**DESIGN AND IMPLEMENTATION OF UPPER-LIMB REHABILITATION DEVICE BASED ON EMBEDDED SYSTEM**

**ABSTRACT**

This paper is mainly on designing a wearable device for upper-limb rehabilitation by the integration of network communication, mechatronics design, interactive webpage, and database management. The developed function modules include a multi-dimensional mechanical structure, sensor and driver circuits, database, and interactive interface. In the design of mechanical structure, 3D printing is used to product some key components. The signal acquisition and analysis, information transmission, and controller design are implemented in a Raspberry Pi based embedded kernel. From system integration and testing, the required functions are all verified.

**INTRODUCTION**

In recent years, portable devices have been developed for human limbs due to the progress of robotics. These devices are used in military, industrial and medical disciplines to increase the weight-bearing capacity and assist long-term activities and medical rehabilitation. Aging society is a normal and irreversible process of human life. Increasing the aging population will necessitate more healthcare workers. Not only the problem of aging, but also the high proportion of people suffering from musculoskeletal and neurological injuries with accidents through the medical care staff and equipment to assist treatment. Nowadays, many scholars have already set their sights on the development of medical rehabilitation devices. In particular, wearable devices are an important development for rehabilitation device. However, patients need a long time to recover their body. A large area of scalded wounds appeared will cause scar contracture, and then causes limb dysfunction, nerve damage, limb deformity, muscle atrophy and other issues. The medical technology advances, patients greatly increased survival rate, but they don’t have the originally body.

**EXISTING SYSTEM**

Early rehabilitation is the key to the success of surgery. In practice, rehabilitation is not a continuous activity so that patient activities for one to two hours will not have too substantial effect, but will result in the burden on patients [11]. Effective rehabilitation is best repeated several times a day, every time for five to ten minutes and maintains the joints and muscle activity. Robot devices for rehabilitation can be divided into full-body, upper-limb, lower-limb, etc. The robotic device is designed to be worn by the user or patient to achieve synchronized operation of the human body and it is also a technically challenging. The mechanical design must be light weight and the motor torque should not be too small. How to balance the human-machine interaction is the most technical issue in design. The limbs and rehabilitation device requires an ideal control system if not properly controlled, the consequences can put patients at risk. The application of remote parameter setting for health-care services has also gradually entered the daily life. In medical applications, the remote operating system for rehab can reduce the distance between rehabilitative patients, therapists and have better interaction with each other. This will increase the understanding of physical therapists on recovery of patients with recuperation and will increase the range of possible applications. An effective rehabilitation program should be expected, rehabilitation is to train patients with muscle and joint activities. Nowadays, most of the rehabilitation is based on the rehabilitation engineer to assist the patients, make assessment, plan rehabilitation courses, and use the rehabilitation equipment in the hospital to help patients. In this paper, upper limb rehabilitation device is used to help patients recover. Taiwan government focus on health-care and community care, the rehabilitation device needs to be improved for medical treatment to replace the current doctors take care of one by one with patients and make the device portable, lightweight, with the SQL database to provide more effective rehabilitation, and to collect the rehabilitation information of each patient such like personal status, showing the state of rehabilitation through the visual chart, physicians can use this platform for patient follow-up treatment planning and achieved by a physician, while monitoring a number of patients, saving medical resources, rehabilitation can be done anywhere. At the same time, among safe, comfortable and effective operating environment are possible for the body recover to a good state.

**PROPOSED SYSTEM**

This paper presents a system for rehabilitation patients who have upper-limb impairment. Patients have different shape of upper-limb so we consider that design a suitable device for all patients is difficult. An ideal rehabilitation system has to combine with custom design and the system also has well enough for safe, comfortable and efficient. This work designed a platform by using Raspberry Pi, which is a control kernel for rehabilitation system. The system also connected to doctor database and doctors can easily monitor patient situation for rehabilitation with upper-limb. And website is designed for better treatment assignments so doctors can remotely execute the range setting of exoskeleton device. This rehabilitation system is better than traditional device for upper-limb because this mobile device is with market values, having the advantages of small volume, less weight, lower cost and easy to operate. Traditional rehabilitation device is heavier than this paper proposed and this work is able to support remotely health care so the proposed system is convenient for patients and doctors. Users and doctors are able to choose many operation models which will be discussed in section B. In the design of mechanical structure, some key components are self-designed with 3D printer to fulfill the required rehabilitation operations. We use Solid Works software to design key components for 3D designing. This part will introduce digital control platform and focus on ARDUINO micro controller and Raspberry Pi. We use I2C to connect to ARDUINO and Raspberry Pi so that the two devices can easily change each data and data address in order to control rehabilitation system. We discuss two parts of Raspberry Pi and ARDUINO to introduce the function what to do. First, we use Raspberry Pi to build a double loop scenario, evaluate velocity and data storage with patients. Raspberry Pi support double loop controller and supply Wi-Fi protocol and TCP/IP protocol to connect web service and database. ARDUINO is a micro controller which support PWM signal as output and we can generate DC motor or encoder to measure some data such as motor position, motor velocity and voltage. It is easy to develop our control platform by using I²C protocol between ARDUINO and Raspberry Pi so we can easily integrate with rehabilitation system PID controller is a common type of closed-loop control method which is widely adopted in industry control systems because of its simplicity and flexibility. Compared to the other control methods, PID controller can be tuned without obtaining the complex model of the process to be controlled.

**PROPOSED SYSTEM ADVANTAGE**

* The wireless network communication access to database and data records can be done through interactive web pages as visual presentation.
* To provide a safe, comfortable and effective environment for the patients.
* The quality of rehab medical care and save on medical manpower and equipment costs.

BLOCK DIAGRAM

MOTOR

ARDUINO

RASPBERRY PI

POWER SUPPLY

GSM/GPRS

HARDWARE REQUIREMENT

* Raspberry pi
* Arduino
* GSM/GPRS
* Motor