Team (73) Gesture Controlled Robotic Arm: A Report

Team members:

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Drive Link:
https://drive.google.com/drive/folders/1wO108Icn6LPJzzDOD1jvVpJ8kIhzGSvC?usp=sharing

INTRODUCTION:

Our problem statement is Gesture controlled robotic arm. The use of hand gestures as a means of controlling robotic systems has gained significant attention in recent years due to its potential for intuitive and natural human-robot interaction.

In this report, we present a project that aims to control a robotic arm using hand gestures. The robotic arm is equipped with servo motors, controlled by an Arduino board, and hand gestures are detected using an accelerometer-based gesture sensor. The goal of the project is to create a system that allows users to control the robotic arm movements through hand gestures, providing a user-friendly and immersive human-robot interaction experience. The same can be used for multiple purpose like in the research area of radiation related which is harmful for humans or can be used in the medical area which is helpful for the remote operations.

MOTIVATION:

Hand gestures are a natural and intuitive way for humans to communicate and interact with their environment. Using hand gestures to control robotic

arms leverages this inherent human ability, allowing for a more natural and intuitive way of controlling the robotic arm movements and actions.

Hand gesture-based control can also improve safety in certain applications, such as in industrial or hazardous environments, where using physical controls may pose risks to human operators. Gesture-based control allows operators to control robotic arms from a safe distance, reducing the risk of accidents or injuries.
Hand gestures can enable more natural and intuitive human-robot interaction, fostering better communication and collaboration between humans and robots. This can lead to more efficient and effective human-robot teamwork in various domains, such as manufacturing, healthcare, and assistive robotics.
Advances in computer vision, machine learning, and sensor technologies have made hand gesture recognition more accurate, robust, and accessible. These technological advancements have paved the way for using hand gestures to control robotic arms with higher levels of accuracy and reliability, motivating further research and development in this area.

LITERATURE SURVEY:

- **"Robotic Arm Control using Hand Gesture Recognition" by P. Kaushik (2019)**

This paper presents a vision-based approach for controlling a robotic arm using hand gestures. It uses a camera to capture hand gestures, which are then processed using image processing techniques to recognize different hand gestures. The recognized gestures are then mapped to specific robotic arm movements to control the arm in real-time.

- **Real-time Hand Gesture Recognition for Robotic Arm Control" by R. Thakur (2018)**

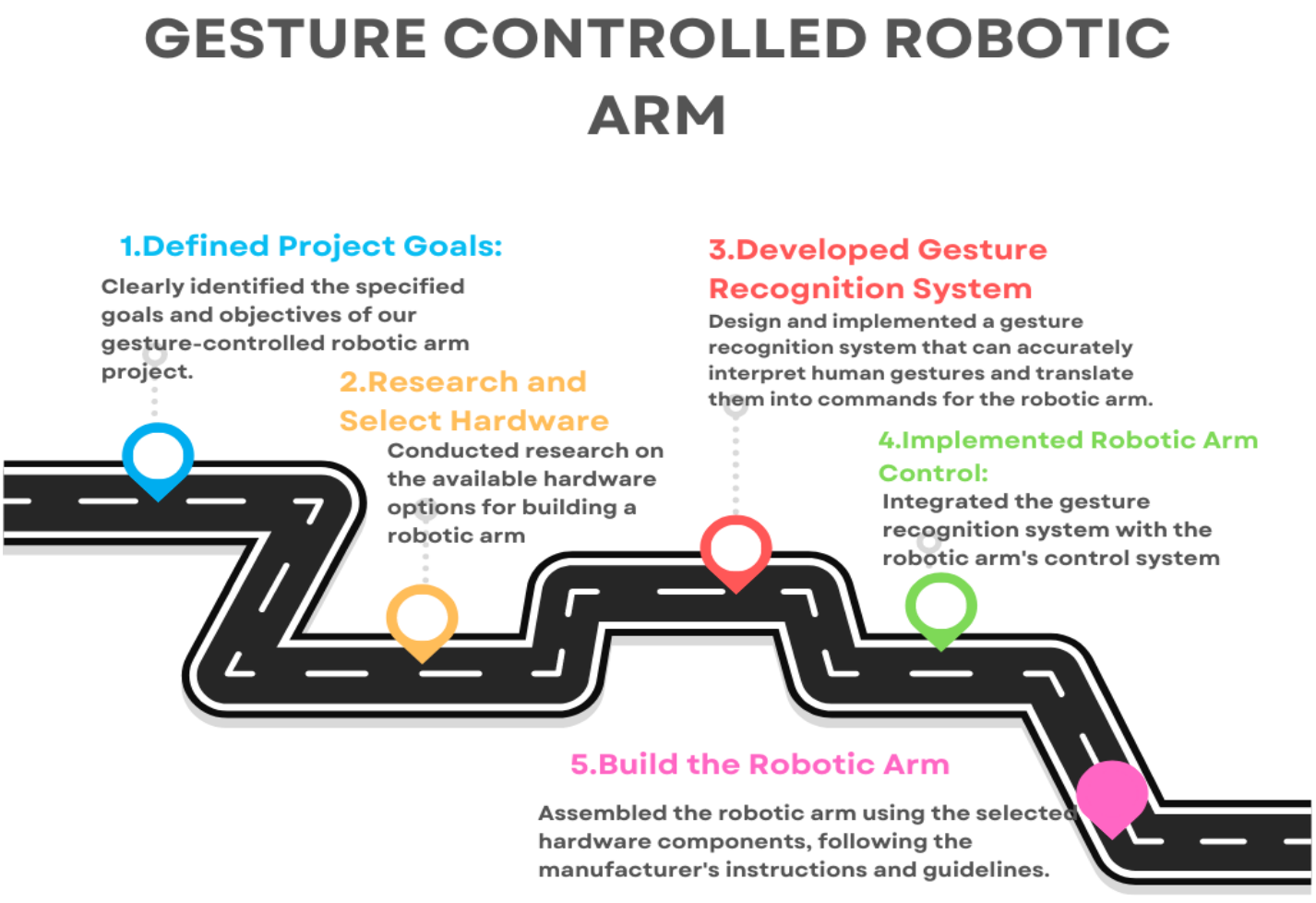
This paper proposes a real-time hand gesture recognition system for controlling a robotic arm. It uses a depth sensor to capture hand gestures

and employs machine learning algorithms for gesture recognition. The recognized gestures are used to control the robotic arm movements in real-time, allowing for intuitive and natural human-robot interaction.

- **Robotic Arm Control using Hand Gesture Recognition based on Wearable Sensors" by A. Gupta (2018)**

This paper proposes a wearable sensor-based approach for hand gesture recognition to control a robotic arm. It uses inertial sensors attached to the user's hand to capture hand gestures and employs machine learning algorithms for gesture recognition. The recognized gestures are used to control the movements of the robotic arm, offering a portable and non-intrusive solution for human-robot interaction

ROADMAP:



ROLES AND RESPONSIBILITIES:

Although we worked as a team through the project but still there were some specific tasks/parts done by each member: -

- **NIKHIL SINGH**: Figuring out the design of the model and develop the 3D model of the project and then 3D printing of model and then the final assembling of the project.

- **SATYAM RAO**: Figuring out the electronics parts and connection of the electronic part and developing the circuit and coding of the circuit..
- **KHUSHAL VERMA**: Helping in the assembling of the model and ordering all the parts and collecting them

- **PRINCE KUMAR**: Complete documentation of the project and helped in the developing circuit with Satyam

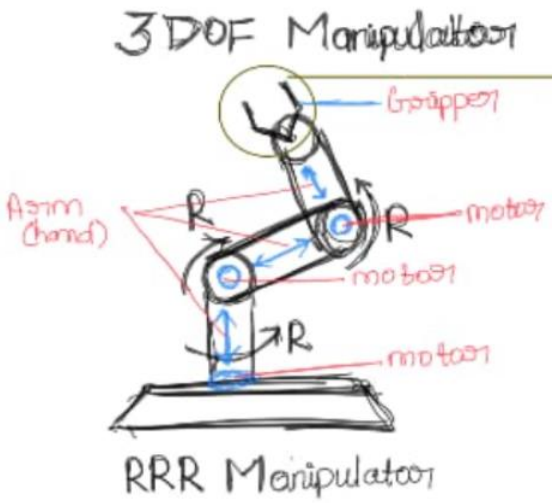
METHADOLOGY:

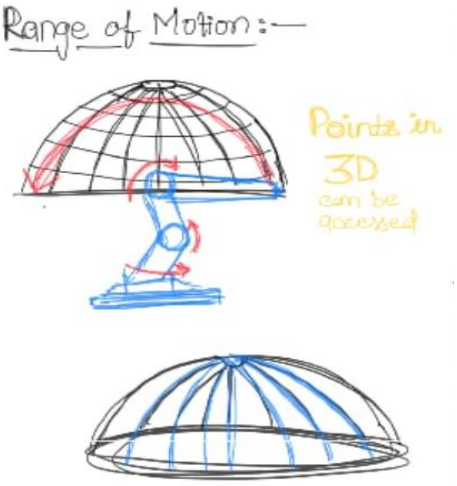
a) DESIGN PROCESS: -

- First, we defined the requirements of the robotic arm, including its size, payload capacity, range of motion, and other functional specifications. Determined the desired hand gestures that will be used for control.
- Conduct research on available robotic arm components, such as actuators (e.g., motors, servos), sensors (e.g., accelerometers, flex sensors), and controllers (e.g., microcontrollers, development boards). Select components that meet the requirements and constraints of the project.
- Created a mechanical design for the robotic arm, considering factors such as the number of joints, linkages, and end effectors needed. Utilized computer-aided design (CAD) software to create detailed 3D

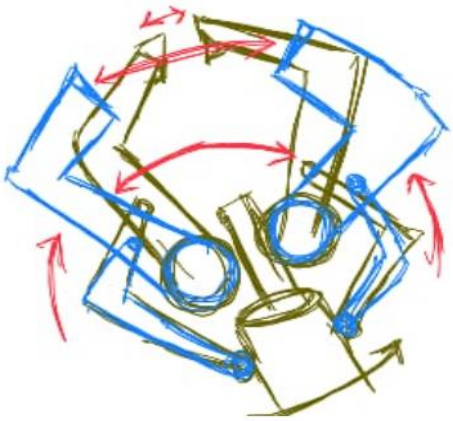
models of the arm components, and perform simulations to evaluate the arm's range of motion and structural integrity, and 3d printed the same.

- Developed an electrical design for the robotic arm, including the wiring and connections for the actuators, sensors, and controllers. Consider power requirements, communication protocols, and safety considerations.
- Implemented hand gesture recognition algorithms using appropriate sensors, such as accelerometers or flex sensors, to capture the hand gestures for controlling the robotic arm. This involved signal processing, machine learning and other techniques to interpret the gestures and convert them into control commands for the arm.
- Assembled and integrated all the mechanical and electrical components of the robotic arm, and connected them to the hand gesture recognition system. Conducted thorough testing to verify the arm's functionality, performance, and safety.

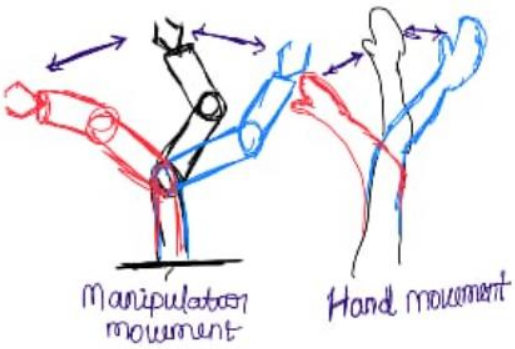




GRIPPER—

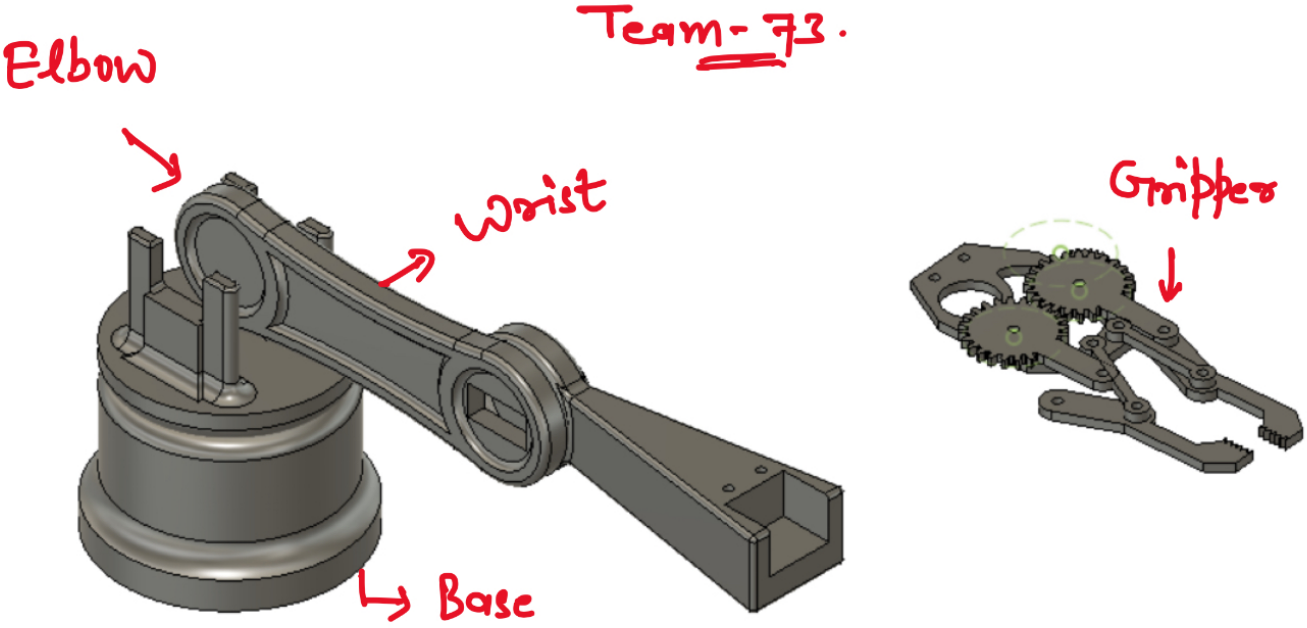


CONCEPT—



CAD MODEL:

Team-73.



PROTOTYPE:



BILL OF THE MATERIAL:

1. 6 servo motor 1300rs
2. Bluetooth module 450 rs
3. Battery 50rs
4. Arduino 450 rs
5. Jumper wires 50rs
6. Gyroscope sensor 200rs

SCOPE AND CONSTRAIN:

The "in" and "out" scope of hand gestured robotic arm refers to the potential areas of application and limitations of this technology.

IN SCPOE:

- **Industrial Automation:** Hand gestured robotic arms can be used in industrial settings for tasks such as pick-and-place operations, assembly, and material handling. By using hand gestures, operators can intuitively control robotic arms without the need for complex programming or manual controllers.

- **Healthcare:** Hand gestured robotic arms have potential applications in healthcare, such as assisting surgeons during minimally invasive surgeries, rehabilitation and physical therapy, and assistive devices for individuals with physical disabilities.

- **Virtual and Augmented Reality:** Hand gestured robotic arms can be used in virtual and augmented reality applications to provide a more immersive and interactive experience, such as virtual object manipulation or virtual teleoperation.

- **Human-Robot Interaction (HRI):** Hand gestured robotic arms can enhance the interaction between humans and robots, making it more intuitive and natural. This can have applications in fields such as entertainment, education, and social robotics.

OUT OF SCOPE:

- **High-precision and Fine Manipulation:** Hand gestured robotic arms may have limitations in terms of fine manipulation and high-precision tasks that require delicate control or intricate movements, such as microsurgery or small-scale assembly.

- **Safety-critical Applications:** Hand gestured robotic arms may not be suitable for safety-critical applications where precise control and accuracy are paramount, such as handling hazardous materials or operating in high-risk environments.

- **Complex and Dynamic Environments:** Hand gestured robotic arms may face challenges in complex and dynamic environments, such as

unstructured outdoor environments, where factors like changing lighting conditions, cluttered scenes, and varying hand gestures can impact the accuracy and reliability of gesture recognition.

- **Limited Range and Dexterity:** Hand gesture robotic arms may have limitations in terms of their range of motion and dexterity, which may impact their ability to perform certain tasks or manipulate objects in complex ways.

WORKING:

A robotic arm controlled by hand gestures typically involves using sensors to detect hand movements and translating them into commands that control the robotic arm's movements.

Sensors, are used to capture the hand gestures in real-time. These sensors can detect hand movements, finger positions, and other hand gestures.

The captured hand gestures are then processed by an algorithm that recognizes the gestures. This can involve using machine learning techniques, to analyse and classify the hand gestures based on predefined gestures or patterns.

Once the hand gestures are recognized, the system generates corresponding commands based on the recognized gestures. These commands can be in the form of specific movement instructions, such as "move left," "rotate wrist," or "open gripper," depending on the type of robotic arm being controlled.

The generated commands are sent to the robotic arm's control system, which interprets the commands and controls the motors of the robotic arm accordingly. The robotic arm then mimics the hand gestures by moving its joints or end-effector based on the received commands.

TESTING AND CALIBRATION:

After uploading the code to the Arduino board, the system has been tested for controlling the robotic arm using hand gestures. Various hand gestures are performed in front of the gesture sensor, and the robotic arm's movements are observed. The system's accuracy and responsiveness are evaluated, and adjustments are made to the code and servo motor movements as needed for fine-tuning the control.

Calibration of the gesture sensor may also be performed to ensure accurate gesture detection.

RESULTS:

The project successfully demonstrates the control of a robotic arm using hand gestures. Users can perform different hand gestures to control the movements of the robotic arm, such as grabbing, lifting, and rotating. The system provides an intuitive and interactive way of controlling the robotic arm, allowing for natural and immersive human-robot interaction.

LEARNING FORM THE PROJECT/COURSE:

We understood to capture data from sensors on the robotic arm and on the user's hand, such as accelerometers, gyroscopes, and various sensors.

We learnt about signal processing that processed the sensor data to extract features, that was used to recognize different hand gestures.

In addition to these technical skills, we also learnt about the practical applications of hand gesture controlled robotic arms, including their use in manufacturing, healthcare, and assistive technology for people with disabilities.

FUTURE SCOPE:

Some of the possible areas where robotic arm hand gesture technology may find significant applications in the future include:-

I. Robotic arm hand gesture technology can be used in manufacturing and industrial settings to improve productivity, safety, and ergonomics. Hand gestures can be used to control robotic arms for tasks such as assembly, material handling, and inspection, allowing for more efficient and flexible automation in manufacturing processes.
II. Robotic arm hand gesture technology can be used as assistive technology for individuals with disabilities or elderly individuals who may have limited mobility or dexterity. Hand gestures can be used to control robotic arms for tasks such as feeding, dressing, or performing daily activities, enhancing the independence and quality of life for individuals with disabilities or older adults.
III. Hand gestures can be used to control virtual objects, navigate through virtual environments, and interact with virtual characters, enhancing the user experience in virtual and augmented reality applications.

CONCLUSION:

In conclusion, the project presents a system for controlling a robotic arm using hand gestures. The hardware setup, including the robotic arm kit, Arduino board, servo motors, and gesture sensor, is assembled and integrated. The software implementation involves code for reading hand gestures from the gesture sensor and controlling the servo motors accordingly. The system is tested and calibrated for accuracy and responsiveness, and the results demonstrate successful control of the robotic arm using hand gestures. Further improvements and optimizations can be explored, such as incorporating additional sensors or refining the gesture recognition algorithm. Overall, the project showcases the potential

of hand gesture-based control for robotic systems and its applications in human-robot intraction.

REFRENCES:

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