

ABHA - Advanced Biomechanical Hand Assistant

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Abstract—The outlook for the future of physiotherapy is very promising, with a gradual increase in its demand. This trend is mainly explained by the fact that there is an increasingly active and ageing population in developed countries. The growing demand for this area will consequently lead to the need for many resources, both human and economic. Currently, there are several bionic hands with various uses and functions, and most of these hands are programmed to respond to the movements of a particular user. Besides, most of the applications of medical robotics are mainly directed to the area of surgery. With this proposal, we intend to simplify the whole physiotherapy or rehabilitation process. For that, we have developed an equipment capable of helping the patient to perform the exercises in the comfort of his home, but in an equally efficient way. The operation of the system consists of autonomous use by the patient, who must wear the glove and replicate the exercises, predefined for each user, performed by the biomechanical hand. Having the possibility to define the exercises, ABHA is transferable and can be used by more than one patient.

Keywords—Rehabilitation, Medical Robotics, Physiotherapy, Stroke

I. INTRODUCTION

The increase in demand for physiotherapy sessions for motor recovery is a common problem in society and with greater incidence in more developed countries, where the average life expectancy has been increasing with the improvement of living conditions. In this sense, an imbalance between the supply of physiotherapists and the demand for these services has been born.[1]. An imbalance between the supply of physiotherapists and the demand for these services has been emerging. If the current needs for physiotherapy are maintained at the national level, demographic changes in the population imply a forecast of an increase of 9.85% in the need for physiotherapists in 2030 in relation to 2010.[2] The processes carried out by the existing bionic hands in the rehabilitation area consist of taking advantage of the reflex on the part of the hand and the movements made by the patient with the glove. In this way, it is possible to aid the recovery of people who need treatment for minor injuries, and it can be carried out autonomously.[3] Our hand can be classified as a fully active bionic hand, as it is driven by multiple motors in each finger, which allows full degrees of control of each finger

and can conduct flexible tasks with independent joint movements.[4] The resources available in the health area are used with the purpose of improving the quality of life and reducing the time spent by the patient travelling to all the physiotherapy sessions.

II. MATERIALS AND METHODS

A. Prototype

The 3D hand model was developed in SolidWorks software and is made of PLA (Fig. 1). It allows familiarization with the shape of a human hand to facilitate contact with the patient. Servomotors connected to the fingers by nylon wires allow the movement of the finger joints. In addition, the system also consists of a glove, which should be worn by the patient to replicate the movements performed by the hand, and a website that allows the health professional to manage his patients and prescriptions and also to establish the angles of the fingers and number of repetitions that the user should perform.



Fig. 1- Biomechanical Hand

B. Electronic Components

The electronic components are responsible for the major automation of the biomechanical hand and are as follows: Microcontroller (Esp32-wroom-32), RFID-RC522, Display, LEDS, Accelerometer/Gyroscope (mpu6050), a multiplexer (TCA9548A) and, like mention before, five servomotors. These components allow the glove to communicate with the hand which connects to the database providing the necessary data to establish the finger angles and number of repetitions corresponding to the patient in question so that the process runs automatically and problem-free (Fig. 2).

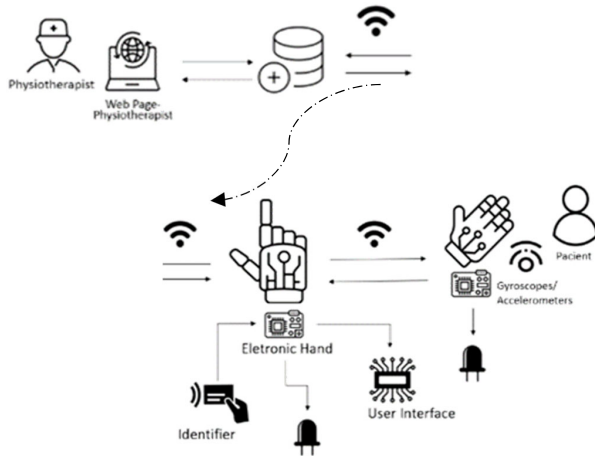


Fig. 2- General Overview

III. PROPOSED SOLUTION

The *ABHA - Advanced Biomechanical Hand Assistant* emerges as an alternative to traditional physiotherapy and aims to make the whole recovery process more comfortable and easier for the patient. With this model, the patient has to come to the treatment center only a small number of times and the hand physiotherapy is completely autonomous, automated and easy to understand for all ages. In this way, the patient saves time and money.

A. Biomechanical Hand and Glove

It constitutes the first contact with the patient since it has the device responsible for user authentication through a personal and non-transferable card. Communication with the database, after validation, will ensure the identification of the patient, the proposed exercises, as well as the number of repetitions and the position of each finger.

The patient will be using a glove with sensors capable of reading the angles produced by the fingers. This way, the patient's exercises are being monitored automatically and the system advances with the next exercise only when the previous one is done correctly.

B. Website and Database

The search for software with the capacity to carry out advanced wireless communication at a distance between the physiotherapist and the biomechanical hand led to the need to create a website. The website allows the health professional to register his patients as well as the plans outlined for them to carry out independently. In addition, it allows a daily follow-

up of the compliance or not of the patients with the pre-established exercises. All the data is stored in an external database and the microprocessor in the biomechanical hand collects the necessary data to elaborate different exercises for different patients.

Número de profissional de saúde: 123

Registrar Paciente

Nome	Nascimento	Nr de Paciente
Rafael Lima	2000-10-21	1235
Mario	1972-07-07	6666

Nr de Utente	Nr de Prof. de Saúde	Ação
123456778	123	Planos Excluir
555666789	123	Planos Excluir

Fig. 3- Website Page

In Fig. 3, an example of one of the several web pages displayed on the website is represented. In this case, it is possible to see a list of patients registered in the system from a certain healthcare professional.

IV. CONCLUSION

ABHA was developed to assist, accommodate and promote the modernization of traditional rehabilitation techniques, allowing a patient to perform series of exercises at home, without the need to physically go to a location. Using concepts from computer science, electronics and other areas, a prototype was implemented to help consolidate the vision of this project, along with a website that simulates the eventual interaction between a health professional and the patient. In general terms, the development of ABHA constituted a learning experience for the team through the application of concepts learned in different areas, establishing a link between them and developing autonomy and the ability to take advantage of available resources.

In sum, this project joins so many others within an increasingly promising sector where technological advances make it possible to foresee an eventual reality where people can enjoy medicine in a simpler way, but with greater quality and comfort.

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