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Mechanized Physiotherapy Device for Accident Victims

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Abstract

Assistive robots are in high demand because they allow people to work freely. Physiotherapy is an outstanding recovery session given to mostly all accidental victims during recovery span. Although, due to the experimental nature of examination, assessment, and treatment, the lack of scientific measures, current methodologies, and modernization, as well as the empirical nature of examination, assessment, and treatment, this endeavour is hampered. This paper proposes an idea of using an exoskeleton-based system for the physical therapy of the hand (primarily). Our system endeavour to enhances the existing therapy methods by introducing accurate and repeatable linger motion, continuous measurement, interactivity, Great exercise assortment and statistical storage and evaluation. The robotic arm is controlled using robotic kinematics concepts. The graphical user interface (GUI) is used to operate the actuators that control the robotic arm's joints. Because the robotic devices may assist in moving the patient's limbs during exercises, this system helps therapists save time by increasing the number of therapy sessions per patient and the number of patients undergoing therapy.

Keywords: Therapy sessions, physiotherapy, occupational therapy, graphical user interface (GUI), electric motor

INTRODUCTION

Robots are utilized for a variety of tasks, including product assembly, handling hazardous materials, spray painting, cutting, and polishing, and product inspection, and this trend will continue in the future years. As a consequence, research in biomedical discipline is also striving towards developing robotics to physical capabilities of both patients and clinician.

Here initially we have worked on similar concepts of devising robotic arm for simplifying physiotherapy sessions specially for challenged, elderly and busy individuals by its one of its main attributes of feasibility The process of developing and building a safe robotic arm for use in physical therapy sessions is described in this study (Figure 1) [1].

The merit of this system are:

- Minimize the shortage of physiotherapist
- Improves the performance of the upper limb
- Upgradation in technology is possible

The significance of having a normally functioning hand for living a self-sufficient and active life cannot be overstated. The hand is one of the sources of sensation, checker of minute variation details. Regrettably, the number of occurrences of unintentional injuries has increased dramatically in recent years. Congenital malformations, traumatic injuries, neurological

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and arthritic diseases, and regional pain syndrome of the hands are just some of the injuries that can leave sufferers with lasting scars. The therapist uses two types of exercises throughout the rehabilitation phase

In the rehabilitation phase, therapist employs two groups of exercises:
1. physiotherapy exercises
2. occupational therapy exercises

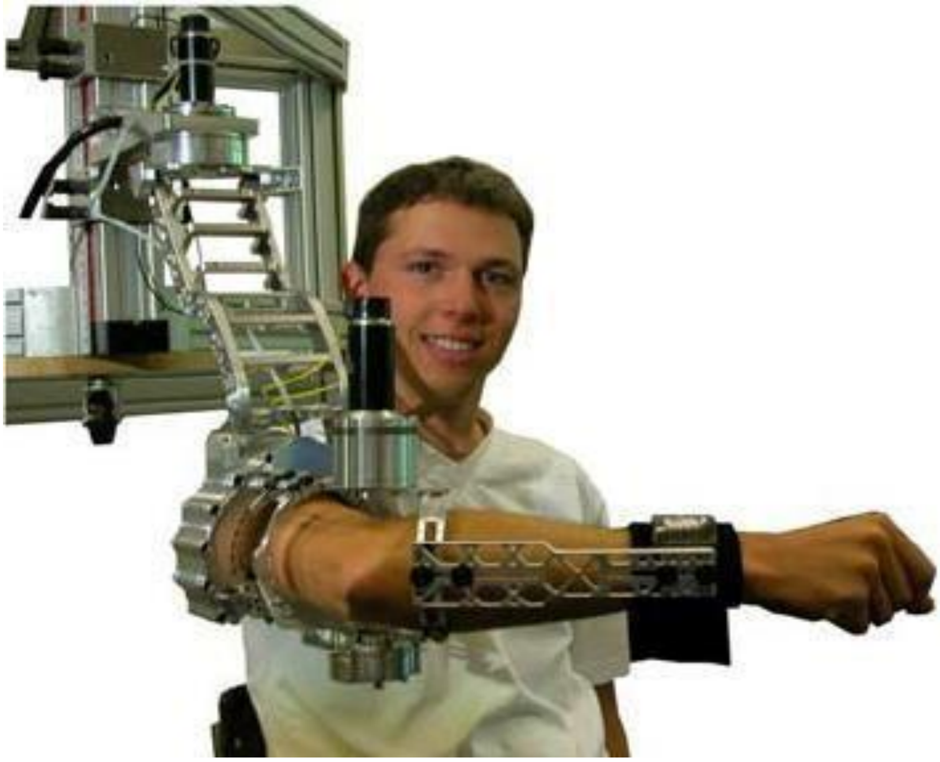

Figure 1. Arm exoskeleton.

Basic gross mobility skills, such as moving specific joints and strengthening specific muscles, are the emphasis of physiotherapy exercises. Occupational therapy focuses on daily activities [2]. Both sets of exercises have the goal of reducing pain, restoring joint mobility, and promoting maximum independence.

However traditional hand treatment, on the other hand, has a number of drawbacks, which are stated:
1. Recovering motor skills necessitates repeated rigorous sessions.
2. Measuring subjectively. The patient is first checked for discomfort, as well as any loss of strength, feeling, range of motion, or structure. The data is compiled into a numerical impairment assessment, which is then used to track the patient's progress over time. Currently, functional assessment is done by evaluating a patient's performance on defined motor skill tests [3]. Examining information and extracting conclusions from it, on the other hand, can be time consuming, costly, and prone to observer error. Furthermore, when several examiners diagnose the same patient, repeatability of the patient's conditions report becomes a concern, making it difficult to track a patient's improvement over time.
3. In many cases simple mechanical devices are used. Rehabilitation devices are mainly mechanical. Very few of them are sensorised but even those don’t work properly. No improvement or progress record are stored for further analysis neither in online nor in offline mode. Therefore, therapist may falsify in diagnosing patient’s condition properly [4].

4. Unavailability of remote monitoring or any re-evaluation of progress of patient's improvement can't be monitored accurately. There is presently no monitoring facility to keep and monitor the portion of therapy that the patient does at home [5]. And in scenario when patients' own exercise results in varying degrees of compliance with the prescribed exercise regimen, which has negative effects on the treatment outcome, again it goes unnoticeable.
5. Patients who dwell in suburbs are forced to commute all the way to metro cities for therapy. These results to incur additional expenses and disruption in routine life.

In addition to the above disadvantages, the numbers of rehabilitative centers that can give such services are limited geographical and distribution of such service over the most countries is uneven. It means that the current system fails to provide many in needy patients with the prompt attention required for brain remodeling and functional adjustments [6]. The adverse financial, social, and psychological benefits of the current hand rehabilitation system on the patient, his family, and the community as a whole, has motivated the research efforts into innovative hand therapy methods and systems [2].

Safety and enabling components, among other things, must be included in therapeutic robot systems. Enabling devices were initially created for industrial system operators to ensure the safety thresholds during a brief presence in the protected area. Enabling equipment for therapy robots, on the other hand, must be continually manipulated by patients during the treatment session in order to allow therapy [3]. National medical device conformity evaluations will be required for all robots used in biomedical applications, including robot assisted physiotherapy. This method involves the examination of conformity with the Medical Device Directive 93/42/EEC in the European Union 6. The safety evaluation is in the hands of approved bodies in Europe and other countries, which invariably leads to case-by-case differing safety procedures for rehabilitation robot systems [7]. This dispersion necessitates the ongoing worldwide safety standards. The system was created using the experimental findings of a study on the kinematics and dynamics of the human arm in everyday activities. The mechanical components that link the human arm to the exoskeleton framework and allow force transfer between them. Positioning the device adjacent to an immobile arm to permit sleeve-like donning through closed bearings is less desired in the usage of immobile platforms for therapeutic applications, and joint designs should be carefully considered. The assurance of safe functioning is crucial for HMIs. On three levels, safety safeguards have been included into the mechanical, electrical, and software designs [4]. The mentioned systems' safety is intertwined with the system's mechanics, power supply, and software development in each situation. When robots gather kinetic energy, they pose the greatest risk [8]. Dynamic collisions between the robot and the person are possible, or static pressure can be applied on stuck body parts if the robot can halt. All of the therapeutic robot systems investigated had one or more emergency stops within easy reach of the user.

Only a handful of the therapeutic robots tested had extra safety features [3].

Demerit of Conventional Physiotherapy Sessions
1. Regaining motor skills needs intensive and multiple sessions.
2. Subjective measurement.

At the beginning the patient is examined for the presence sharp pain and any strength loss, numbness. The results are put together and thereby numerical assessment of impairment used to evaluate the patient's progress over time. Functional evaluation is currently achieved by observing patient's performance on standardized tests for motor skills.

MATERIAL AND METHOD

Servo motors will provide external force to move exoskeleton by comparing coordinates of hand to the one of many proposed degrees of freedom (DOS). Serial input will be keep reverting back to controller as well, after continuous threshold comparison and continuous adjustment and this process will keep going. Other joints i.e., the shoulder, elbow, wrist, and the gripper consist within the supportive robotic arm. Servo motors are used as they are easy to control giving HIGH or LOW pulses from the Arduino I/O board [1].

Hardware Description

The commands from the user are given through the Graphical user interface which communicates with Arduino I/O board serially [1].

Servo Motor

A servomotor is a basic electric motor controlled by servomechanism. When a motor is used as a controlled device with servomechanism, it is referred to as a Dc servo motor. An Ac servo motor is one that uses AC to regulate the controlled motor.

The key benefit of employing a servo is that it provides angular accuracy, meaning that it will only spin as far as we want it to before stopping and waiting for the next signal. The servo motor is unlike a traditional electric motor in that it starts rotating as soon as power is provided and continues until the power is shut off [9].

We can't control the speed of an electrical motor, but we can control the speed of a servo motor and turn it on and off.

ESP32

The ESP32 is a low-cost, low-power micro controller that comes with built-in Wi-Fi and Bluetooth. It has an antenna and an RF sensor embedded in, as well as a power amplifier, low-noise amplifiers, filters, and a power management module

Muscle Sensor (Myoware)

This sensor detects the electrical activity of your muscles using EMG (electromyography). This is then converted to a variable voltage. It's the newest version of the old Muscle Sensor, with a new wearable design that lets you attach biomedical sensor pads directly to the board itself, eliminating the need for those annoying cords.

EMG circuits and sensors have made their way into a wide range of control systems, thanks to the introduction of ever smaller and more powerful microcontrollers and integrated circuits [10].

GUI

A person with an upper limb disorder will have fewer or limited limb functionality when it comes to moving their wrists or fingers. The user inputs are processed by the GUI, which moves the joints accordingly. Processing 3, a software tool that uses the Java framework for programming, is used to create the GUI. The key advantage of utilizing this software is that it is open-source and may be customized to meet the needs of the user [1].

SOFTWARE IMPLEMENTATION

The built robotic arm is automated using the Arduino IDE and PyCharm software platforms, which connect serially with one another. As previously mentioned, the PyCharm software is utilized to create the GUI. For initializing servo motors, robotic arms, and sensors, the Arduino IDE is used [1].

METHODOLOGY

Figure 2 shows the workflow of developing mechanized physiotherapy arm. Starting with designing of exoskeleton arm of patient in accord with the proper movement and dimensions. Then Electrical circuit will be made and checked in the simulating software like proteus and the model will be trained with data set using machine learning. Then all the necessary electrical interfacing will be done with the prototype and later validation of function will be verified.

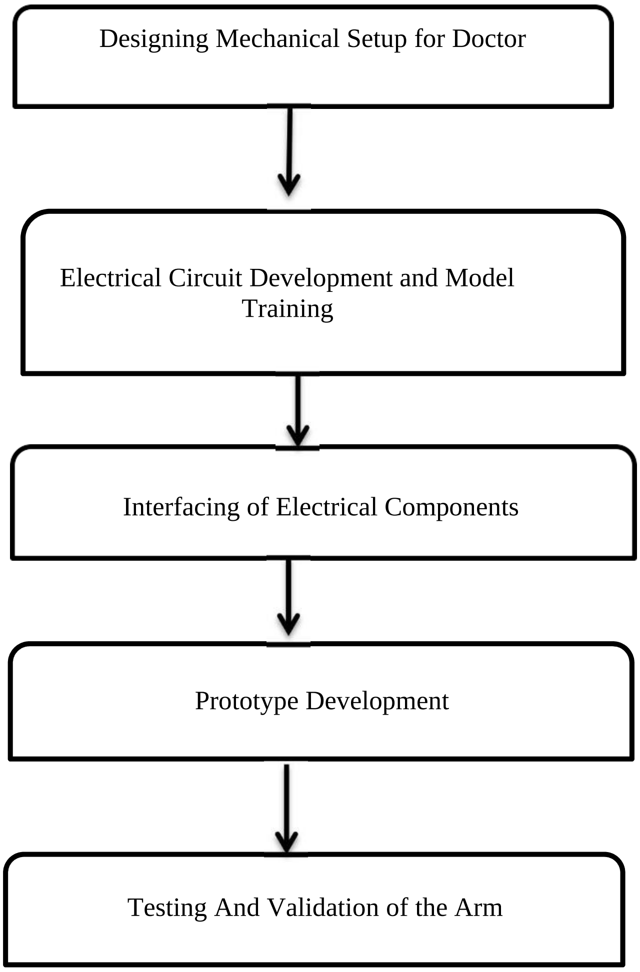

Figure 2. Methodology of mechanized physiotherapy arm.

CONCLUSION AND FUTURE SCOPE

This robotic arm for physiotherapy can assist the physiotherapist. The performance of the injured patients' upper limbs can be improved by automating treatment exercises under the supervision of a physiotherapy expert. The number of caregivers required for patients decreases, and the patient's upper limb performance rate improves. Implementing this automation approach for physiotherapy exercise benefits all small-scale physiotherapy hospitals. The new method is easy to use and far more efficient than the previous one. By linking the number of patient arms to the single doctor arm, a single doctor may exercise a larger number of patients at the same time. With the help of doctors, testing can be done based on clinical validation.

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