>Kano State Institute for Information Technology, Kura, Nigeria.

<sup>4</sup>Department of Architecture Technology, School of Environment Studies Gwarzo, Kano State Polytechnic, Nigeria.

<sup>7</sup>Department of Computer Science, Mai Idris Aloomo Polytechnic Geidam Yobe State, Nigeria.

<sup>8</sup>Department of Civil Engineering Technology, School of Technology, Kano State Polytechnic, Nigeria.

<sup>9</sup>Independent Researcher, USA. ORCID: 0000-0001-5959-3136

<sup>10</sup>Department of Mechatronics Engineering, Nigerian Defence Academy (NDA), Kaduna, Nigeria.

DOI: 10.5281/zenodo.14039558

Submission Date: 11 Oct. 2024 | Published Date: 05 Nov. 2024

\*Corresponding author: **Muhammad Ahmad Baballe**

Department of Mechatronics Engineering, Nigerian Defence Academy (NDA), Kaduna, Nigeria.

ORCID: 0000-0001-9441-7023

### Abstract

Humanoids are bipedal, general-purpose robots that are based on the human form factor and are intended to assist humans in order to increase productivity. They can learn and carry out a wide range of tasks, including loading or unloading boxes, transporting containers, and gripping objects. These robots can move and interact to replicate human dexterity and even navigate themselves thanks to their advanced actuators, sensors, on-robot computing, and software. To prepare them for the unpredictability of real-world situations, robots are trained to perform a variety of movements and reactions in simulated environments.

**Keywords:** Computer Vision, Humanoid Robots, Artificial Intelligence, Deep Learning, Machine Learning.

## I. INTRODUCTION

In the rapidly developing field of robotics, mobile robots have become increasingly popular in a variety of contexts and are used for a range of tasks that primarily require human involvement and collaboration [4-6].



Fig.1: A model of the Humanoid Robot

## II. LITERATURE REVIEW

This paper presents the design of a novel humanoid robot head. This humanoid head is based on biological likeness to the human being, so that the humanoid robot could interact agreeably with people in various everyday tasks. An innovative contribution with regard to computer vision systems implemented in former humanoids lies in the proposed humanoid head's configuration, equipped with an omnidirectional stereo vision system. Furthermore, this design integrates human-like cervical vertebrae in order to support the head. They should subsequently serve as a physical interface to the pitch and roll movements of the humanoid robot's neck. Likewise, other sensors are added to improve the robot's performance during bipedal locomotion, i.e., inertial sensors [1]. Computer vision is an artificial intelligence field that is widely used in many fields today. Smart glasses and humanoid robots, on the other hand, are new technologies with a lot of investment, but their development is progressing very quickly and impressively. Computer vision and augmented reality constitute the working principles of smart glasses. On the other hand, the data and technologies to be obtained with smart glasses directly affect the development of humanoid robots. While humanoid robots are on the way to become a big part of our future, computer vision and smart glasses are the main subjects of this article as areas that enable the development of this technology. In this study, the interaction of smart glasses and humanoid robots was examined. The effect and development of computer vision on smart glasses and humanoid robots are explained. In addition, the effect of artificial intelligence and mind-reading investments on humanoid robots in the future is also mentioned [2]. This paper presents the design of an autonomous humanoid robot designed to optimize and enrich customer service in showrooms, e.g., electronic equipment, mobile network operators, and generally in stores with various articles. The proposed humanoid robot design is distinguished by two key components: a sensor-equipped mobile platform with drives and a body featuring a head outfitted with a touch tablet and an RGBD camera. The control system enables autonomous navigation in both known and uncharted environments, with a special focus on diverse, crowded, and cluttered spaces. To enhance its adaptability, this robot is not only fitted with LIDAR sensors but also cliff and ultrasonic sensors. While the interactive ability with humans is an expected functionality, this paper brings forth certain distinct innovations in humanoid robot design for customer service. One of these unique aspects includes the robot's ability to physically alter its configuration, such as rotating its head and adjusting the height of its torso to maintain line-of-sight with the customer. This capability signifies a novel degree of spatial responsiveness that exceeds static interaction. Moreover, the proposed robot is equipped with a user-friendly gesture recognition system, uniquely designed to detect and recognize simple human hand gestures. This attribute paves the way for understanding simple commands such as requests for assistance. Upon recognizing a request, the robot tailors its services by following the person around the showroom, effectively assisting and answering customer queries or displaying requisite information on its screen. This active assistance model, specifically tailored for human interaction, showcases the robot's unique capability to respond proactively and dynamically to human inputs [3]. The focus of this paper is the development of an autonomous humanoid robot designed for these interactive tasks, with a special emphasis on customer service environments such as hotels, stores, and hospitals. The authors of [5] discussed the utilization of robots in healthcare recently. They discovered that a considerable number of robots deployed in hospitals aim at facilitating direct cooperation with patients. The authors of [7] introduced a rudimentary robot equipped with a screen and camera, designed to function as a personal assistant and walk-helper. Subsequent work continued on this robot, with the authors delineating and demonstrating the holonomic system of the robot's mobile base [8]. The authors of paper [9] also exhibited a remotely operated system for the provision of aid. In [10], human-robot collaboration for on-site construction was discussed. A system designed to augment construction productivity and safety by synchronizing robot intelligence with human skills was showcased. It was pointed out that the personal robots introduce numerous challenges, one of which is security. Robots are often stronger and faster than humans, potentially creating hazardous situations. The second challenge, pertinent to this paper, is the communication gap between the robot and the human. Conventionally, a robot designed to assist a human will typically not cooperate with qualified individuals possessing advanced programming knowledge. Consequently, robot communication cannot rely on complex interfaces but must utilize interfaces comparable to natural human interactions. Robots designed to cooperate with humans should be capable of understanding speech or gestures for natural communication. There is also a category of robots known as Attract, Interact, and Mindset (AIM). Their function is to draw attention to products in stores or shopping malls, then present offers and advertisements, or assist in shopping. Many AIM robots have been introduced in recent years [11–15], typically comprising a mobile base, a torso with a touchscreen, and a camera. The simplest models offer touchscreen interactions, while more sophisticated ones incorporate voice recognition. The tallest model enhances visibility but may intimidate some users. A unique model [15] incorporates gesture recognition for natural interaction. However, none offer the comprehensive interaction modalities and height-adjustable design of our proposed autonomous humanoid robot. Gesture recognition systems, which are increasingly leveraging artificial intelligence, have become popular recently. Their reliability has improved due to ongoing advancements in algorithms, programming frameworks, and large datasets necessary for such models. The application of gesture recognition systems has been widely discussed in publications [15–18]. Paper [15] describes a basic system for recognizing gestures, hands, and faces. The authors suggested wide-ranging applications of this system, such as facilitating communication for deaf individuals, enabling children to interact with computers or other devices, detecting lies, or monitoring patients in hospitals. The authors of paper [16] introduced hand gesture recognition systems using 3D depth sensors and reviewed widely-used commercial sensors and datasets. Various gesture recognition systems based on 3D hand modeling, static

hand recognition, and hand trajectory tracking were also described. Similar insights into gesture recognition methods were provided in [16], while [17] presented various applications of gesture recognition systems in the realm of human-computer interaction. Gesture recognition systems have also found an application in robotics. There are environments where a robot may struggle to recognize human speech, such as crowded or noisy places such as shopping malls or factories. Here, robots need alternative communication methods, such as gestures. Given the advancements in image analysis algorithms and portable hardware, robots equipped with various types of cameras could leverage human gesture recognition for interaction. The authors of [19] suggested the use of a gesture recognition system for therapy with children diagnosed with autism spectrum disorders, as these children often struggle with imitating gestures. They proposed therapeutic games involving joint gesture imitation by the robot and children. The authors of [20] designed a non-verbal communication system using gesture recognition for people fluent in sign language. In [21], a real-time gesture recognition system implemented in a dynamic human-robot application was presented. Paper [22] presented a system where the UR5e robot was operated via gestures in collaboration with humans. The authors of [23] proposed a comprehensive system for gesture-based teleoperation, tested in a pick-and-place case study. The application of a gesture recognition system was also reported in [24], where an agricultural robot with a ZED 2 camera was presented. Recent studies such as [25–28] have used the Media Pipe open-source framework [29] for real-time gesture recognition. In contrast to the existing literature, our innovative mobile humanoid robot has been specifically designed to operate effectively in crowded and noisy environments. Equipped with a gesture recognition system, the robot can understand and respond to human gestures, thus facilitating non-verbal communication when voice recognition might be impractical. This is particularly useful in noisy places such as shopping malls or factories.

### **III. THE ADVANTAGES OF THE HUMANOID ROBOTS**

#### **1. Versatility in Tasks:**

The multitude of tasks that humanoid robots can accomplish is one of their main advantages. Their human-like mobility and dexterity enable them to travel and engage in a variety of situations, from intricate industrial processes to domestic tasks.

#### **2. Human Interaction:**

Humanoid robots are designed with a focus on human interaction. They possess features such as facial recognition, speech synthesis, and natural language processing, enabling them to engage in conversations and comprehend human emotions.

#### **3. Assistance to the Elderly and Disabled:**

These robots have the potential to revolutionize the caregiving industry. Humanoid robots can provide companionship to the elderly, assist with daily activities, and even offer physical support to those with mobility challenges.

#### **4. Efficiency in Hazardous Environments:**

Humanoid robots can be deployed in situations deemed dangerous for humans, such as search and rescue missions during natural disasters or handling hazardous materials in industrial settings.

#### **5. Enhanced Learning and Training:**

In fields like medicine and education, humanoid robots can serve as effective tools for training purposes. They can simulate scenarios, allowing learners to practice and refine their skills in a controlled environment [30].

### **IV. SEVERAL SAFETY PRINCIPLES LISTED BELOW MUST BE INCORPORATED INTO THE DESIGN OF HUMANOIDS IN ORDER FOR THEM TO WORK SAFELY AND COOPERATIVELY WITH HUMANS**

1. Conventional functional: safety to guarantee that robot software and hardware are made to function dependably and safely.
2. Robotics safety: to enable emergency and protective stops to prevent accidents.
3. Human-machine collaborative safety: to recognize and respond appropriately to human presence and actions.
4. Sensor safety: to test and validate the accuracy of robot sensors so humanoids can accurately perceive their environment.
5. AI safety: to check that the algorithms that humanoids rely on avoid misinterpretations and don't introduce new risks.

### **V. CONCLUSION**

The technological developments in humanoid robots have been covered in this study. These developments have been reported in many study journals. We have also discussed its effects and the safety precautions that should be implemented throughout design and construction.

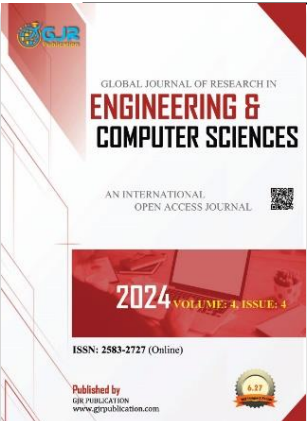
## REFERENCES

1. H., Montes, et al., “Omnidirectional Stereo Vision Head for Humanoid Robots”, *Mobile Robotics*, pp. 909-918, [https://doi.org/10.1142/9789814291279\\_0111](https://doi.org/10.1142/9789814291279_0111), 2009.
2. Ş. UYANIK, “A New Vision for Computer Vision: Smart Glasses with Humanoid Robots”, *Innovative Research in Engineering*, September 2023.
3. T. Lindner, D. Wyrwał, A. Milecki, “An Autonomous Humanoid Robot Designed to Assist a Human with a Gesture Recognition System”, *Electronics* 2023, 12, 2652. <https://doi.org/10.3390/electronics12122652>.
4. H. Ye, S. Sun, R. Law, “A Review of Robotic Applications in Hospitality and Tourism Research”, *Sustainability* 2022, 14, 10827.
5. J. Holland, L. Kingston, C. McCarthy, E. Armstrong, P. Dwyer, F. Merz, M. McConnell, “Service Robots in the Healthcare Sector”, *Robotics* 2021, 10, 47.
6. V. Vasco, A. Antunes, V. Tikhonoff, U. Pattacini, L. Natale, V. Gower, M. Maggiali, “HR1 Robot: An Assistant for Healthcare Applications”, *Front. Robot. AI* 2022, 9, 813843.
7. J. Palacín, E. Clotet, D. Martínez, D. Martínez, J. Moreno, “Extending the Application of an Assistant Personal Robot as a Walk-Helper Tool”, *Robotics* 2019, 8, 27.
8. J. Moreno, E. Clotet, R. Lupiañez, M. Tresanchez, D. Martínez, T. Pallejà, J. Casanovas, J. Palacín, “Design, Implementation and Validation of the Three-Wheel Holonomic Motion System of the Assistant Personal Robot (APR)”, *Sensors* 2016, 16, 1658.
9. E. Clotet, D. Martínez, J. Moreno, M. Tresanchez, J. Palacín, “Assistant Personal Robot (APR): Conception and Application of a Tele-Operated Assisted Living Robot”, *Sensors* 2016, 16, 610.
10. M. Zhang, R. Xu, H. Wu, J. Pan, X. Luo, “Human–Robot Collaboration for on-Site Construction”, *Autom. Constr.* 2023, 150, 104812.
11. Smart Delivery Robot-Pudu Robotics. Available online: <https://www.pudurobotics.com/> (accessed on 2 April 2023).
12. Cheetah Mobile—Make the World Smarter. Available online: <https://www.cmcm.com/en/> (accessed on 2 April 2023).
13. E. Schulenburg, Elkmann, N.; Fritzsche, M.; Girstl, A.; Stiene, S.; Teutsch, C. LiSA: “A Robot Assistant for Life Sciences”, In *Proceedings of the KI 2007: Advances in Artificial Intelligence*, Osnabrück, Germany, 10–13 September 2007; Hertzberg, J., Beetz, M., Englert, R., Eds.; Springer: Berlin/Heidelberg, Germany, 2007; pp. 502–505.
14. ARI—The Social and Collaborative Robot. Available online: <https://pal-robotics.com/robots/ari/> (accessed on 2 April 2023).
15. Intelligent Telepresence Healthcare Robot—SIFROBOT-1. Available online: <https://sifsof.com/product/intelligent-telepresence-robot-sifrobot-1-1> (accessed on 2 April 2023).
16. S. Mitra, T. Acharya, “Gesture Recognition: A Survey”, *IEEE Trans. Syst. Man Cybern. Part C Appl. Rev.* 2007, 37, 311–324.
17. H. Cheng, L. Yang, Z. Liu, “Survey on 3D Hand Gesture Recognition”, *IEEE Trans. Circuits Syst. Video Technol.* 2016, 26, 1659–1673.
18. J. Suarez, R.R. Murphy, “Hand Gesture Recognition with Depth Images: A Review”, In *Proceedings of the 2012 IEEE RO-MAN: The 21st IEEE International Symposium on Robot and Human Interactive Communication*, Paris, France, 9–13 September 2012; pp. 411–417.
19. S.S. Rautaray, A. Agrawal, “Vision Based Hand Gesture Recognition for Human Computer Interaction: A Survey” *Artif. Intell. Rev.* 2015, 43, 1–54.
20. A.S. Ivani, Giubergia, A.; Santos, L.; Geminiani, A.; Annunziata, S.; Caglio, A.; Olivieri, I.; Pedrocchi, A. “A Gesture Recognition Algorithm in a Robot Therapy for ASD Children. Biomed”, *Signal Process. Control* 2022, 74, 103512.
21. B. Illuri, V.B. Sadu, Sathish, E.; Valavala, M.; Roy, T.L.D.; Srilakshmi, G, “A Humanoid Robot for Hand-Sign Recognition in Human-Robot Interaction (HRI)”, In *Proceedings of the 2022 Second International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT)*, Bhilai, India, 21–22 April 2022; pp. 1–5.
22. C. Scoccia, G. Menchi, Ciccarelli, M.; Forlini, M.; Papetti, A. “Adaptive Real-Time Gesture Recognition in a Dynamic Scenario for Human-Robot Collaborative Applications”, *Mech. Mach. Sci.* 2022, 122 MMS, 637–644.
23. M. Mustafin, E. Chebotareva, Li, H.; Martínez-García, E.A.; Magid, E. “Features of Interaction Between a Human and a Gestures-Controlled Collaborative Robot in an Assembly Task”, *Pilot Experiments*. In *Proceedings of the International Conference on Artificial Life and Robotics (ICAROB2023)*, Oita, Japan; 2023; pp. 158–162.
24. W. Zhang, Cheng, H.; Zhao, L.; Hao, L.; Tao, M.; Xiang, C. “A Gesture-Based Teleoperation System for Compliant Robot Motion”, *Appl. Sci.* 2019, 9, 5290.
25. V. Moysiadis, Katikaridis, D.; Benos, L.; Busato, P.; Anagnostis, A.; Kateris, D.; Pearson, S.; Bochtis, D. “An Integrated Real-Time Hand Gesture Recognition Framework for Human–Robot Interaction in Agriculture”, *Appl. Sci.* 2022, 12, 8160.

26. R. Damindarov, Fam, C.A.; Bobby, R.A.; Fahim, M.; Klimchik, A.; Matsumaru, T. "A Depth Camera-Based System to Enable Touch-Less Interaction Using Hand Gestures", In Proceedings of the 2021 International Conference "Nonlinearity, Information and Robotics" (NIR), Innopolis, Russia, 26–29 August 2021; pp. 1–7.
27. R.K. Veluri, Sree, S.R.; Vanathi, A.; Aparna, G.; Vaidya, S.P. "Hand Gesture Mapping Using MediaPipe Algorithm", In Proceedings of the Third International Conference on Communication, Computing and Electronics Systems, Coimbatore, India, 28–29 October 2021; Bindhu, V., Tavares, J.M.R.S., Du, K.-L., Eds.; Springer: Singapore, 2022; pp. 597–614.
28. B. J. Boruah, A.K. Talukdar, K.K. Sarma. "Development of a Learning-Aid Tool Using Hand Gesture Based Human Computer Interaction System", In Proceedings of the 2021 Advanced Communication Technologies and Signal Processing (ACTS), Virtual, 15–17 December 2021; pp. 1–5.
29. C. Lugaresi, Tang, J.; Nash, H.; McClanahan, C.; Uboweja, E.; Hays, M.; Zhang, F.; Chang, C.-L.; Yong, M.G.; Lee, J.; et al. MediaPipe: A Framework for Building Perception Pipelines. arXiv 2019, arXiv:1906.08172.
30. <https://www.linkedin.com/pulse/pros-cons-humanoid-robots-the-team-robotics>.
31. [https://www.nvidia.com/en-us/glossary/humanoid-robot/?srsltid=AfmBOoqm\\_C4iuGZY8Lz0zcZqHPxSJ9ypQuWE7P5R9T7FI-6LNJ5zHtZS](https://www.nvidia.com/en-us/glossary/humanoid-robot/?srsltid=AfmBOoqm_C4iuGZY8Lz0zcZqHPxSJ9ypQuWE7P5R9T7FI-6LNJ5zHtZS)

#### CITATION

Mukhtar I.B., Lawal M.I., Musa DA M., Umar F. M., Shariff A. M., Bello A.I., Usman B.U., Mustapha A.Y., Deepak D.R., & Muhammad A. B. (2024). A Review on the Humanoid Robot and its Impact. In Global Journal of Research in Engineering & Computer Sciences (Vol. 4, Number 6, pp. 16–20).  
<https://doi.org/10.5281/zenodo.14039558>



**Global Journal of Research in Engineering & Computer Sciences**

**Assets of Publishing with Us**

- Immediate, unrestricted online access
- Peer Review Process
- Author's Retain Copyright
- DOI for all articles

ISSN: 2583-2727 (Online)

Published by GJR PUBLICATION  
[www.gjrpublishing.com](http://www.gjrpublishing.com)