Mechanical Helper Hand: An Assisting Device

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***Abstract*— The mechanical helper hand is an innovative assistive device designed to provide support and enhance the independence of elderly and specially-abled individuals in performing daily tasks. This concept introduces a robotic hand equipped with two distinct actuators, enabling both vertical and horizontal movements. The hand's versatile design offers a seamless and intuitive interface, catering to a wide range of users with varying physical abilities. The primary objective of the mechanical helper hand is to aid individuals with limited dexterity, strength, or mobility, allowing them to carry out essential activities, such as lifting lightweight items, and performing basic tasks without external assistance. The device promotes ease of use and comfort, ensuring prolonged user engagement.**

The first actuator facilitates vertical movement, allowing the hand to lift or lower its position based on the user's requirements. This feature is particularly beneficial for reaching objects at different heights, such as picking up items from shelves or placing objects on elevated surfaces.

The second actuator is responsible for horizontal movement, enabling the hand to move forward and backward in a controlled manner. This functionality further enhances the device's flexibility, permitting users to extend their reach and access objects within a broader range without having to overstretch or exert excessive effort.

The mechanical helper hand can be customized to meet individual preferences and limitations, making it a personalized assistive tool. It finds applications in homes, healthcare facilities, and assisted living centers, promoting autonomy and reducing dependence on external aid. By providing a means for greater independence and ease in performing daily activities, this mechanical helper hand has the potential to significantly improve the quality of life for elderly and specially abled individuals, empowering them to lead more fulfilling lives.

Keywords— Actuators, External Assistance, Healthcare Facilities, Customizable.

I. INTRODUCTION

In an era of advancing technology and a growing emphasis on inclusivity, the pursuit of innovative solutions to enhance the lives of elderly and specially abled individuals have become a great concern. As populations age and physical challenges become more prevalent, the need for assistive devices that promote independence and facilitate daily tasks has never been more pressing.

This paper introduces a groundbreaking concept designed to address these pressing needs - the Mechanical Helper Hand. Developed as a state-of-the-art assistive device, this revolutionary invention aims to empower elderly and specially abled individuals by granting them newfound autonomy in performing everyday activities around their homes.

The Mechanical Helper Hand is equipped with two actuators, facilitating smooth and controlled up-and-down as well as front-and-back movements. This feature allows users to effortlessly reach for objects at varying heights and access items from a broader range without straining or relying on external assistance. Its mobility is enhanced by a purpose-built wheelbase, allowing individuals to navigate their surroundings effortlessly. Most notably, the integrated camera system provides real-time video streaming, granting users a unique perspective of their environment and enabling remote control to ensure safe and obstacle-free navigation.

In addition, the Integrated Camera system also complements the mechanical hand's functionalities by offering real-time view of the user's surroundings not only provides a new level of situational awareness but also allows remote caregivers and family members to monitor and offer timely support whenever required.

Throughout this paper, we will delve into the multifaceted benefits of the Mechanical Helper Hand, exploring its versatile applications and the positive impact it can have on the lives of its users. By focusing on empowering independence and fostering connectivity, this assistive device seeks to usher in a new era of enhanced quality of life for elderly and specially-abled individuals, exemplifying the true potential of technology to serve the betterment of humanity

Through this in-depth exploration, we aim to shed light on the significance of robots and real-time visual capabilities in

the realm of assistive technology. The Mechanical Helper Hand serves as an exemplar of innovation and compassion, redefining the boundaries of independence and safety for elderly and specially-abled individuals. As we delve deeper into its key features, potential benefits, and user experiences, this research aims to inspire further advancements in assistive technology and contribute to the betterment of the lives of those in need.

II. RELATED WORK

In the domain of assistive robotics, researchers have made significant strides in developing devices to aid elderly and specially-abled individuals in their daily lives. Various assistive robotic solutions have been explored to provide support, enhance mobility, and promote independence.

One category of assistive devices focuses on wearable exoskeletons, designed to augment users' mobility, and provide support for walking or movement. These exoskeletons often use advanced sensor technologies to detect user movements and help where needed. While exoskeletons have shown promise in improving mobility, they may still pose challenges related to weight, energy consumption, and cost, limiting their widespread adoption.

Another line of research has focused on developing robotic arms and grippers, enabling users to grasp and manipulate objects with precision (which we have opted). These robotic arms can be remotely controlled through various interfaces, such as buttons or joysticks, offering a high degree of dexterity for users with limited hand functions. However, the stationary nature of these robotic arms restricts users' freedom to move around their environment, so we have produced wheelbase robots so it can interact with objects in various locations with integrated cameras, capable of real-time object detection and recognition.

III. PROPOSED METHOD

The proposed system MECHANICAL HELPER HAND is controlled remotely by mobile interface for the moment which takes real-time object feed as input and follows the operational process shown in Fig.1.

1)Detect objects in the way.

2)Takes deviations (controlled by user).

3)Adjusts the machine height using vertical actuators.

4)Adjusts the horizontal moment for dragging the required object.

5)Expand and contacts to place object in the cushioned tray.

6)Return the object.

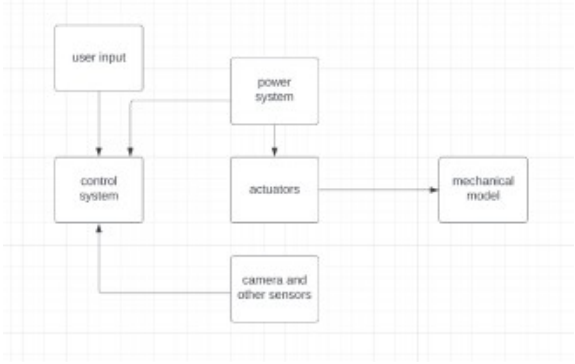

Fig 1. Block diagram of Proposed System

The model uses 500mm and 300mm Actuators which act as the backbone. These actuators can achieve an Average height of about 1.5ft vertically and about 2 ft horizontally which is enhanced by robots' height for the reach. ESP32 Development Board with Wi-Fi and Bluetooth are used for observing the POV of the model.

A. Hardware Environment

TABLE I. HARDWARE ENVIRONMENT

Actuators	500mm and 300mm
ESP32 module	With Wi-Fi and Bluetooth
Arduino	Arduino Nano
Wheels	150mm diameter
HCO5	Bluetooth Module
L293D	600-mA
Servo motors	4 DC
Regulated power supply module	1

The design and components of the Mechanical Helper Hand are crucial to its functionality as an assistive technology for elderly and specially-abled individuals.

Specifications:

1. **Actuators**

   Functionality:

   - Vertical Movement (500mm Actuator): The 500mm actuator is responsible for vertical movement. This functionality enables the robot to reach objects at different heights.
   - Horizontal Movement (300mm Actuator): The 300mm actuator is responsible for horizontal movement, facilitating forward and backward motion of the Mechanical Helper Hand. This feature is crucial for navigating through the environment and positioning the robot precisely for specific tasks.
   - Actuator Synchronization: The actuators are synchronized to work harmoniously, allowing the Mechanical Helper Hand to achieve complex movements that involve both vertical and horizontal motions simultaneously. This synchronization ensures smooth and coordinated actions, enhancing the robot's overall performance.

2. **Wheels and Navigation Mechanism**

   Functionality:

   - Wheels: The Mechanical Helper Hand is equipped with wheels with a diameter of 150mm. The choice of wheel diameter is crucial in determining the robot's stability, traction, and overall performance.
   - Traction and Grip: The wheels are designed to provide excellent traction and grip on various

surfaces, including smooth floors, carpets, and uneven terrains. This feature ensures that the Mechanical Helper Hand can navigate through different environments.

- Swivel Mechanism: The wheels are integrated with a swivel mechanism that allows them to rotate freely in any direction.
- Wheel Encoders: The encoders enable the robot to measure and control its distance and speed accurately, ensuring smooth and consistent motion during navigation.

3. Live Streaming Camera

Functionality:

- Wi-Fi Connectivity: The camera is connected to the robot's control system via Wi-Fi. This enables seamless communication between the camera and the robot's central processing unit, allowing the captured video feed to be transmitted in real-time to a remote device, such as a smartphone or computer.
- Live Video Streaming: The camera provides live video streaming capabilities, enabling users or caregivers to remotely monitor the robot's movements and activities. This feature ensures that the user has visual access to the robot's surroundings, enhancing their situational awareness and facilitating better control and coordination.
- Assistance in Navigation: The live video feed from the camera can aid users in navigating the robot through challenging or unfamiliar environments. By having a real-time view of the robot's surroundings, users can make more informed decisions about the robot's movements and routes.

4. Advanced Control Modules: ESP32 and Arduino Nano

ESP32 Module:

Fig 2. ESP32 Module

The ESP32 is a powerful microcontroller module equipped with Wi-Fi and Bluetooth capabilities.

Functionality:

- Communication: The ESP32 facilitates real-time communication between the robot and external devices, such as smartphones, computers, or tablets, through Wi-Fi and Bluetooth. This enables remote control and interaction, as well as live video streaming, enhancing user engagement and control.
- Internet of Things (IoT) Integration: The ESP32's Wi-Fi capability allows the Mechanical Helper Hand to be integrated into IoT ecosystems, enabling seamless interaction with other smart devices and systems within the user's home or environment.
- Data Processing: The ESP32 serves as a central processing unit, handling data from various sensors, actuators, and the **live streaming camera.** It processes the data and provides necessary feedback for the robot's movements and actions.
- Programming Flexibility: The ESP32's programmable nature allows developers to customize the robot's functionalities, adapt it to specific user needs, and implement advanced algorithms for improved performance.

Arduino Nano:

Fig 3. Arduino Nano

The Arduino Nano is another essential control module in the Mechanical Helper Hand, responsible for precise control of actuators and sensor integration

Functionality:

- Actuator Control: The Arduino Nano handles the control of the dual actuators, enabling precise and synchronized vertical and horizontal movements. It ensures smooth and accurate execution of tasks, enhancing the robot's versatility and dexterity.
- Sensor Integration: The Arduino Nano collects data from various sensors for obstacle detection and wheel encoders for measuring motion. It processes this data to aid in navigation and overall safety.
- Integration and Communication: The ESP32 and Arduino Nano work collaboratively through serial communication, allowing them

to exchange data and synchronize actions seamlessly. The ESP32 communicates with external devices, while the Arduino Nano manages the robot's internal operations.

5. L293D Motor Driver:

Fig 4. L293D

- A motor driver is a circuit chip that is used to control motors in autonomous robots. It acts as an interface between the Arduino and the motors.
- The L293D is a 16-pin IC with eight pins on each side for motor control. There are two output pins, two input pins, and one enable pin for each motor.
- The L293D consists of two H-bridges, which are simple circuits that can be used to drive low-current motors.
- To have complete control over a DC motor, you need to be able to control its speed and direction of rotation. This can be achieved by combining PWM (pulse-width modulation) and H-bridges.
- PWM is a technique for controlling the speed of a motor by varying the width of the pulses of current that are applied to it. H-bridges are circuits that can be used to reverse the direction of current flowing through a motor.
- By combining PWM and H-bridges, you can have complete control over the speed and direction of a DC motor.

6. HCO5 – Bluetooth Module

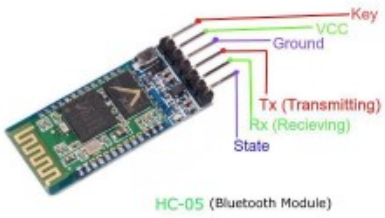

Fig 5. HC-05

- The HC-05 is a Bluetooth module that is designed for wireless communication. It can be used in a slave or master configuration, and it can be used to communicate between two microcontrollers, such as an Arduino and a smartphone or laptop. There are many applications available that make this process easier. For this project, we used the Serial Bluetooth Terminal application.

7. Servo Motors

- A servo motor is an electrical apparatus that rotates machine parts precisely and efficiently.
- Torque and velocity depends on the provided current and voltage. Here we used low rpm to achieve high torque.
- A servo motor has a control circuit that delivers feedback concerning the present orientation of the motor shaft, allowing servo motors to change direction with a higher degree of precision.

B. Software Environment

Embedded C has been selected as the programming language for developing code for the control of the prototype. Code is developed in Arduino IDE and is integrated with Serial Bluetooth Terminal application which receives a character as input for different actions, and it is relayed to Arduino using HCO5 module.

C. Software Explanation

Arduino IDE is used for developing the model. Serial Bluetooth Terminal application is used as interface, where these both communicate with each other serially. The application is used as GUI. Arduino IDE is used for initialing motor or actuators after it receives commands from GUI using HC05 and later initialize them by sending commands to L293D.

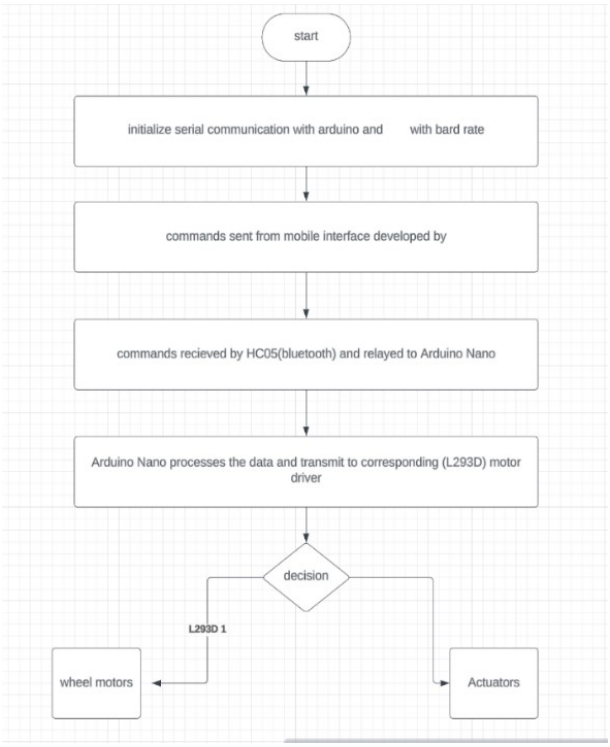

Fig 6. Flowchart of Execution

IV. RESULT ANALYSIS

The following command i.e., the characters are sent to Arduino by HC05 module interface as shown in the figure.

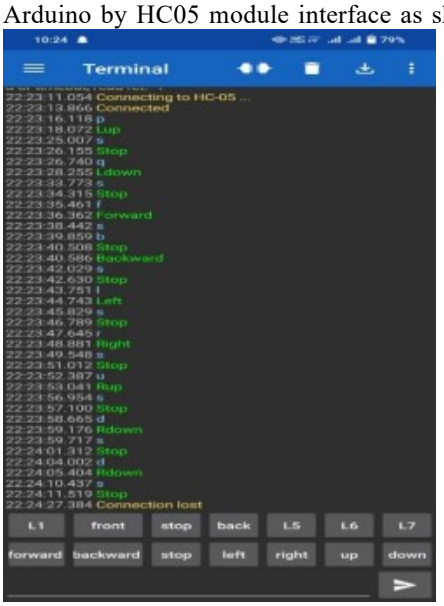

Fig 7. Commands

- **We have used rack and pinion instead of Actuators for the prototype.**
- Following is the prototype of the project and some of the functionalities based on commands.

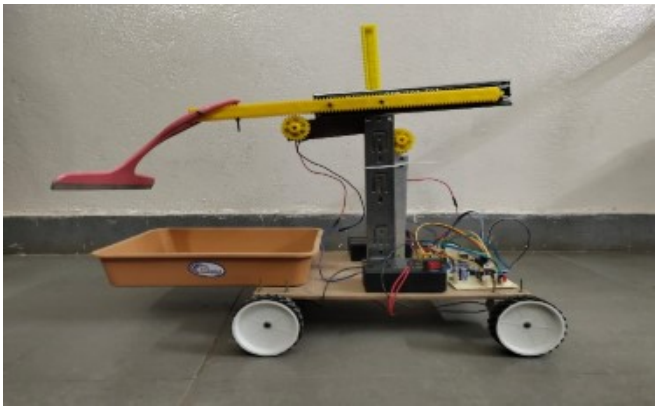

Fig 8. Prototype

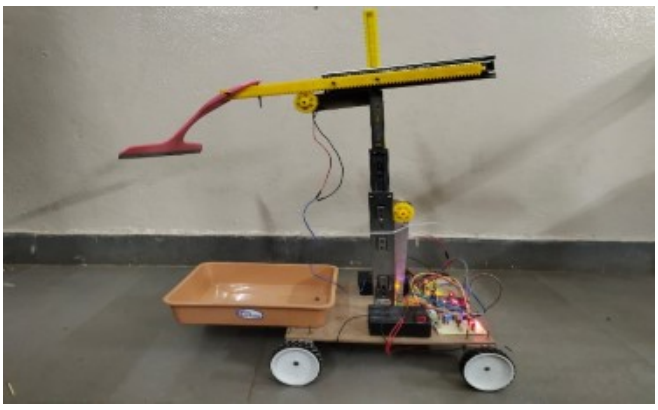

Fig 9. For the command **U**

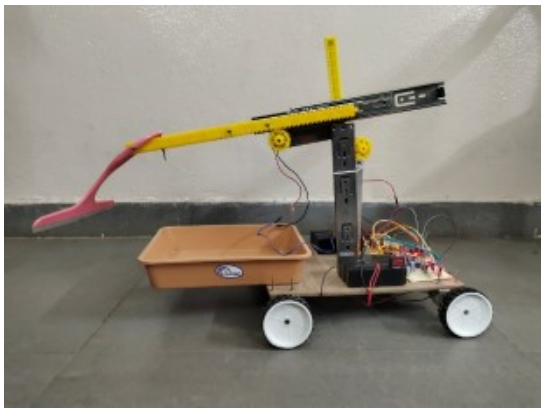

Fig 10. For the command **F**

Combining the commands of front(F), back(B), up(U), down(D) we control the actuators in the project just like here in the prototype.

V. CONCLUSION

In conclusion, the Mechanical Helper Hand emerges as a groundbreaking assistive technology, tailored to empower elderly and specially-abled individuals, fostering independence and improving their overall well-being. The device's seamless integration of dual actuators enables precise and adaptable movements, facilitating the execution of diverse tasks. Supported by robust wheels and motor drivers, smooth navigation across various terrains is assured. Moreover, the incorporation of advanced modules, such as the ESP32 with Wi-Fi and Bluetooth capabilities, enables real-time video streaming and remote control, enhancing user interaction and engagement. The Mechanical Helper Hand holds the promise to redefine the lives of its users, offering a reliable and intuitive companion to aid daily activities and elevate overall quality of life. Future avenues of exploration encompass heightened environmental awareness through the implementation of obstacle avoidance algorithms and sensor data processing with additional sensors, personalized assistance via machine learning algorithms, and seamless integration with smart home systems, fostering inclusivity and accessibility for those with mobility challenges and enabling Emergency SOS feature.

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