

# Keypad-Controlled Limb Therapy Glove: Restores Strength and Flexibility to Fingers

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**Abstract**— In this paper, servo motor is used to control the movement of hand-finger. To give the information, rehabilitation activities require a constant monitoring method. The goal is to assist them in enhancing and personalizing the recovery process. The main objective of this project is to design and develop a keypad-controlled smart glove aimed at improving finger strength, mobility, and coordination through customized rehabilitation exercises. In this paper, by integrating a 4x4 keypad with an Arduino Uno R3, users will be able to input commands, select therapy durations, and control the speed of their exercises. The glove will utilize servo motors to simulate natural hand movements providing targeted therapy for finger rehabilitation. The LCD will offer real-time feedback, allowing users to track progress. Overall, this paper demonstrates a pocket friendly, portable hand-finger rehabilitation device.

**Keywords**— Rehabilitation, Servo motor, keypad, Therapy.

## I. INTRODUCTION

The rehabilitation of hand and finger mobility has witnessed remarkable advancements through the integration of cutting edge technology. Traditional physiotherapy methods, while effective, often face limitations such as high costs, limited access to consistent therapy sessions, and a one-size-fits-all approach that may not cater to individual needs. These barriers can hinder patient participation and slow recovery progress. In response, recent trends in rehabilitation emphasize affordable, user-friendly, and personalized solutions. Wearable smart devices, such as keypad controlled smart gloves and servo motor-driven systems, are transforming how finger rehabilitation is approached. These innovations enable patients to exercise independently, track progress, and customize therapy routines, making recovery more efficient and engaging. These devices leverage technologies such as development boards

(Arduino), servo motors, and interactive keypads offering patients the ability to perform guided exercises in the comfort of their own homes. With real-time feedback and customizable exercise routines, these smart gloves can be tailored to meet individual recovery needs, thus improving rehabilitation outcomes. The use of such techniques aligns with current trends in the healthcare industry, which emphasizes remote monitoring, personalized treatment, and the incorporation of technology to enhance patient engagement and recovery efficiency. Designing and creating a keypad-controlled smart glove with the goal of enhancing finger strength, mobility, and coordination through personalized rehabilitation activities is the primary goal of this project. Through the integration of an Arduino Uno R3 with a 4x4 keypad, users will be able to choose therapy durations, enter commands, and regulate the pace of their workouts. The glove will provide targeted therapy for finger rehabilitation by simulating natural hand movements like flexion, extension, and gripping using servo motors. Real-time feedback will be provided by the LCD, enabling users to monitor their progress and stay inspired during their recuperation. This project's scope is centered on developing an affordable, user friendly rehabilitation tool that can be used by people recovering from neurological disorders, arthritis, or hand injuries. The device will provide customized therapy options that are tailored to each user's specific needs and can be used in the comfort of their own home, reducing the need for frequent physiotherapy visits. Its portability, ease of use, and customizable features make it accessible to a wide range of patients, providing an innovative approach to finger rehabilitation. This paper will shine a light on developing a hand rehabilitation device. Section 2 describes the detailed description of device. The proposed system methodology is discussed in section 3. The result and analysis of the model is discussed in section 4. The proposed model is concluded in section 5.

## II. LITERATURE SURVEY

Many literature survey and background studies on the rehabilitation techniques for injured hand have been done. Some of the existing methodology that were impactful in this research are summarized in this section. The goal of the project is to use controlled and interactive robotic training to help chronic stroke survivors regain hand capabilities. To support rehabilitation activities, the device converts EMG information from muscle activity into equivalent robotic hand movements [1]. The gadget provides useful support to people with limited upper limb mobility by supporting shoulder and elbow movements via cable actuation. Because of its small size, it may be easily incorporated into everyday tasks. Initial tests reveal that the exosuit effectively lowers muscle effort during arm movements, which may find use in physical support and rehabilitation for the elderly or those suffering from neuromuscular illnesses [2]. Soft polymers are used in the device's lightweight and flexible design to allow for safe and organic interactions. Tendon-driven actuation supports dexterous movements for everyday aid or rehabilitation by precisely transmitting force. According to preliminary findings, it has the potential to enhance hand functionality while preserving wearability and user comfort [3]. Active engagement in rehabilitative exercises is made possible by the system's utilization of EMG signals to identify hand motions and regulate the exoskeleton. In order to guarantee accurate and responsive control, which is essential for successful therapy, it measures gesture recognition delays. Findings show that it can improve motor recovery by offering prompt, logical support during rehabilitation exercises [4].

Examine how to recognize hand and finger gestures in human-computer interaction using inertial measurement units (IMUs). The technology can accurately identify intricate hand and finger movements by obtaining motion data from IMUs. The method makes use of machine learning and signal processing techniques to facilitate real time gesture identification. The study shows how IMU based systems can be used in wearable technology, assistive technologies, and virtual reality [5]. A system for hand gesture identification employing an accelerometer and EMG sensor combination is proposed in this paper. The system recognizes a wide variety of gestures with accuracy and robustness by combining motion and muscle activity data. To improve performance, classification algorithms are used in conjunction with signal preparation and feature extraction approaches. The paper shows how the framework can be used in prosthetics, assistive technology, and human-computer interaction, providing a dependable and user-friendly method of gesture-based control [6]. This study presents a cable actuated finger exoskeleton that provides precise support for individual finger movements and is intended for hand rehabilitation following a stroke. Its ergonomic, lightweight design promotes neuroplasticity and motor recovery while guaranteeing comfort and utility during repetitive, task oriented training. According to preliminary findings, it can effectively improve hand

functionality and aid in stroke rehabilitation [7]. introduces a flex-controlled robotic arm for amputees that uses muscle flexion signals to provide simple and useful control. Electromyographic (EMG) sensors are used by the system to identify muscle activation and convert it into precise robotic arm movements. By offering more natural, flexible control, the design aims to improve amputees' quality of life and simplicity of use. Initial tests show the system's potential to improve amputee recovery and help with everyday duties [8]. The design and initial characterization of a soft wearable exoskeleton for upper limb assistance are presented in this work. The exoskeleton facilitates natural mobility and enhances user comfort by using soft materials and actuators to provide lightweight, flexible support. For people with restricted upper limb function, the system is intended to improve mobility or aid in rehabilitation. According to preliminary tests, users' motor performance can be improved and their physical strain during rehabilitative exercises can be decreased [9]. The passive orthosis, an interactive hand and wrist exoskeleton intended for at-home stroke therapy, is shown in this research. Stroke sufferers may now undertake hand and wrist workouts on their own thanks to the device's interactive features and passive movement support. It aims to enhance recovery by promoting functional training in a comfortable and userfriendly environment. Preliminary testing suggests its potential to improve motor function and provide effective, at-home rehabilitation for stroke patients [10].

This report describes the creation of an assistive device and rehabilitation tool for the index finger that will help people with restricted finger mobility. The device's primary function is to give users tailored assistance with index finger movements so they can carry out daily tasks and engage in rehabilitation exercises. It provides controlled and adaptive help by utilizing a combination of sensors and mechanical actuators. According to early findings, it may help people with motor impairments regain their dexterity and aid in their rehabilitation [11]. The index finger module of a hand exoskeleton intended for post-stroke rehabilitation is described in this work along with its mechatronic design and characterization. By combining actuators and sensors, the gadget offers accurate, flexible support for finger movements, speeding up recuperation and enhancing motor function. A thorough description of the module demonstrates how well it supports rehabilitative exercises and encourages neuroplasticity. The study shows how focused, index finger specific therapy can improve hand functionality in stroke patients [12]

## III. PROPOSED MODEL

The following section depicts the working of keypad controlled smart glove designed to aid in the rehabilitation of finger strength, and mobility. It integrates an Arduino Uno R3 development board, servo motors, a 4\*4 keypad, and a 16\*2 LCD to provide a customizable and interactive rehabilitation experience. The glove utilizes servo motors to simulate natural finger movements like flexion, extension,

and gripping, facilitating targeted exercises for rehabilitation. The system used to implement this is illustrated in the following block diagram.

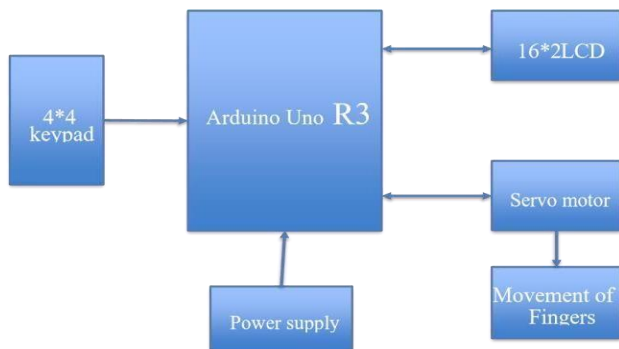


Figure 1. Proposed Model

For this system, Arduino UNO R3 is the main control unit that links all the components required for the rehabilitation system. When the user presses a key on the 4\*4 keypad, the Arduino reads this input through its GPIO (General Purpose Input/Output) pins. Based on the input, the Arduino executes pre-programmed instructions. The Arduino sends PWM (Pulse Width Modulation) signals to the servo motors, telling them to move the fingers of the glove in specific patterns (like flexion). Additionally, the Arduino also communicates with the LCD display to show important feedback to the user, such as remaining time, and speed of rotation.

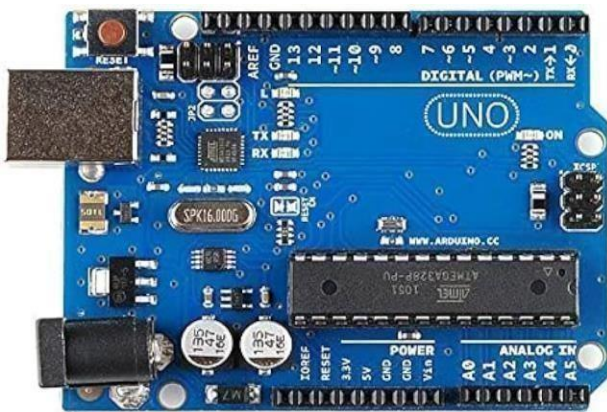


Figure 2. Arduino Uno R3 Development Board

The ATmega328P is the actual microcontroller located on the Arduino Uno R3 board. It is a highly versatile 8-bit microcontroller that handles all the logic and decision making for the project. When the user inputs a command via the 4\*4 keypad, the ATmega328P processes the signal and controls the servo motors based on specified parameters like exercise duration, and intensity. The microcontroller continuously checks the input, drives the motors accordingly, and updates the LCD to provide feedback on the user's rehabilitation progress.



Figure 3 . 4\*4 Keypad

Keypad serves as the user interface for interacting with the finger rehabilitation system. When a user presses a button on the keypad, a signal is sent to the Arduino Uno, which processes the input and triggers the corresponding action. The smart glove with a keypad provides a customized, affordable, and easily accessible therapy. The project is to decrease the need for physiotherapy appointments, guarantee more constant therapy, and improve the effectiveness and engagement of the rehabilitation process by empowering patients to practice finger exercises at home. Additionally, the glove will offer real time feedback, which is essential for monitoring patients' development and inspiring them. Essentially, by offering a novel, practical, and efficient hand rehabilitation solution, this research closes a significant need.

#### IV. RESULT ANALYSIS AND DISCUSSIONS

The proposed model is tested in Mangalore Institute of Technology and Engineering. After assembling all the components, and powering the Arduino and servo motor. The flexibility of the servo motor, combined with the user controls via the 4\*4 keypad, enables the patient to adjust the difficulty of the rehabilitation exercises. The user can modify parameters such as start or pause, and the intensity of the movement. The MG995 responds to these commands, ensuring that the patient gets an effective rehabilitation workout. Figure.4 shows the connection of Arduino where the input is stored and when the code is dumped with respect to that input, we obtain the output.

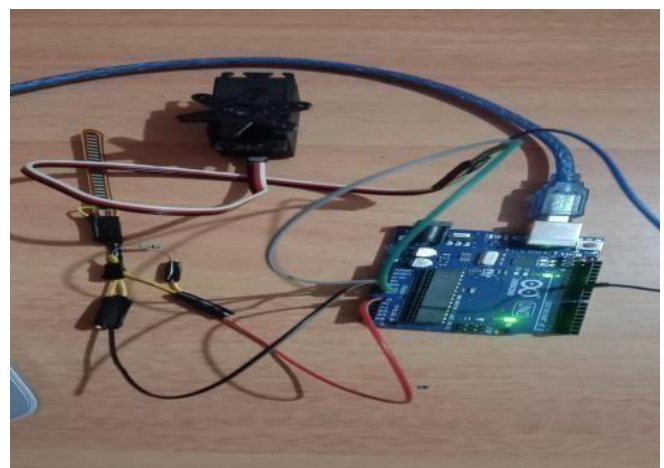


Figure.4 Connections of Arduino UNO R3



Figure.5 Connection of Servo motor

Fig.5 shows the connection of servo motor which is responsible for simulating finger movements such as flexion, extension, and gripping. allowing it to perform precise movements, which are essential for finger rehabilitation. The motor's precise control allows the system to mimic the natural motion of fingers in a safe and controlled manner such as bending and straightening at different speeds and angles, which helps to improve the range of motion and strength of the finger.



Figure.6 LCD displaying the message

Figure.6 shows the lcd displaying the message, upon pressing the key, that is initially when the power is on it asks to enter the duration in minutes. Entering the duration, pressing A will start the session and again pressing A will resume the session without any interruptions. Pressing B will increase the motor speed to level 2. On pressing D the motor rotation is stopped. After the set duration is complete, the LCD will display "Rotation complete" and the motor automatically reset for a new session.



Figure 7. Connection of the Frame

Figure.7 shows the connection of the frame to which the injured hand will be placed. This will help with the movements of fingers to bend.



Figure 8. Frame connected with components

Figure.8 shows the connection of the entire components. When the key is pressed and when the duration of session is entered, the servo motor rotates and makes the fingers of the hand to bend.

## V. CONCLUSION AND FUTURESCOPE

Rehabilitation could be automated using various mechanisms and techniques. One such is explained in detail in this paper. In this paper. An Arduino Uno R3 microcontroller, servo motors, a 4\*4 keypad, and an LCD is integrated to create a comprehensive system aimed at supporting individuals in their rehabilitation journey. The device allows users to set the duration of the rehabilitation session, adjust the speed of the motor, and pause or resume the exercise, making it a flexible and user-friendly tool for therapeutic use. Upon powering on the system, the LCD also prompts the user to enter the duration of the exercise in minutes, after which the user can press a key to start the motorized movement. In future work this idea can be extended to design a quadriceps physiotherapy device enabling automated leg rehabilitation. The system could help the patient to perform repetitive up and down leg movements which is much essential for the patients recovering from any leg injuries. The system can be useful for the patients recovering from the post surgery or muscle injury, Further the device can be incorporated with wireless connectivity where the doctor can monitor real time performance and personalized exercise recommendations. Such device make therapy faster and more efficient.

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