Device for Monitoring Kinesiotherapy in Rheumatic Patients

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Abstract:
Rheumatoid arthritis (RA) is a long-lasting autoimmune disorder that primarily affects joints. Most commonly, the wrist and hands are involved. This disability limits one’s daily activities of their life. Moreover the affected person could feel more pain in their joints if they were inactive. The clinical practice suggests that recovering from chronic diseases requires therapeutic exercises along with pharmacological treatments. The therapeutic exercises are called kinesiotherapy exercises. In the patients view, the challenge is that they should travel to any centre or any hospital to attend the session. This will be more difficult, because if the patients were subjected to any stress (E.g. Strong or sudden movements with their joints) they will feel more pain in their affected joints. The solution is to design a portable kit or a device that should be capable of monitoring the exercise done by the patients and guide them throughout the therapy session. After the completion of the session the kit should send the main statistics of the therapy session to the clinician website, where the doctor can monitor and make a conclusion about the patient’s condition.

Keywords: Inflammation, kinesiotherapy, rheumatoid arthritis, therapeutic exercise.

I. INTRODUCTION

Arthritis (from Greek Arturo- joint + itis- inflammation) is a form of joint disorder that involves inflammation in one or more joints. There are over 100 different forms of arthritis. The most common form of arthritis is Rheumatoid arthritis (RA). RA is a disorder in which the body’s own immune system starts to attack body tissues. The attack is not only directed at the joint but also in many other parts of the body. Due to RA, most damage occurs to the joint lining and cartilage which eventually results in erosion of two opposing bones. RA often affects joints in the fingers, wrists, knees and elbows and can lead to severe deformity in a few years if not treated. RA occurs mostly for women at the age group of 25 and above. Although research into medications to treat RA is ongoing, there’s no current cure for this condition. Still, a healthy diet, proper rest, stress management, pharmacological treatments and regular therapeutic exercises can help to improve the health condition. Those therapeutic exercises are called Kinesiotherapy exercises which means, the application of scientifically based principles to design specific exercises aimed to enhance the strength, endurance, and mobility of individuals with functional limitations which require extended physical conditioning. A kinesiotherapy exercise program, prescribed by health professionals is often a necessary step for individuals who have been recovering from RA. Kinesiotherapy aims to (i) Strengthen the muscles and provide greater joint support by reducing the stress at the affected joints (ii) Improve the flexibility in affected joints and in the surrounding tissues (iii) Reduce bone loss related to inactivity and inflammation.

II. PROBLEM

The problem that could be faced by the patient as well as the doctors were, the active kinesiotherapy session would require constant monitoring by health professionals but often it is impossible to closely assist every patient, because of the reduced availability of specialized facilities and quailed staff. A clinician need to concentrate every patient sessions, it becomes a tedious one if the number of patients were increased. The clinician cannot assist them at a time. At the same time the patient should travel to any centre or any hospital to attend the session, their comfortless is very important, they should not undergo any stress. And also these exercise sessions were repetitive one; patients were advised to take the session every day. The clinician cannot spend all his time for monitoring those activities.

III. SOLUTION

In this paper a device with remote monitoring and guiding capabilities especially for the rheumatic patients is developed. Through this device, patients can attend the session wherever they feel comfort, and will be free from travelling stress or any discomfort. This kit will send the final statistics of each exercise results to a clinician webpage soon after the completion of the session. The doctor need not to monitor each and every patient separately, instead doctors can simply analyse the final statistics of the therapy session to know the condition of the patients.

IV. INTRODUCTION TO THE DEVICE

The device is a portable, compact, looks like a suitcase in structure, made of dry plywood of half inch thickness with less weight and easy to carry. The device is resistance to earthing or any shock, because it is made of an insulator. It will withstand without any crack up to a meter drop. It has the capability of guiding and monitoring the kinesiotherapy exercise. There is a processor to control the operation of the whole device. The device will monitor the exercise done by the patients on the basis of data given by the sensors, which are placed inside the exercise tool kit, or for some exercise patients were advised to do exercises directly on the sensors. For the guiding purpose, an LCD is mounted on the device, it will
display the instructions for the exercise. A battery is attached to it; it is supported for recharging facilities. On the whole the device is more user-friendly. Fig-1 shows the front view of the device.

![Figure.1. Front view of the device](image1)

**V. LIST OF EXERCISE**

In this device, it is planned to concentrate mainly for joints below the wrist. For that the set of exercises were developed by consulting with the therapists who were specialized in handling the RA disorder. The exercise developed is based on the patient’s condition, so that it will vary with patient to patient. Each patient will have a different set of exercise kit. Based on their defects they will be grouped and then the training programmes will be provided for handling the kit. Four type of exercises were developed and the kit is designed accordingly. The list of exercises is follows:

- Hand pinch
- Hand grip
- Finger pinch
- Screwing with fingers

**VI. EXERCISE DESCRIPTION**

The hand pinch and hand grip exercises refers to pressing the thump against the remaining fingers and gripping the fingers with the tool in the palm. Fig-2 refers to the hand pinch exercise. Fig-3 refers to the hand grip exercise. The tool kit for these exercises is embedded with force sensitive resistor (FSR) sensor having small active area. This sensor is used to measure the pressure applied by the patient. By measuring the sensor value, the pressure applied by the patient can be calculated.

![Figure.2. pinch exercise](image2)  ![Figure.3. grip exercise](image3)

The tool kit for the finger pinch exercise is embedded with force sensitive resistor (FSR) sensor having small active area. By measuring the sensor value, the pressure applied by the patient can be calculated. The sensor used for the screwing with finger exercise is a multi-turn precision potentiometer. By measuring the sensor value, the speed of the rotation can be calculated. Fig-4 refers to the finger pinch exercise. Fig-5 refers to the screwing with fingers exercise.

![Figure.4. finger pinch exercise](image4)  ![Figure.5. fingers exercise](image5)

**VII. DEVICE SPECIFICATIONS**

An ultra-low power MCU AT mega 2560 of Atmel Corporations is used to control the process of the whole kit. It has an inbuilt A/D converter. The sensor outputs are connected to the analog pins of the controller. The controller is coded in such a way that it receives the sensor value and converts it into respective pressure value. The maximum pressure that the sensor can measure is 2kg. The controllers then send the data to the website through raspberry pi. The Arduino and raspberry pi can communicates each other serially through an usb cable connected between them. Raspberry pi connects to the internet through a Wi-Fi usb adapter, edimax 7811un. Whenever a hotspot is turned on, raspberry pi will automatically get access to the internet through the connected network. An alphanumeric LCD is used for the guiding purpose. The LCD consists of 16X4 displays, which is used to display the instructions for the respective exercise, and it is interfaced with the controller. The kit is completely user friendly. Suppose, if the patient wants to skip or move to next exercise or wants to quit, it is possible to do so by pressing simple buttons. Indications are given by the LED’s to indicate the charge level of the battery, current exercise, ON/OFF, etc. The detailed block diagram of the device is shown in the figure 6.

![Figure.6. Device specifications](image6)
VIII. WEBSITE

The website is developed and hosted. The data from the device is send to the database, from the database the data will be retrieved and a statistics will be generated and displayed in a web page. The front page layout of the website is shown in the figure 7.

![Website Image]

Figure 7. Website

In order to protect the details of the Patients, the statistics and the details of them can be accessed only if logged in, so that only known persons can access the details. In the front page the details of the project and the photos have been displayed. The statistics will hold the data related to pressure, speed, etc., according to the exercise, against the time the patients taken to do the exercise. The statistics of the hand pinch exercise is shown in the figure 8.

![Hand Pinch Image]

Figure 8. Hand Pinch

IX. HIGHLIGHTED FEATURES

(i) Feature for guiding the patients throughout the session  
(ii) Wi-Fi techniques for internet connection to access the data faster  
(iii) Reminder to the session through text messages  
(iv) Cost of making a device is reduced  
(v) Feature for interaction between doctor and patient through the device at the time of session.

X. CONCLUSION

In this paper we presented a device which will be more benefit to the society of rheumatic patients. In future we will improve this device by analyzing the impact it is created among the patient’s, thereby improving present features and adding additional features with the device and the technology used. Adding to this, we will take the results of the device into various aspects and modify the device according to that.

XI. REFERENCES


