IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DESIGN AND FABRICATION OF HUMANOID ROBOT FOR COLLEGE ADMISSION: AN OVERVIEW

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ABSTRACT

The rapid development and implementation of humanoid robots has emerged as a key field of study in modern robotics, aimed at replicating human motion and behaviour to assist in various applications. This project focuses on the design and fabrication of a humanoid robot specifically tailored to assist in college admission processes. The primary objective is to create a robot that can interact with prospective students / parents / guardians, provide detailed information about courses, campus facilities, and admission procedures, and enhance the overall efficiency and experience of the admission process. The design phase emphasizes a flexible mechanical structure (Humanoid Robot) that mimics human movements, ensuring both functionality and an approachable appearance. This project aims to design a humanoid robot with additive manufacturing process for cost effectiveness. Various parts of the robot are designed in the Solid Work's Software and then the parts are printed with the help of a 3-D printer (material-PLA (Polylactic Acid)), and then they are assembled with addition to various components like servo motors etc. The fabrication process involved precision machining and assembly of parts, followed by the incorporation of sensors, actuators, and a robot control system. Humanoid robot is equipped with artificial intelligence (AI) algorithms and natural language processing (NLP) capabilities, enabling it to engage in meaningful conversations and process complex information efficiently. The successful implementation of this humanoid robot for college admissions not only illustrates a significant technological achievement but also sets a standard for further advancements in the field of educational robotics. The final prototype will be tested in a real-world college admission setting

to evaluate its performance, usability, and impact on the admission process. Feedback from users will be gathered to refine the robot's functionalities and enhance its user interface. The project aims to demonstrate the potential of humanoid robots in transforming administrative processes and providing innovative solutions in educational environments.

KEYWORDS: Humanoid Robot, College Admission, Design and Fabrication, Artificial Intelligence, Natural Language Processing, Educational Robotics, Machine Learning, 3D Modelling, Mechanical Structure, Sensors and Actuators.

INTRODUCTION

The rapid evolution of technology has profoundly transformed various industries, with education being one of the most notably affected. The incorporation of robotics into many areas of educational institutions is a significant step towards updating conventional procedures. A developing use of robotics in education involves the utilization of humanoid robots to optimize and improve the college admission process. This study explores the creation and construction of a humanoid robot specifically designed for college admissions. It discusses the various advantages of the robot and acknowledges the difficulties involved in its development and use [1-4].

Research Background

The humanoid robot, an intelligent robot designed to resemble a human, is considered a crucial technology for driving economic growth. Its applications are anticipated to be a promising industry in the next generation, following the dominance of the car industry. Presently, the production of humanoid robots designed for entertainment and personal service necessitates meeting many intricate criteria, including height, weight, intimacy, safety, and flexibility. Consequently, the methodology of product design is being employed in the development of humanoid robots. Humanoid robot design includes the design of action and behavior structures, human-robot interaction, and appearance. For personal service robots that aid and support human existence in domestic environments, it is crucial to prioritize emotional interaction with humans. Designing the personality of humanoid robots is a fundamental aspect in achieving this goal. The integration of humanoid robot design can serve as a crucial interface between humans and advanced technology. This research on the design process of humanoid robots can uncover innovative solutions to address the challenges posed by current technology. Robot development focused on the centre [5-8].

THE DEVELOPMENT OF ROBOTICS IN EDUCATION

The impact of robotics on education has been significant, just as it has been in other areas. Robots have been implemented in various settings, such as automated laboratories and intelligent tutoring systems, to carry out a wide range of jobs, including both basic administrative responsibilities and more intricate pedagogical roles. The concept of employing humanoid robots in education mostly arises from the necessity to optimize efficiency, augment the learning experience, and offer constant and dependable support to students and faculty.

Within the realm of college admissions, the procedure is conventionally arduous and time-consuming, encompassing many stages such as the distribution of information, the handling of applications, the verification of documents, interviews, and orientation. Colleges might possibly transform this process by utilizing the capabilities of humanoid robots, resulting in increased efficiency, engagement, and reduced susceptibility to human mistake.

Fig. 3 Humanoid robot for educational system

THE SIGNIFICANCE OF HUMANOID ROBOTS IN COLLEGE ADMISSIONS

Humanoid robots, which are created to imitate and replicate human behavior, has a distinct advantage when it comes to engaging in interactive and communicative tasks. Their anthropomorphic appearance and behavior can enhance the level of engagement and relatability for potential students and their families. These robots can be trained to do a range of functions that are essential to the admissions process, such as:

Humanoid robots can act as the initial source of information, offering comprehensive details about the university, its programs, admission criteria, and deadlines. With their natural language processing skills, these robots can respond to inquiries and offer assistance in several languages, guaranteeing accessibility for applicants from across the world [9-12].

APPLICATION ASSISTANCE:

- The robots provide support to students by helping them complete application forms accurately, ensuring that all mandatory fields are filled out correctly, and verifying that all essential papers are provided. This can greatly diminish the quantity of incomplete or inaccurately completed applications.
- Interviews are conducted to evaluate applicants' communication skills, motivation, and suitability for certain programs using humanoid robots. The robots can be configured with a predetermined set of questions and evaluation criteria, guaranteeing an impartial and equitable assessment.
- Campus tours can be conducted by humanoid robots that are equipped with mobility and navigation systems. These robots are capable of guiding prospective students and their families, offering thorough information about different facilities and promptly addressing any questions they may have.

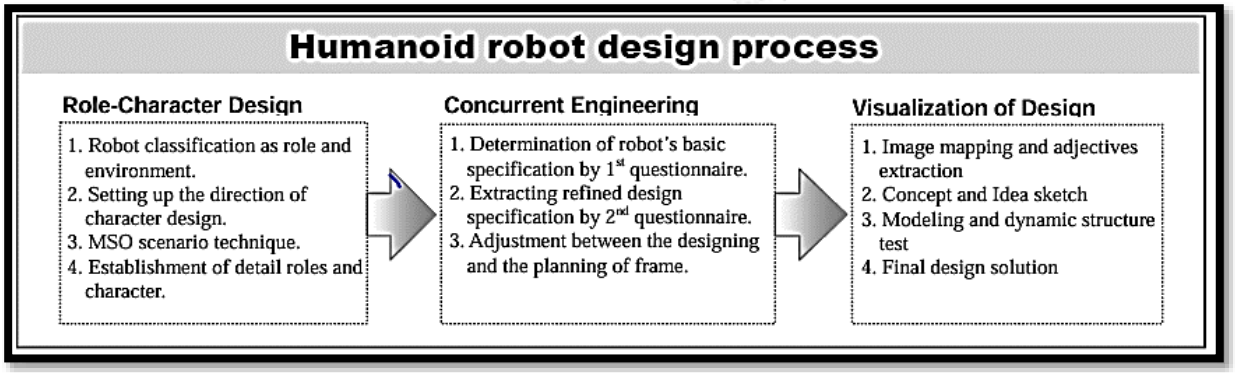
ORIENTATION & ONBOARDING

- Following admission, humanoid robots can aid in the orientation process by facilitating new students' adjustment to the campus environment, comprehension of the curriculum, and engagement with resources and support services.

DESIGN CONSIDERATIONS TO CONSIDER FOR HUMANOID ROBOTS IN ADMISSIONS

- Creating a humanoid robot for college admissions requires considering various technological and functional elements to ensure the robot can efficiently and consistently carry out its intended activities. Important factors to consider in the design process are:
- The robot must possess sophisticated Human-Robot Interaction (HRI) capabilities in order to enable seamless and instinctive interactions with users. This encompasses the utilization of speech recognition, gesture recognition, and emotional expression to facilitate a more anthropomorphic engagement experience. The robot design process as shown in the Fig. 1.

Fig. 1



Humanoid robot design process [2]

- Robust mobility and navigation systems are necessary for tasks such as campus visits. This entails utilizing sensors, cameras, and mapping algorithms to securely and effectively navigate the campus area.

- Data management involves the handling of sensitive information, such as personal details and academic records, which necessitates the use of secure data management systems. The robot is required to adhere to data privacy standards and guarantee the secure storage and processing of all information.
- Customizability and scalability are essential features for the robot's software and hardware. They should be easily adaptable to meet the specific needs of different institutions and capable of efficiently handling varying volumes of admissions duties.
- Importance of User-Friendly Interface: A user-friendly interface is essential for both potential students and admissions personnel. This encompasses a transparent and instinctive touch screen or voice interface that enables effortless interaction.
- Regular maintenance and technical support are crucial for ensuring the robot's reliable operation. This encompasses software upgrades, hardware maintenance, and troubleshooting assistance.

The development and manufacturing of humanoid robots for college admissions signify a hopeful merging of technology and education. By implementing automation and improving many components of the admissions process, these robots can offer a more streamlined, interactive, and tailored experience for potential students. With the increasing adoption of technology in educational institutions, humanoid robots are expected to play a larger role. This expansion will bring new possibilities for innovation and enhancement in the educational experience of students globally.

Humanoid robots are being more commonly incorporated into many industries to automate processes and improve effectiveness. This technology has the potential to greatly improve the education industry, especially in the area of college admissions, because it can handle the large number of routine and repetitive tasks involved. Although there are potential benefits, there is a significant lack of research on the use of humanoid robots designed expressly for college admissions. As shown in Fig. 2.

1. Focus and Personalization: Existing research primarily concentrates on the overall abilities of humanoid robots, without exploring specialized applications designed specifically for the college admissions process. Insufficient research has been conducted on the customization of robots to perform certain jobs, such as processing applications, disseminating information, and interacting with students in a college environment.

2. User Interaction and Experience: Although there has been significant effort in enhancing the mechanical and artificial intelligence components of humanoid robots, there is a lack of research in maximizing user interaction and experience specifically in the realm of college admissions. Comprehending the subtle and specific requirements of potential pupils and the interactions between staff and humanoid robots is essential for successful implementation.

3. The exploration of integrating humanoid robots with existing college admission processes and databases is still limited. There is a lack of studies that examine the methods for smoothly incorporating different elements, such as data security and privacy concerns, into college admissions.

4. Evaluation and Metrics: There is a significant lack of thorough evaluation metrics and long-term research that analyze the efficacy and influence of humanoid robots in college admissions. The metrics used to evaluate success, which go beyond technical performance, such as user happiness, reduction in processing time, and overall system efficiency, are not fully addressed.

5. Ethical and Social Implications: Further inquiry is required to thoroughly examine the ethical and social consequences of using humanoid robots in the setting of college admissions. Areas that necessitate further concentrated research include potential biases in AI decision-making, the ramifications for administrative staff employment, and the adoption of robots across varied student demographics.

It is crucial to address these deficiencies in order to establish a strong foundation for the efficient creation, execution, and assessment of humanoid robots in college admissions. This will ultimately result in a more streamlined, user-friendly, and fair admission process.

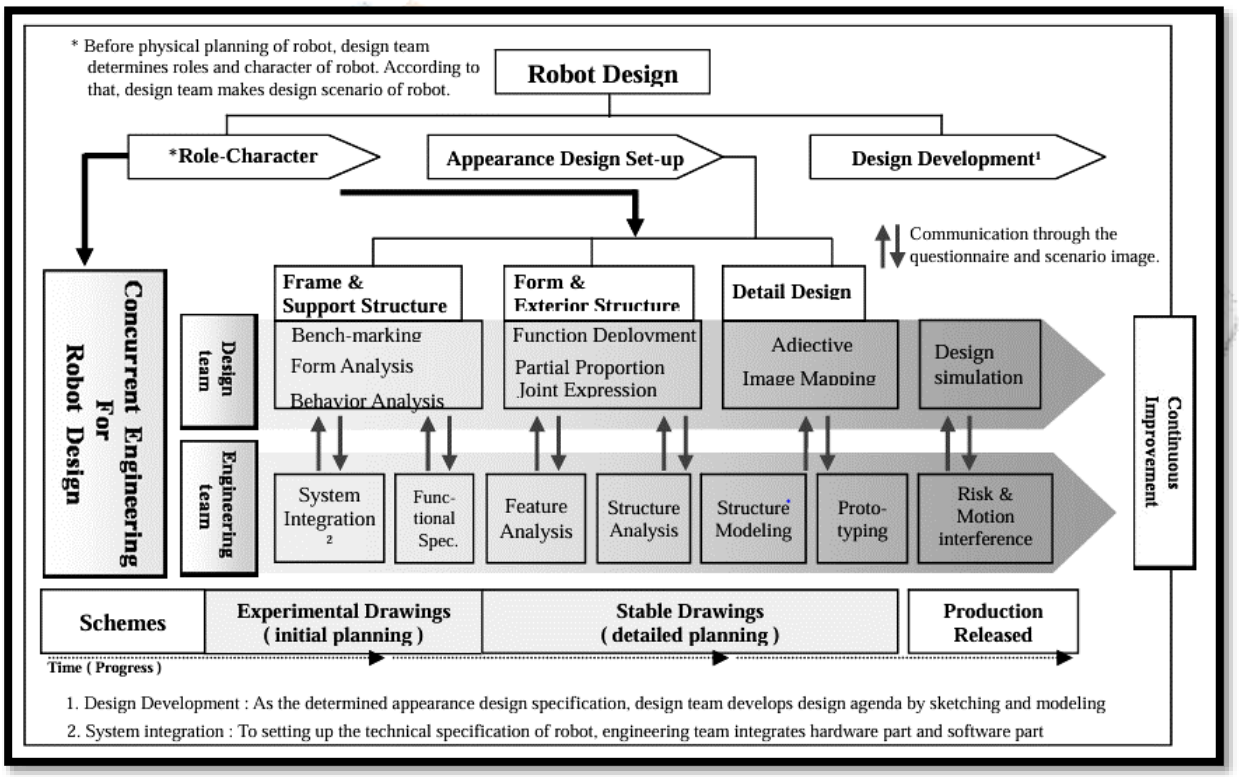


Fig.2 Concurrent engineering chart for humanoid robot design [2]

CHALLENGES AND PROSPECTS FOR THE FUTURE

- Although the use of humanoid robots into the college admissions process provides certain advantages, it also poses several difficulties. The upfront expenses associated with development and implementation might be substantial, and there might be opposition from employees who are accustomed to conventional approaches. Furthermore, it is crucial to retain trust and reliability by continually assuring pleasant interactions with the robot and swiftly correcting any technological problems.

- Subsequent investigations and advancements in this field may concentrate on augmenting the robot's functionalities via artificial intelligence, thereby facilitating more intricate interactions and decision-making procedures. Furthermore, investigating methods to smoothly include these robots into the wider educational ecosystem could enhance their influence even more [1-12].

Materials Mechanical Components:

- The frame and body of the product are constructed using an aluminum alloy, which ensures a combination of lightness and durability.
- Joints and Actuators: Utilize high-torque servomotors to replicate human-like movements in the joints.
- Hands and Grippers: Versatile, sensor-equipped grippers designed for manipulating documents and engaging with touch screens.

Electronics and sensors:

- Microcontrollers and processors such as Arduino Mega and Raspberry Pi are used to control a wide range of functions.
- Sensors: Infrared (IR) sensors are utilized to identify obstacles.
- Ultrasonic sensors designed for accurate measuring of distances.
- Cameras designed for the purpose of visual processing and facial recognition.
- Microphones and speakers are used for capturing and playing back audio.
- Touch sensors used to provide feedback during interaction.

Electricity source:

- Lithium Polymer (Li-Po) batteries having sufficient capacity to provide several hours of uninterrupted operation.
- Power distribution boards are used to regulate and control the voltage and current that is supplied to different components.
- Modules for communication:
- Wireless connection and data transfer can be achieved using Wi-Fi and Bluetooth modules.
- RFID readers designed for the purpose of identifying and recognizing ID cards.

Computer program:

- Operating Systems: Linux-based operating system designed specifically for the Raspberry Pi.
- Programming Languages: Python is used for high-level logic and control, while C++ is utilized for real-time motor control.
- Libraries and frameworks used in this project include OpenCV for image processing, TensorFlow for machine learning applications, and ROS (Robot Operating System) for integrating and communicating between hardware and software components.

Assorted:

- Fasteners such as screws, nuts, bolts, and other similar components used for assembly purposes.
- Insulating materials and wiring harnesses are used to ensure secure electrical connections.

Techniques

Design and simulation:

- CAD Modeling: Utilize tools such as SolidWorks to create the structural framework of the humanoid robot and simulate its motions.
- Simulation: Employ software tools like MATLAB and Gazebo to replicate the processing of sensor data and the motions of robots in a virtual setting prior to physical production.

Manufacturing:

- Frame Construction: Precisely cut and join the aluminum alloy components in accordance with the CAD blueprints. Utilize precision equipment such as CNC machines for exact fabrication.
- Joint Assembly: Securely affix servomotors to the frame at designated joint locations. Ensure accurate positioning and fasten securely using bolts.
- Hand Construction: Create and fabricate the hand components using a design software and a 3D printer. Incorporate adaptable grippers and sensors to enable gentle manipulation of documents.

Integration of electronics:

- Microcontroller Configuration: Install the Arduino and Raspberry Pi on the robot. Write the necessary code to enable the microcontrollers to process input from sensors and manipulate output to operate actuators.
- Sensor Installation: Position IR, ultrasonic sensors, and cameras strategically to provide optimal environment sensing and interaction capabilities.
- Power System: Incorporate Li-Po batteries and maintain equitable power allocation. Test for secure and effective provision of power to all components.

Software development:

- Control Algorithms: Create and execute algorithms for controlling motors and interpreting sensor data. Employ PID controllers to achieve seamless and accurate motion.
- Utilize the OpenCV and TensorFlow libraries to execute image and audio processing tasks, specifically for the purpose of face identification and interaction analysis. Create algorithms for audio interactions that involve speech detection and synthesis.
- Protocols for communication: Configure Wi-Fi and Bluetooth modules to enable the transfer of data and remote-control functionality. Guarantee the establishment of a secure and dependable means of communication between the robot and external equipment.

Integration and testing:

- Component Integration: Combine all mechanical, electrical, and software components. Ensure that the connections are correctly established and the fittings are securely fastened.
- System Testing: Perform comprehensive tests to validate the functionality of every subsystem. Conduct practical experiments in a simulated admission procedure to verify the dependability and efficiency.
- Calibration: Adjust sensors and actuators to achieve optimal performance. Refine algorithms by using test data to enhance precision and reduce response time.

Implementation and User Education:

- Installation: Arrange the humanoid robots at specified college admission centres. Ensure a reliable and strong network connection and a stable power source.
- User Training: Provide comprehensive instruction to college staff on the operation of humanoid robots, including troubleshooting techniques for typical faults and the execution of fundamental maintenance duties.
- Solicit input from users and applicants to pinpoint areas that can be enhanced through iterative processes. Execute modifications and improvements to optimize the robots' functionality and user satisfaction.

By implementing these techniques, the engineered humanoid robots can effectively aid in college admission procedures, delivering a smooth and interactive encounter for applicants and staff.

CONCLUSIONS

- The development and construction of humanoid robots for college admission processes signify a notable progress in automating and improving administrative chores.
- By combining modern mechanical components, sophisticated electronics, and intelligent software, these robots are capable of carrying out a range of tasks that simplify the admissions process.
- These tasks include managing paperwork, engaging with applicants, and offering information and assistance.
- The incorporation of high-torque servomotors and lightweight aluminum frames guarantees that the robots possess both durability and the ability to execute seamless, human-like motions.
- The incorporation of diverse sensors, such as infrared, ultrasonic, and webcams, enables the robots to traverse their surroundings, identify faces, and engage proficiently with individuals. In addition, the utilization of RFID readers and connection modules enables smooth data interchange and identification procedures.
- The software development component, employing programming languages such as Python and C++, in conjunction with robust frameworks like OpenCV, TensorFlow, and ROS, equips the robots with

the essential capabilities for tasks such as image processing, machine learning, and system integration.

- The integration of hardware and software components guarantees the robots' efficient and dependable task execution.
- The project's success relies heavily on thorough testing and calibration phases, which are essential for assuring the proper and seamless functioning of all subsystems.
- Through comprehensive user training, the deployment phase ensures that college staff can proficiently operate and maintain the robots, facilitating a smooth integration into the admissions workflow.

To summarize, the creation of humanoid robots for college admission procedures not only increases effectiveness in operations but also enriches the whole experience for candidates and personnel. This novel technique demonstrates the capacity of robotics to revolutionize administrative tasks in educational institutions, opening up possibilities for future progress in the subject.

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