SASTRA
ENGINEERING · MANAGEMENT · LAW · SCIENCES · HUMANITIES · EDUCATION
DEEMED TO BE UNIVERSITY
(U/S 3 of the UGC Act, 1956)
THINK MERIT | THINK TRANSPARENCY | THINK SASTRA

VOICE RECOGNITION BASED ROBOTIC ARM

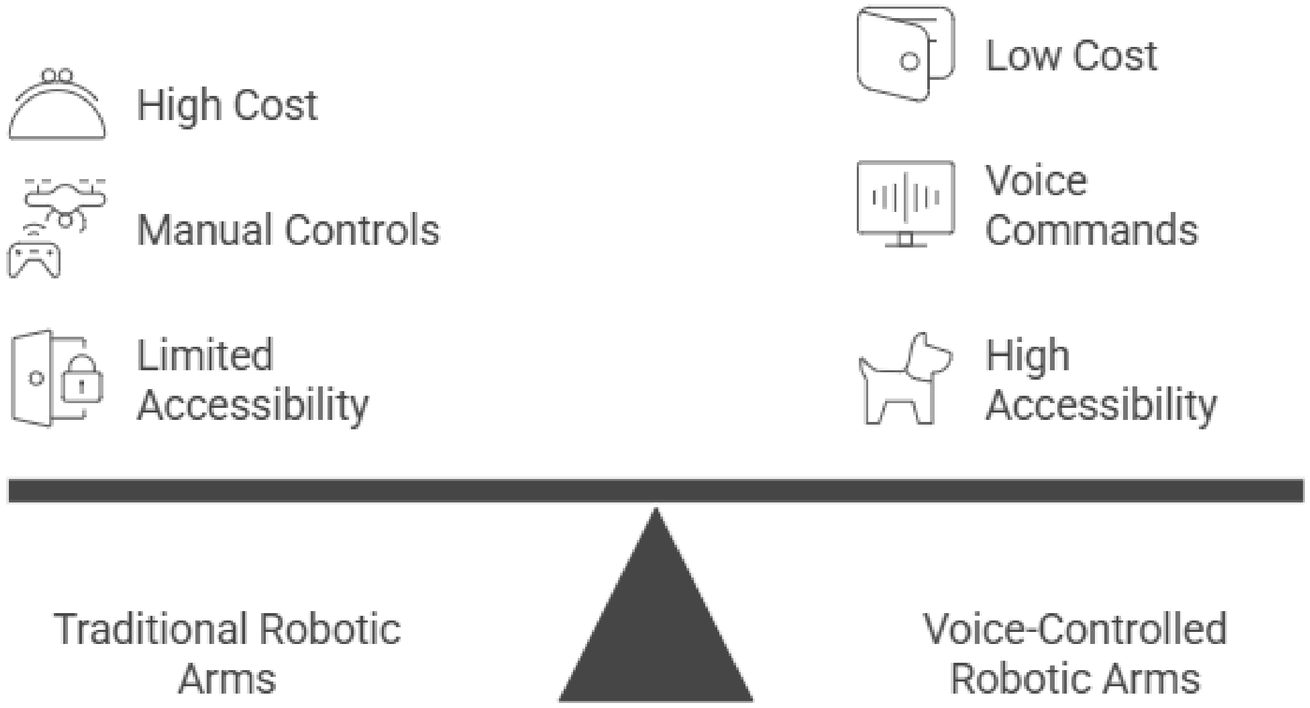
By:

Arthi Priya A (126011004)
Charoo Kiren G.L (126018008)
Sanjai.S (126018042)

INTRODUCTION

- Robotics is increasingly used to automate repetitive tasks; traditional robotic arms rely on manual controls like joysticks and buttons.
- Voice control offers a more natural and user-friendly method of operating robotic systems.
- To build a low-cost robotic arm using ice sticks and 3 servo motors that can be controlled through voice commands for simple pick-and-place tasks.

PROBLEM STATEMENT



LITERATURE SURVEY

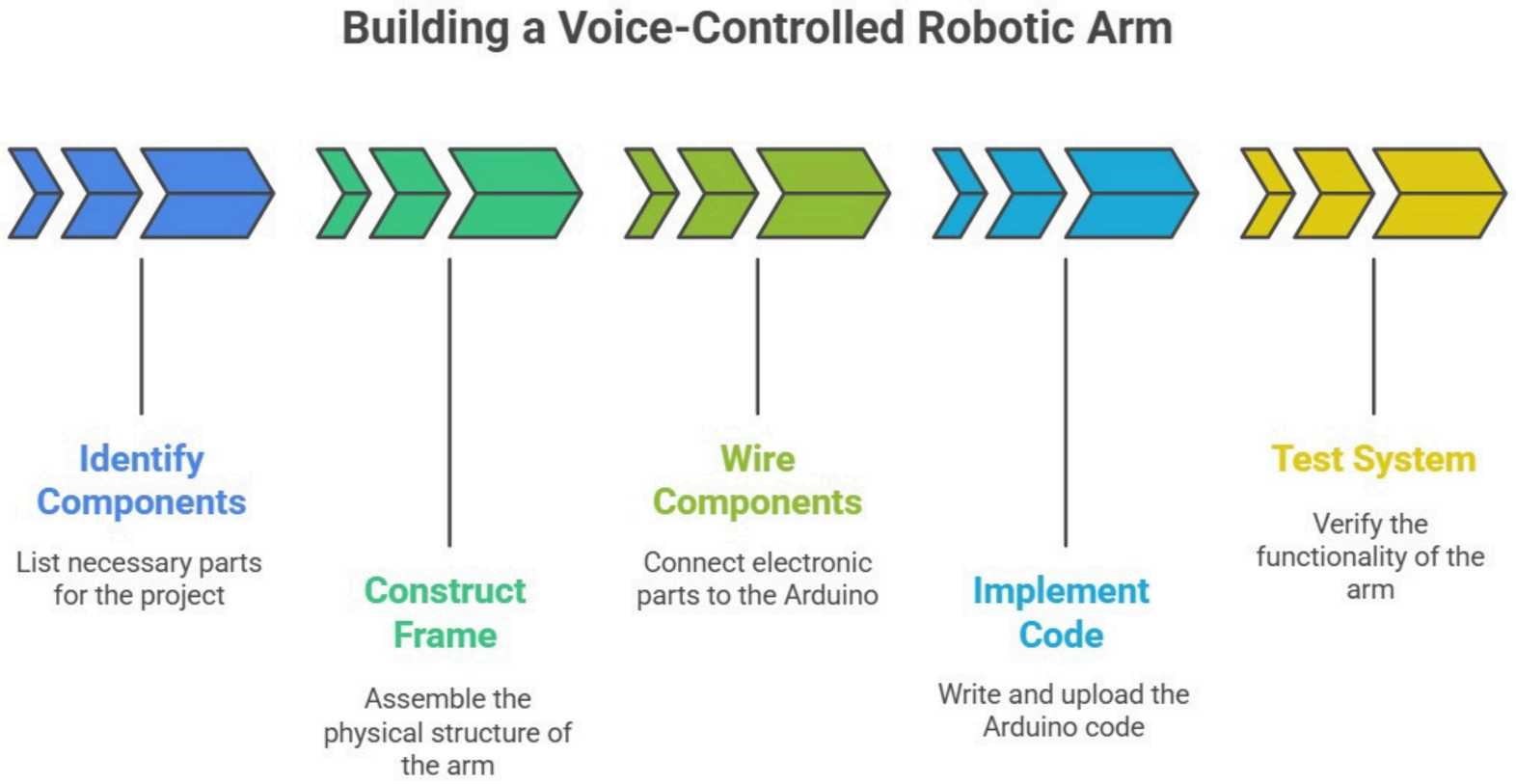
SPEECH CONTROLLED ROBOTIC ARM

- Voice-controlled robotic arms have advanced from simple to intelligent systems capable of precise movements.
- The base paper developed a **5-DOF robotic arm** using **neural network-based speech recognition** and **inverse kinematics**, powered by a **PIC microcontroller** and **servo motors**, achieving **over 90% accuracy**.
- Later projects focused on **low-cost, 3D-printed arms** using **Arduino** and **smartphone voice commands**, helping **physically disabled users**.
- Other designs used **Bluetooth**, **non-verbal voice sounds**, and **vision-based control** for **industrial and medical applications**.
- Most systems use **open-source platforms** like **Arduino** and **Raspberry Pi**, programmed in **Embedded C**.
- Current trends include **machine learning**, **wireless and multimodal control** (voice, gesture, vision), and **user-friendly, affordable designs**.
- Voice-controlled arms are now used in **healthcare, rehabilitation, and industries**, promoting **independence and accessibility**.

OBJECTIVES

- Build a voice-controlled robotic arm using Arduino UNO and servo motors.
- Use three MG995 servo motors to control the joint angles and movement.
- Construct the arm cardboard for a lightweight and low-cost design.
- Perform arm movements through voice commands, demonstrating basic robotics and automation.

METHODOLOGY



COMPONENTS SPECIFICATIONS

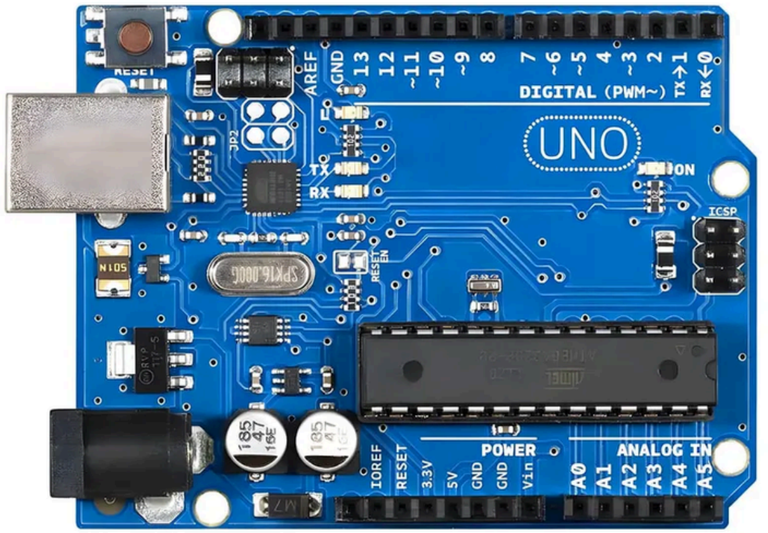
- Arduino Uno is used for its easy programming, sufficient I/O pins, and reliable control of multiple servo motors.
- MG995 servo motor is chosen for its high torque, metal gears, and durability, ideal for robotic arm movement.
- Both are cost-effective, compatible, and efficient, making them perfect for a voice-controlled robotic system.

COMPONENTS USED

- Arduino Uno with Arduino IDE
- Three MG995 Servo Motors
- Breadboard
- Jumper Wires
- Cardboard

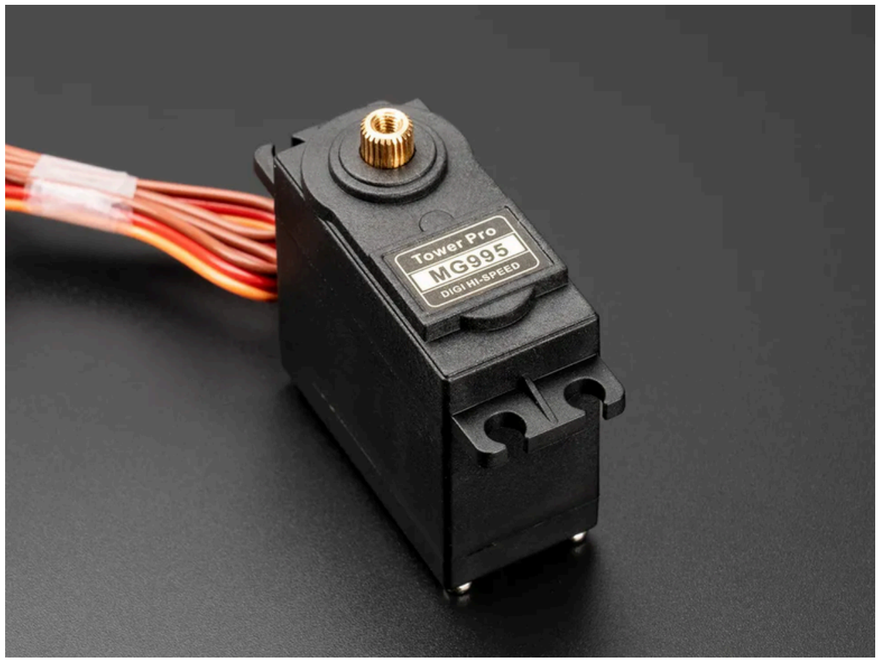
ARDUINO UNO SPECIFICATIONS:

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- Inout Voltage (limit): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- DC current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328P) of which
  0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Length: 68.6 mm
- Width: 58.4 mm
- Weight: 25 g



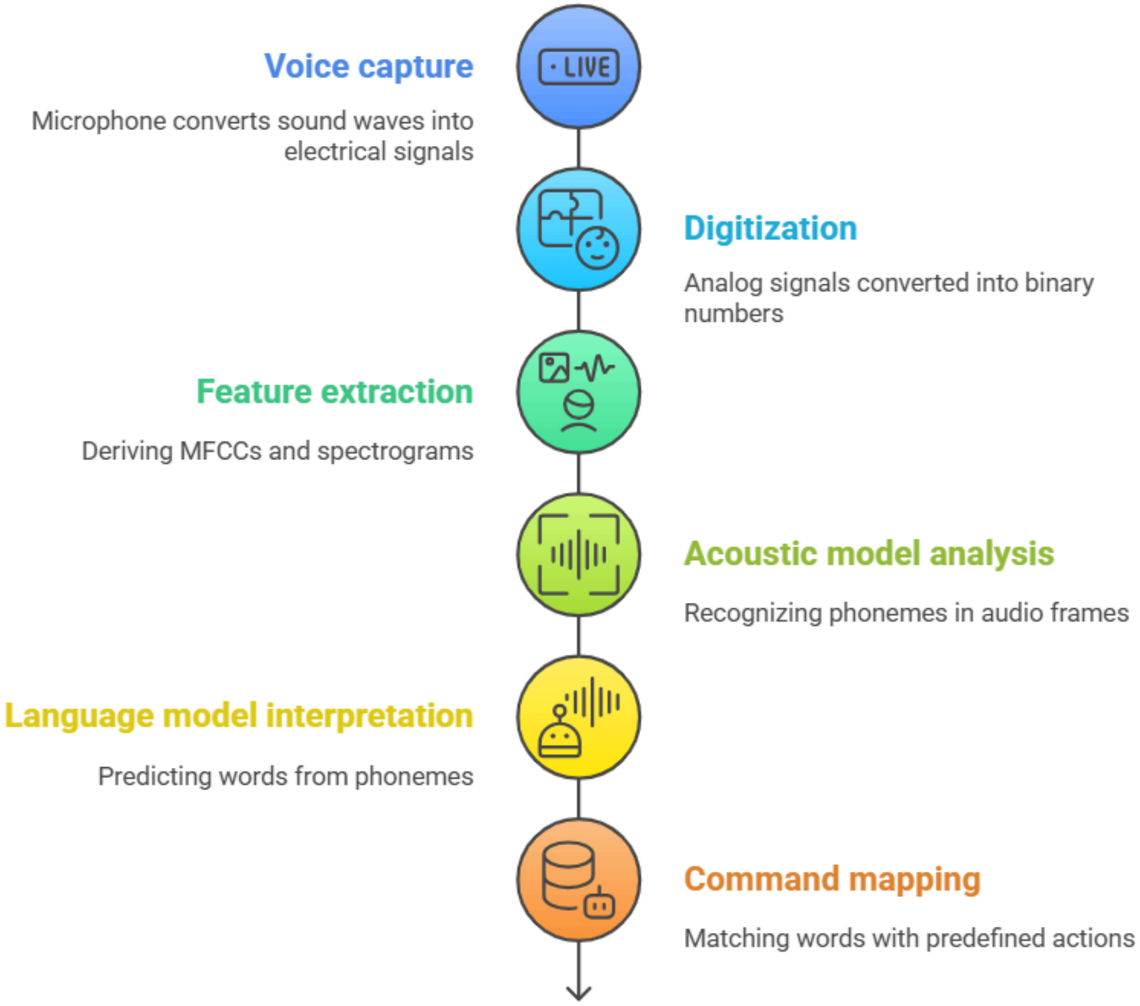
MG995 SERVO MOTOR SPECIFICATIONS:

- Voltage - 4.8V to 6.6V DC
- Torque - 9.4 kg/cm at 4.8V and 11 kg/cm at 6.0V
- Speed - 0.20 seconds / 60 degrees at 4.8V and 0.16 seconds / 60 degrees at 6.0V
- Current - 10 mA (Idle Current) and 170 mA (No Load Current)



SPEECH RECOGNITION MODULE

- The speech recognition algorithm analyzes the sound waves and converts them into digital form.
- The Google Speech Recognition API identifies words from the audio based on language patterns.



SPEECH RECOGNITION MODULE

1. Voice Capture (Analog Signal)

The process begins when the microphone captures your voice and converts the sound waves into electrical signals. These analog signals represent the intensity and frequency of your speech.

2. Digitization (Analog → Digital Conversion)

The analog electrical signals are sampled many times per second, similar to taking thousands of snapshots of your voice. Each sample is then converted into binary numbers (0s and 1s) so that the computer can process and analyze it digitally.

3. Feature Extraction (Finding Patterns in Sound)

Once digitized, the speech recognition system extracts meaningful patterns or features from the sound.

- MFCC (Mel-Frequency Cepstral Coefficients) captures how humans perceive sound frequency.
- Spectrogram – visualizes how sound energy varies over time and frequency.
- This step transforms the raw waveform into numerical features describing tone, pitch, and rhythm.

SPEECH RECOGNITION MODULE

4. Acoustic Model (Mapping Sounds to Phonemes)

The system divides the sound into small time frames and compares each with a trained acoustic model that recognizes phonemes .

For example: "Up" → /ʌ/, /p/

- The model uses Deep Neural Networks (DNNs) or Hidden Markov Models (HMMs) trained on thousands of hours of speech data.

5. Language Model (Making Sense of Words)

After identifying phonemes, the language model predicts the most likely words or phrases they form based on grammar and context. This helps ensure that the output is meaningful and not just a random combination of sounds.

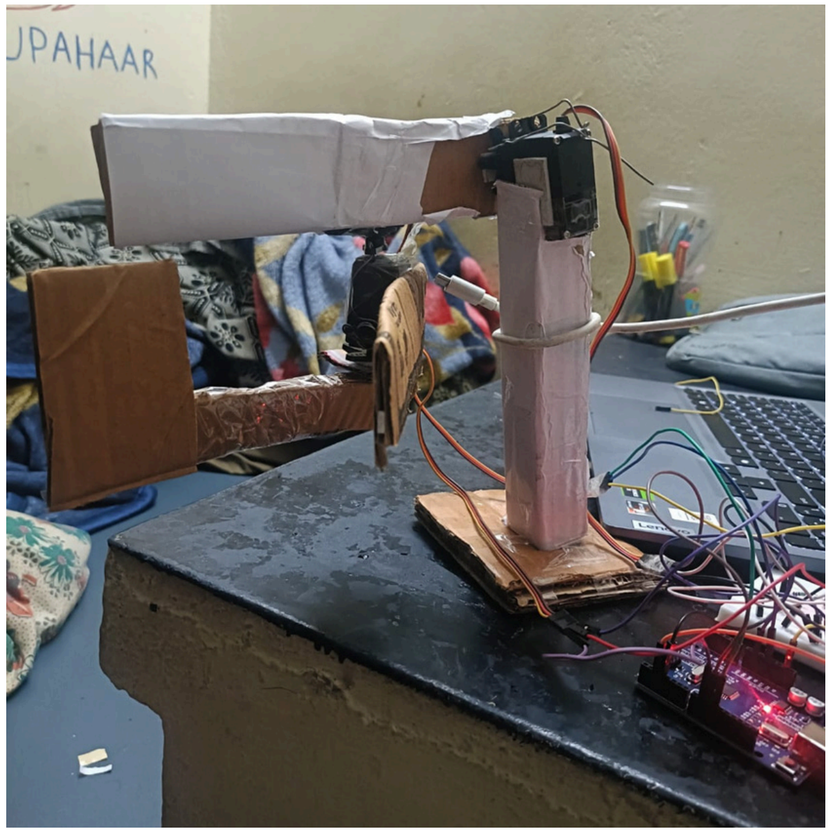
6. Command Mapping (Word → Action)

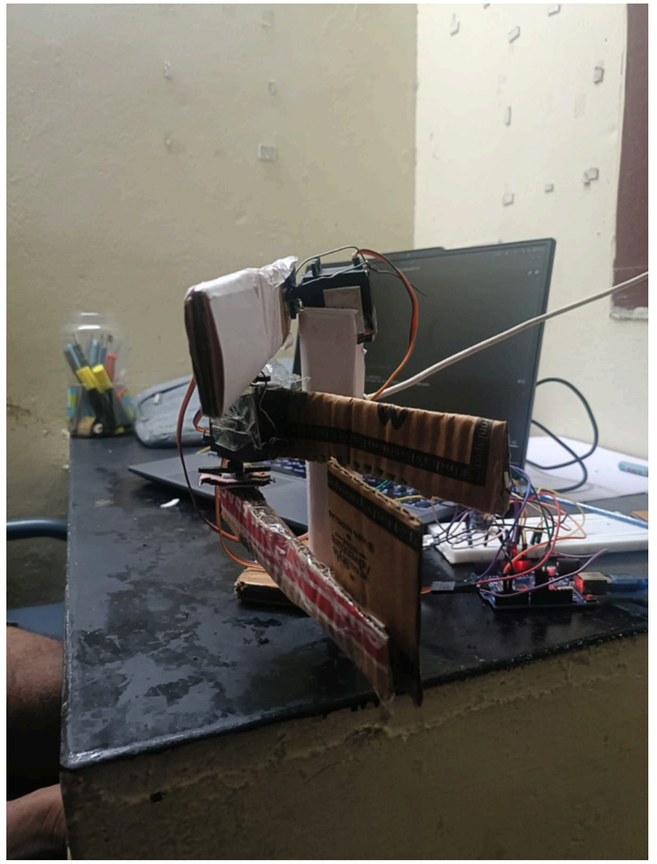
Finally, the recognized word (text) is matched with predefined commands. Each detected command triggers a specific action or response in the system

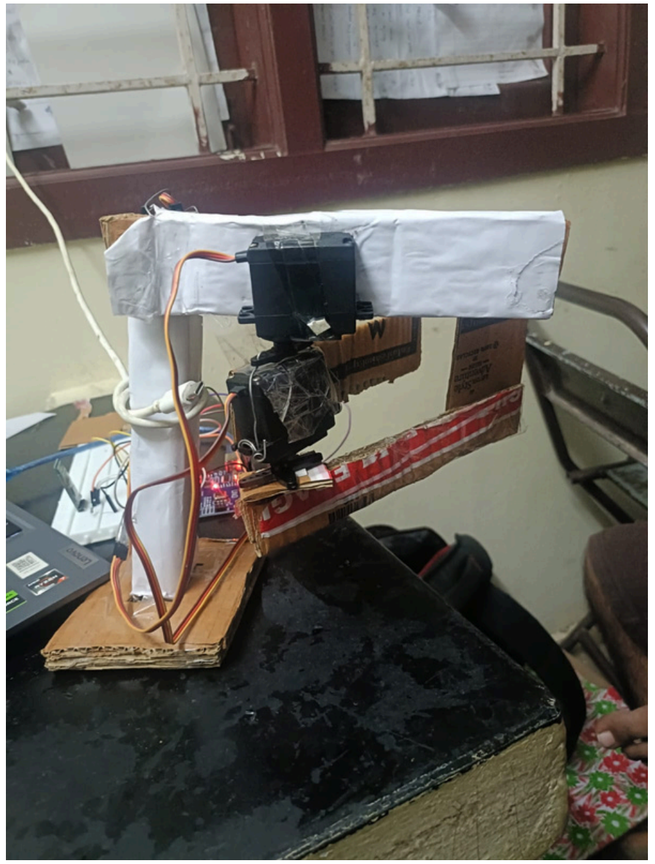
CODE

- https://drive.google.com/drive/folders/1K6bUFCDLZi8YMf44x3hF4nQNwqb4XDeD?usp=drive_link

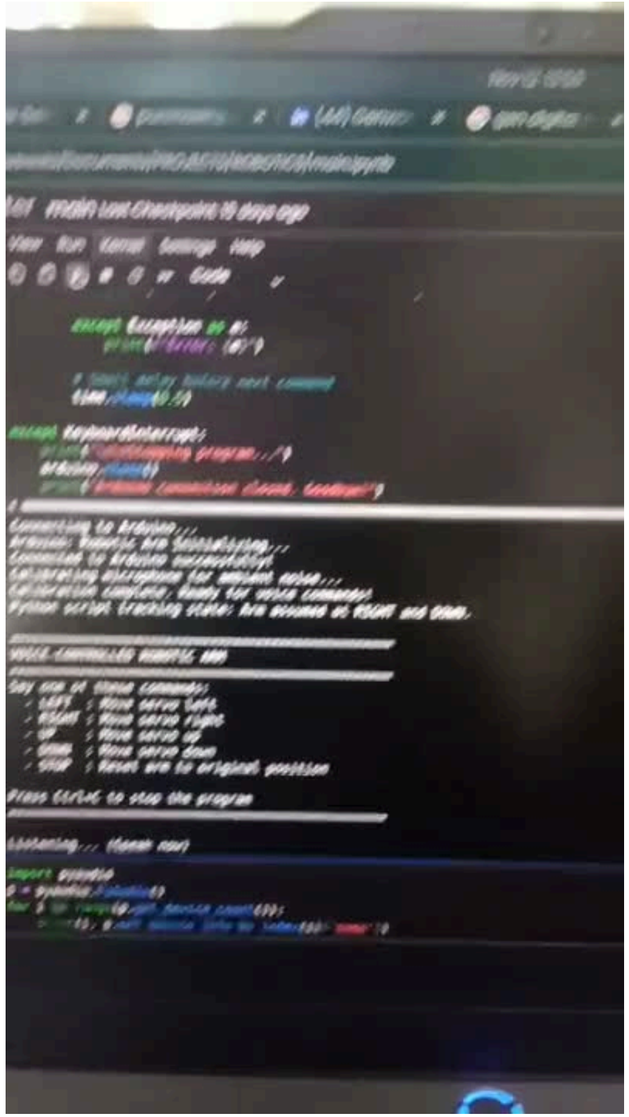
RESULTS







RESULTS



RESULTS

SPECIFIC CONTRIBUTIONS

- Arthi Priya (126011004): Contributed to concept development, construction of the 3DOF robotic arm, and software integration for system functionality.

- Charoo Kiren G.L (126018008): Played a key role in assembling the 3DOF robotic arm and assisting with programming and system integration to ensure smooth operation.

- Sanjai.S (126018042): Involved in mechanical setup of the 3DOF arm, hardware interfacing, and integration of software controls to synchronize movement and response.

LEARNINGS

- Understood how voice commands can control robotic movements.
- Gained experience in building and assembling a 3DOF robotic arm.
- Learned to integrate hardware with software using Arduino.
- Improved teamwork, coding, and troubleshooting skills.
- Understood real-time application of embedded systems and automation.

USE CASES

- Helps disabled people operate devices by voice
- Used in industrial automation for hands-free control
- Useful in medical and rehab support systems
- Acts as an educational tool for robotics learning
- Can assist in home automation tasks
- Great for science fairs and demos
- Basis for service robots in hospitals or restaurants

REFERENCES

- Haque, A. U., Kabir, H., Banik, S. C., & Islam, M. T. (2023). Development of a voice controlled robotic arm. *arXiv preprint* arXiv:2303.09645.
- Saravanan, M., & Sundar, T. (2023). A voice-controlled robotic arm for material handling. *IEEE Transactions on Industrial Informatics, 19*(4), 2345-2355.
- Kiran, V. H., Anandini, C., & Mounika, V. (2024). Fabrication of voice controlled robotic arm. *International Journal of Innovative Research in Technology, 11*(1), 399-407.
- Salim, A., Ananthraj, C. R., Salprakash, P., & Thomas, B. (2015). Voice controlled robotic arm. *International Research Journal of Engineering and Technology, 2*(1), 355-359.
- Singh, P., & Kumar, S. (2021). Arduino based voice controlled robotic arm and wheels. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12*(12), 2452-2457.
- Raj, K., & Verma, P. (2022). Voice control robotic arm using IoT & Arduino.
- *International Journal of Creative Research Thoughts, 10*(5), 1234-1240.
- Nathan, C. A. O., & Balasubramanian, S. (2006). The voice-controlled robotic assist scope holder AESOP for the surgical sciences. *Skull Base, 16*(3), 123-131.
- Mehta, R., & Patel, J. (2023). Voice controlled robot using Bluetooth. *International Journal of Engineering Research and Technology, 12*(3), 155-162.
- Kumar, R., & Singh, D. (2015). Speech recognition writing robotic arm. *International Journal on Recent and Innovation Trends in Computing and Communication, 3*(6), 3599-3603.
- Das, S., & Chakraborty, T. (2024). Vision-based voice controlled robotic arm for handling dental tools. *ESR Journal of Electrical and Computer Engineering, 11*(1), 78-85.

Thank you