

Bilateral Trainer For Stroke Patient Using Wireless Sensor Network

T. Bharathi¹, G. Jeevitha², V. Gowtham³, M. Sivaramaganesh⁴, P. Rubini⁵

PG Scholar, Embedded System Technologies, S.A Engineering College, Chennai, India

Abstract: Bilateral Arm Training (BAT) is one of the popular exercises for the patients affected by stroke. Bilateral training can be used to improve unilateral limb functions affected by stroke. The purpose of this work is to include leg trainer along with the arm trainer for early & better recovery. The bilateral arm training is important and is considered as best served because, it helps for stroke patients skill recovery even from severe levels through some alternative exercise mechanisms. This work consists of conventional bilateral arm trainers such as sanding unit which is made of woods and so it can't provide the data automatically. The proposed work consists of three types of sensors in arm & one pressure sensor in leg using WSN (Wireless Sensor Network) for automatic data collections. One type of sensor have implemented as a pressure sensor for sensing the grip force, second type of sensor have implemented as weight measuring sensor to sense the weight applied & third type of sensor have implemented as distance measuring sensor for measuring the distance. WHART (Wireless High Addressable Remote Transducer) is used as a wireless communication protocol between transmitter & receiver block for transferring the data. EMPCR (Electro Magnetic Proximity Card Reader) have implemented to read the patients information & to store it automatically in controller unit and PC. The use of bilateral arm & leg training is used to activate neural networks, promoting neural plasticity and cortical repair so that can improves the affected limbs.

Index Terms: Bilateral Arm Trainer (BAT), Wireless Sensor Networks (WSN), Wireless High Addressable Remote Transducer (WHART), Electro Magnetic Proximity Card Reader (EMPCR).

I. INTRODUCTION

WSN systems are developed to provide automatic data collections [1] and it is used in variety of applications such as design space [2], autonomous sensor node techniques[3], health monitoring systems [7], elder care systems [10], smart home systems [9] etc. Though there are numerous WSN applications were proposed, there may still existing large amount of procedure and task working without any electronic functions especially for therapy and rehabilitation treatments. For example, conventional sanding unit is a popular bilateral arm trainer for patients after stroke attack. Conventional sanding units are made by woods and they cannot provide data automatically. The features of conventional sanding unit are structure is simple, reliability will be high, easy maintenance and cost is low. But, without any electronic functions a pure mechanical structure cannot be used to record or collect the data automatically during the exercise process.

Two problems may occur when the electronic components are not used. One of the problem is that continuous investigations are necessary to record the patient's information during exercise process and this makes to improve the patient's health care. The second problem occurs from manual investigation. Manual investigations are hard to record the accurate result during the reciprocal exercises. Therefore, automatic rehabilitation data collections of conventional sanding units are necessary to avoid these efforts.

Based on the importance of continuous investigations and automatic data collections, this project uses Wireless Sensor Networks (WSN) to improve data collection efficiency for conventional sanding units. This project

aims at proposing to have not only the arm trainer but also leg trainer along with arm trainer. Hence, the combined arm and leg training machine will be more efficient and useful to patient's better and earlier recovery compared to separate training machine. This paper, also introduces Electromagnetic proximity card reader (EMPCR) to read individual's information and store their data in their account.

II. DESIGN CONCEPT

A. Problems of Existing method

Though the conventional bilateral arm training machine consists of two sanding hand block, it will be efficient for the patient's affected with hands alone. But, this type of machine will not be efficient for the stroke patient affected with hands along with legs. Hence, this project develops a conventional sanding unit having both arm and leg trainer. This project is also implemented with EMPCR (Electromagnetic Proximity Card Reader) to read individual's information and store their data in their account. WHART (Wireless High Addressable Remote Transducer) is used to transmit the information from transmitter block to receiver block.

B. Working of proposed conventional sanding units

Conventional sanding units are the popular bilateral arm & leg trainers which are mostly used in rehabilitation centers. The structure of a conventional sanding unit as shown in fig. 1 is made by woods and it consists of upper plank, sanding hand block of both right & left side with a connected wire having 2 pulleys, angle adjustment of upper plank, Reciprocal exercise platform, two sanding leg blocks with a connected wires[1].

The sanding unit is desired to emulate symmetric push and pull sanding activity with certain resistance levels and the each level of resistance can be achieved by adding various weights on sanding hand blocks or by adjusting upper plank's angles.

This conventional sanding unit bilateral arm & leg trainer makes the patient to do the exercise in simple and convenient way. When an upper limb holds a down moving sanding hand block, has to provide a muscular strength to pull up the other sanding hand block held by the other hand, and for the leg plank. When one limb pulls down one side of sanding hand block, at the same time other side of the sanding hand block is lifted up by using the other side of limb and leg plank also lifted when any one of the sanding hand block is pulled down. Hence, the muscular functions of movements (up and down) of two limbs are coupled, and they are coordinated to complete a reciprocal cycles. As a result, sanding exercise improves the patient's performance and their muscular strengths.

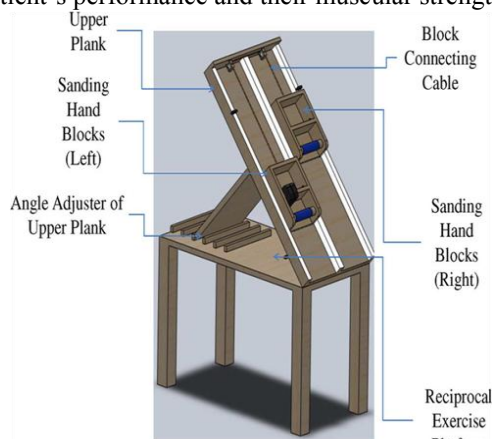


Fig.1 Structure of Conventional Sanding Unit

III. SYSTEM ARCHITECTURE

In this project, WSN techniques are used for automatic data collections as shown in figure 2. Three types of sensors are used to collect the information are pressure sensor, load cell, Infra-Red sensor. Sanding hand block (both left & right) includes all these three types of sensors and sanding leg block consists of only pressure sensor.

EMPCR (Electromagnetic Proximity Card Reader) is a proxy card used to read individual's information and to store their data in their account. This card reader will produce beep sound after the card has been read.

WHART (Wireless High Addressable Remote Transducer) is used to transmit the information from transmitter block to receiver block. WHART is a wireless mesh network communication protocol which is based on IEEE 802.15.4 protocol.

In this project, it utilizes the power of 0-5V. Pressure sensor is used to measure grip force of arms and legs, load cell is used for measuring the weights applied. IR sensor is used to measure the distance. WHART is used for transmitting the information between transmitter block and receiver block at the range of 2.4GHz. Since the trainer is a wooden sanding unit, it is a low cost solution.

IV. METHODS AND IMPLEMENTATION

In this paper three different types of sensors are used to measure the data automatically without any interventions. WSN techniques are introduced to minimize the wiring task and to overcome some unwanted noises. Two pressure sensors are placed on surface of the cylinder handle to measure the gripping force of arm and two pressure sensors are placed on the surface of leg plank to measure the gripping force of the leg during the exercise.

Weights are placed at the weight placement guider and each weight will as 1kg and a weight stopper is placed at the end of applied weights so that the weights are fixed at that position during the exercise. Two Load cell are placed at weight placement guider to measure the weights applied automatically.

Infrared-Red sensors are used to measure the distance till which the cylinder handle is pulled on every side. Two IR sensors are placed near the pulley on both sides. Cycle achievements are important to bilateral arm training exercises because a complete cycle desires exercise stroke which defines a pair of upper and lower cycle limits.

EMPCR (Electromagnetic Proximity Card Reader) is a proxy card or proximity card which is used to read individual's information and to store their data in their account. This card reader will produce beep sound after the card has been read.

WHART (Wireless High Addressable Remote Transducer) is used to transmit the information from transmitter block to receiver block. WHART is a wireless mesh network communication protocol which is based on IEEE 802.15.4 protocol. WHART transmits the data at the range of 100m for indoor and it transmits the data at the range of 300m for outdoor.

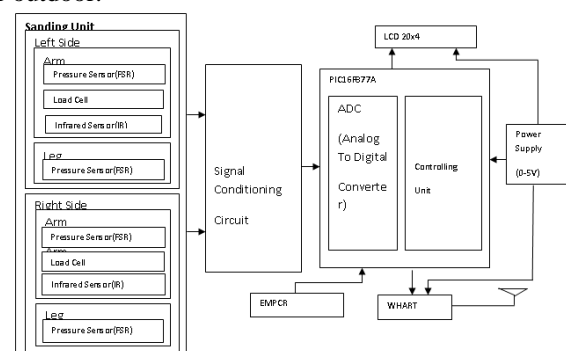


Fig. 2 Block diagram of proposed conventional sanding unit

IV. EXPERIMENTAL RESULTS

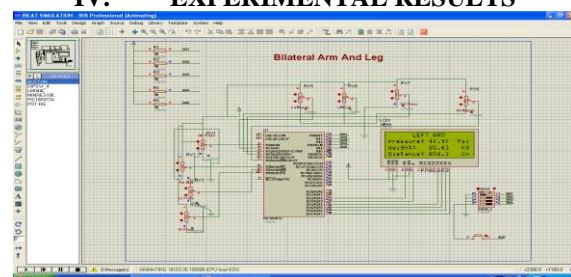


Fig.3. Simulation Result for Left Arm

From the figure 3 it is shown that the pressure, Weight & distance of Left Arm is measured.

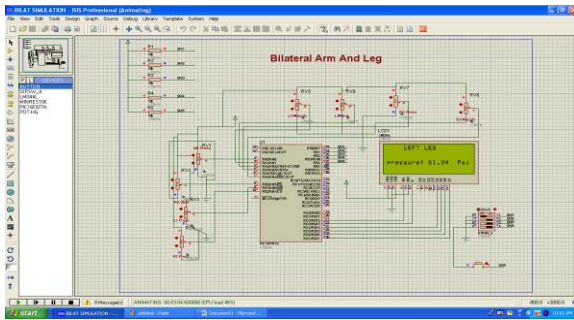


Fig.4. Simulation Result for Left Leg

From the figure 4. it is shown that the pressure of Left leg is measured.

V. CONCLUSION AND FUTURE SCOPE

The proposed work consists of three types of sensors in arm and one pressure sensor in leg using WSN for automatic data collections. One type of sensor have implemented as a pressure sensor for sensing the grip force, second type of sensor have implemented as weight measuring sensor to sense the weight applied & third type of sensor have implemented as distance measuring sensor for measuring the distance. WHART is used as a wireless communication protocol between transmitter & receiver block for transferring the data. EMPCR have implemented to read the patients information & to store it automatically. The use of bilateral arm & leg training in stroke rehabilitation is based on the assumption that symmetrical bilateral movements activate similar neural networks in both hemispheres, promoting neural plasticity and cortical repair that results in improvement in the affected limb. Therefore it will be more useful for stroke patients to recover earlier.

Sometimes patients may get arm recovery earlier compared to legs. Therefore the future scope of this system is leg trainer should be designed with three sensors like arm trainer to give treatment separately for affected leg.

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