Study Of Design and Development of a Gesture Controlled Robotic Arm

G. Shanmugasundar, Bharath Ganesh, M. R. Hemanth, S. Sri Haran, S. Sri Ram, M. Jeeva

*Sri Sai Ram Institute of Technology, Chennai, Tamil Nadu, India.*
Corresponding author Email: shanmugasundar.mech@sairamit.edu.in

Abstract: Currently, the gesture-based control system can generate precise and compliant robot motions through human motions have the characteristics of uncertainty and high-resolution. This study paper analyses the various system designs of robotic arms wherein the user controls the position of the joints of the arms. Various methods of control are explained, namely external circuit modules, Wifi and smartphone applications-based control. A literature study of various methodologies has been made and the possible advantages and disadvantages have been discussed. This paper seeks to survey existing implementations and to highlight potential areas of research and development in the area of Design and Development of a Gesture Controlled Robotic Arm.
Key words: *Gesture Controlled Robotic Arm, ardino controller, NLP.*

1. INTRODUCTION

Recently, some robotic systems gained sufficient control capabilities to perform complex human-robot interaction tasks that heavily involve the mutual exchange of physical forces. Some of these novel light-weight devices were already introduced to the industrial market, i.e. as state-of the-art technology. This made it possible to automate difficult assembly tasks, which were still performed manually up to now. Classical industrial robots are unable to solve these tasks, such as rear axle assembly for automobiles, as they require sensible manipulation capabilities to prevent damages to the components during low tolerance assembly processes.
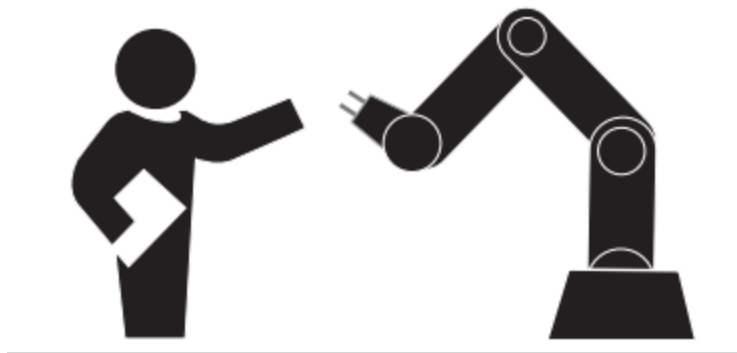
2. LITERAURE SURVEY

Literature 1: "Design and Development of Voice and Gesture Controlled Multitasking Robot "Anjaneyulu, K., Kalyani, P.S. (2022) explained and discussed In today's world, to minimize manual effort across a number of dynamic works like automatic functioning systems are developing. The development of artificial machines that make it possible to do the work of a human being seamlessly and in lesser time. Robots are designed and used in many real contexts, including agriculture, military, space, industry, healthcare, smart home, and many more. In many previous works they used a greater number of microcontrollers to design a robot and by using a greater number of controllers the circuit complexity and cost of the system is high. To reduce

the circuit complexity and cost of the system, a novel type of design is introduced. The robot is built by programming hardware components used to move, trace, catch, raise, hold, drop the target, detects fire and any object fell down on the floor all the functions are done in one device. The functioning of the robot is controlled by audible voice commands or gesture. The target object is placed on the floor, then the robot is controlled either by audible voice commands or gesture. Voice instructions and gesture commands are pre-loaded onto the robot. The robot is controlled by human voices and gestures commands using a smart phone. The robot is connected wireless to smartphone. Arduino board and Arduino mobile app is used to designed the robot. The circuit complexity and cost of the proposed design is less compared to the previous designs.
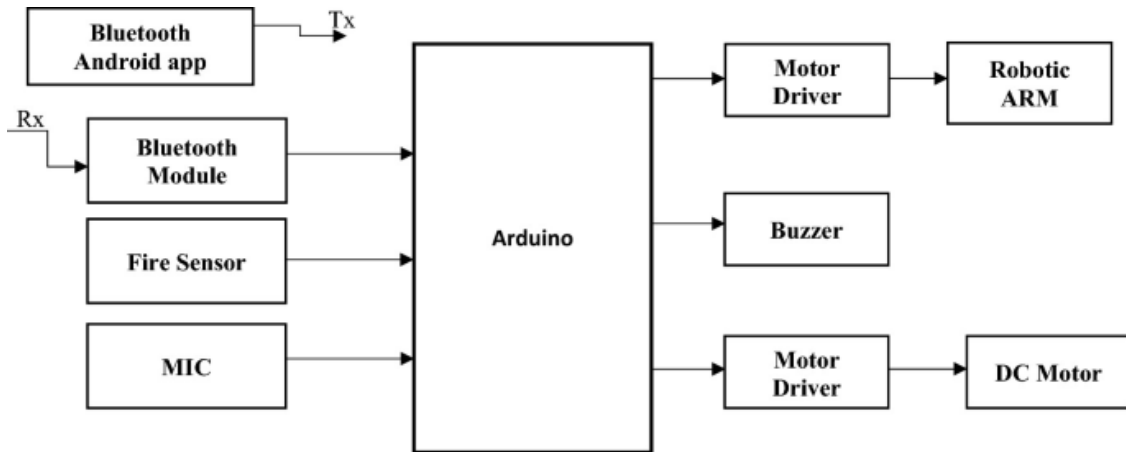

FIGURE 1. Methodology (Anjaneyulu, K., Kalyani, P.S. (2022))

Literature 2: "Voice Assisted and Gesture Controlled Companion Robot" Q. Shaikh, R. Halankar and A. Kadlay (2020) They implemented the design for a robot that can be controlled simply by using interactive inputs from the operator such as voice and gesture along with object tracking. The system aims to create a prototype of a futuristic automated personal assistant for domestic as well as industrial purposes. Google text to speech API and Grassfire algorithm is used to control the basic locomotion of the system. The robot consists of a gripper arm which is used to pick and hold objects as desired by the operator. The robot will be efficient and useful in reducing the human efforts in various applications and hence will improve the overall efficiency of the system. The operation of the robot is distributed into three parts i.e. speech processing, gesture control, and image processing. Using natural language processing (NLP), the scope of their robot, in terms of communicating with humans, can be broadened. Such robots can then be used as waiters in hotels or for domestic purposes in household activities. A sturdy robotic arm can be built and thereby upgrading the hardware of the robot, it can be used to carry heavy loads or objects where the involvement of humans is not possible and is dangerous. It can also be used as a robotic assistant in hospitals for doctors and nurses during treatments of patients or performing surgeries.

Literature 3: 'Object Detection and Gesture Control of Four-Wheel Mobile Robot" M. Jain *et al*., (2019) they development of a four-wheel mobile robot with gesture-controlled robot arm manipulator system is presented. The accelerometer and wifi based gesture control model is used to manipulate the motion of its arm with human hand. The glove data is used to control the movement of the robot arm for pick and place operation. The object detection algorithm is also implemented to detect the object autonomously. An ultrasonic sensor is used to detect the upcoming object. Under their work, only single object is considered. The prototype model of four-wheel mobile robot with two movable arms is developed. The proposed object detection algorithm is implemented on the physical model to check the effectiveness of the algorithm. After object detection operation, the gesture control-based controller is used for pick and place activity. The novelty of their research is collaborative use of object detection algorithm and gesture control scheme.
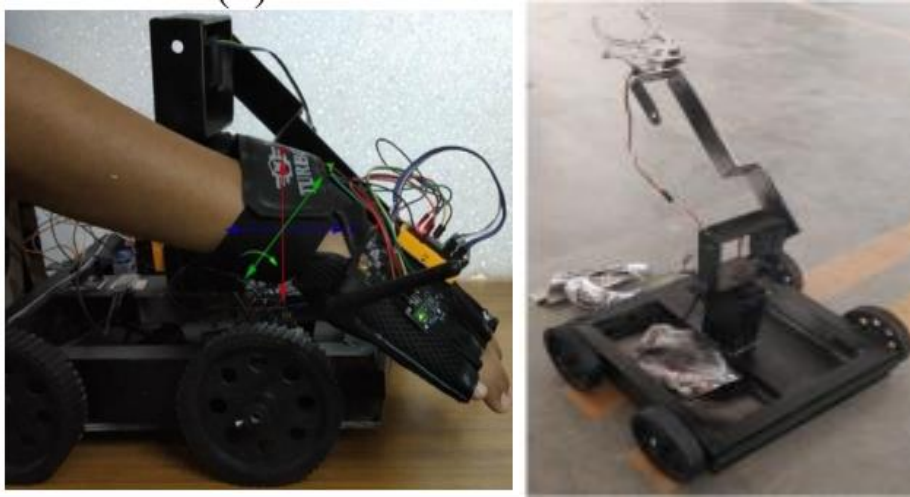
FIGURE 3. Gesture Control of Four-Wheel Mobile Robot (M. Jain *et al*., (2019))

Literature 4: "Visual human machine interface by gestures" M. Frigola, J. Fernandez and J. Aranda, (2003) developed like a oral communication, gestures are a natural way to carry out human machine interface. In the early days of robotic systems, human gesture was used to control robot movements by means of a master-slave structure. In spite of the use if robot programming languages, manual control is the most reliable way to carry out complex tasks in unstructured environments. In these situations, a non-contact, passive and remote system can be helpful to control a teleoperated robot by means of human gestures. In their paper, a vision system able to detect, locate and track the head and hands of a human body is presented. The system uses several calibrated cameras placed around the operator scenario to locate the body parts of a person in 3D. The system combines different computer vision techniques to increase the reliability of the body parts detection: image movement detection, user skin colour segmentation and stereo. The data provided by these modules are focused looking for coherence according to the human body dimensions. With the scheme proposed it is possible to obtain a low-cost real-time system for human computer interfacing based in a natural way of communication (gestures). Civil area such as big robots in shipyards, mines, public works or cranes is some possible applications.
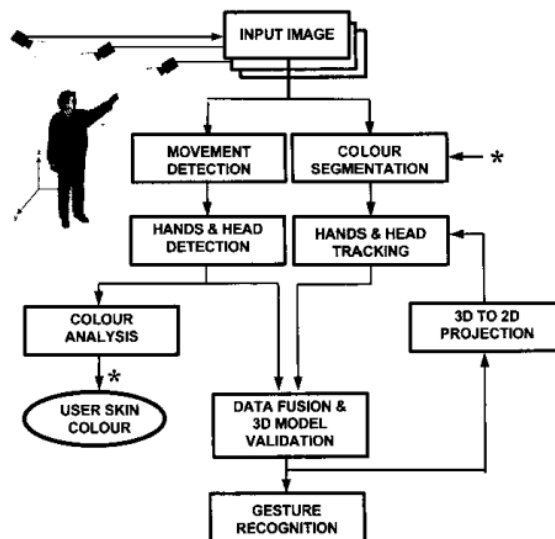

FIGURE 4. System Design (M. Frigola, J. Fernandez and J. Aranda, (2003))

Literature 5: 'Gesture control of mobile robot based arduino microcontroller" S. T. Kebir, M. Bouhedda, S. Mekaoui, M. Guesmi and A. Douakh (2016) The aim of their work is the control of mobile robot by hand gesture. For this purpose, the acquired hand images are treated, using algorithm based essentially on circular Hough transform, in order to define the desired targets. Thereby, the control signals are generated and sent via Wi-Fi communication to make the robot following the desired path. Test results shows the effectiveness of proposed approach. This was a simple approach of target detection and localization

to control a distant robot mobile in real time is presented. Initially, the target extraction is done by combining pre-processing and processing techniques with incorporating mathematical morphological operators with CHT algorithm. After that, the control signal is generated and sent via Wi-Fi communication to movement actuators of the Mobile robot. Experimental and test results shows that robot follows the hand gesture with an acceptable precision. This latter can be enhanced with improving the actuator control systems and using images with better resolution.
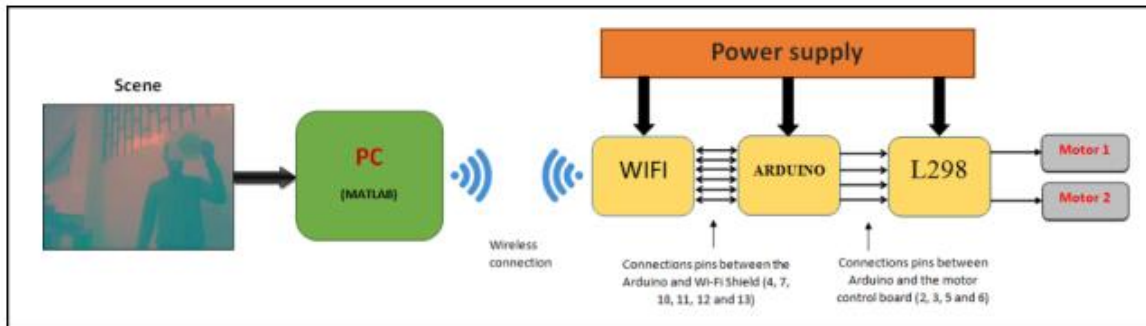

FIGURE 5. Control methods (S. T. Kebir 2016)

3. CONCLUSIONS

This paper given to all readers about the clear knowledge and comparisons, various methods of technology involved in the developing of gesture controlled robotic arm for industrial purposes.

REFERENCES

[1]. Anjaneyulu, K., Kalyani, P.S. (2022). Design and Development of Voice and Gesture Controlled Multitasking Robot. In: Gunjan, V.K., Zurada, J.M. (eds) Modern Approaches in Machine Learning & Cognitive Science: A Walkthrough. Studies in Computational Intelligence, vol 1027. Springer, Cham. https://doi.org/10.1007/978-3-030-96634-8_41

[2]. Q. Shaikh, R. Halankar and A. Kadlay, "Voice Assisted and Gesture Controlled Companion Robot," *2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS)*, Madurai, India, 2020, pp. 878-883, doi: 10.1109/ICICCS48265.2020.9120875.

[3]. M. Jain *et al*., "Object Detection and Gesture Control of Four-Wheel Mobile Robot," *2019 International Conference on Communication and Electronics Systems (ICCES)*, Coimbatore, India, 2019, pp. 303-308, doi: 10.1109/ICCES45898.2019.9002323.

[4]. M. Frigola, J. Fernandez and J. Aranda, "Visual human machine interface by gestures," *2003 IEEE International Conference on Robotics and Automation (Cat. No.03CH37422)*, Taipei, Taiwan, 2003, pp. 386-391 vol.1, doi: 10.1109/ROBOT.2003.1241626.

[5]. S. T. Kebir, M. Bouhedda, S. Mekaoui, M. Guesmi and A. Douakh, "Gesture control of mobile robot based arduino microcontroller," *2016 8th International Conference on Modelling, Identification and Control (ICMIC)*, Algiers, Algeria, 2016, pp. 1081-1085, doi: 10.1109/ICMIC.2016.7804273.

[6]. G. Shanmugasundar, S. Gurudarshan, N. Kirubaharan, & M.S. Sundar. (2022). Design and Development of Tank Cleaning and Inspection Robot. Journal of Pharmaceutical Negative Results, 1009–1012. https://doi.org/10.47750/pnr.2022.13.S03.156.

[7]. G. Shanmugasundar, G. Manoj Kumar, S.E. Gouthem, & V. Surya Prakash. (2022). Design and Development of Solar Powered Autonomous Seed Sowing Robot. Journal of Pharmaceutical Negative Results, 1013–1016. https://doi.org/10.47750/pnr.2022.13.S03.157.

[8]. Shanmugasundar G, Sapkota G, Čep R, Kalita K. Application of MEREC in Multi-Criteria Selection of Optimal Spray-Painting Robot. Processes. 2022; 10(6):1172. https://doi.org/10.3390/pr10061172.

[9]. Shanmugasundar G, Fegade V, Mahdal M, Kalita K. Optimization of Variable Stiffness Joint in Robot Manipulator Using a Novel NSWOA-MARCOS Approach. Processes. 2022; 10(6):1074. https://doi.org/10.3390/pr10061074.

[10]. Shanmusundar, G., Krishana, A. A., Anand, S. M., Kanna, P. K., & Yamini, A. (2022). Design and development of voice controlled robotic wheel chair for handicapped people. In RECENT TRENDS IN SCIENCE AND ENGINEERING. RECENT TRENDS IN SCIENCE AND ENGINEERING. AIP Publishing. https://doi.org/10.1063/5.0074458.