# MONITORING DEVICE FOR HAND FRACTURE & PARALYSED PATIENTS

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***Abstruct- With the huge development and the latest technological advancements in mechatronics, prosthetic device have acquired interest in many different fields such as medical and industrial fields. An artificial substitute for a missing part of the body of humans is called a prosthetic device or prosthesis. Goal of this project is to design a portable, light-weight and low-cost rehabilitation system for people with a fracture/paralysed based on the accelerometer sensor and IOT. In this project, the device designed to make a part of the rehabilitation of hand fracture& physiotherapy practices to the paralysed patients. The wearable device allows a user to perform specific movements and exercises to train the patient's impaired hand using IOT communications. Thus. the user independently practice herself/himself instead of expecting some others help to restore the functionality of his/her hand. Doctors can also analyze the real time movements of the hand of the patients which are not admitted in hospital. The IOT technology alerts the caretaker/doctor when their patient is in any emergency condition.***

***Keywords: Rehabilitation, IOT, Accelerometer, Hand gesture movement.***

## 1. INTRODUCTION

Paralysis is the loss of the ability to move some or all of your body. It can have lots of different causes, some of which can be serious. Depending on the cause, it may be temporary or permanent. There are many possible causes of paralysis such as strokes, spinal cord injuries, traumatic brain injuries and autoimmune disorders such as Guillain-Barre syndrome and multiple scelerosis, born with birth defects. Approximately, 1 in 50 or 5.4 million people have some form of paralysis.Fractures of the hand are common injuries. A fracture implies a break of any of the bones of the hand. Typically, fractures are associated with trauma- a motor vehicle accident, bicycle mishap or sporting event. Due to the presence of multiple joints, hand fracture require skilled care. Fortunately, most hand fractures can heal without surgery.

Rehabilitation is the process of helping a person who has suffered an illness or injury restore lost skills and so regain maximum self-sufficiency. For example, rehabilitation work after a stroke may help the patient walk and speak clearly again. Rehabilitation after a hand fracture begins during the early phases of the fracture healing and continues until skeletal integrity and hand function of restored. The emphasis of the therapy during the early reparative stage of healing is on edema control, pain management, preservation of motion at the uninvolved joints, protective splinting and positioning to prevent disruption of fracture healing and, to prevent joint contracture .general rehabilitation techniques appropriate for all hand fractures include positioning and splinting, edema And pain control, joints and soft tissues mobilization techniques, and tendon gliding and strengthening exercises.

## II. RELATED WORK

### 1.Literature Review

**i ) "Wearable Shoulder Exoskeleton with Spring-Cam Mechanism for Customizable, Nonlinear Gravity Compensation" proposed by Morteza Asgari, Patrick T. Hall at all –IEEE, 2020.**

Wearable passive cable-driven exoskeleton that was intended to counteract half of the gravitational movement during shoulder elevation movements. The rotational moment measured from the bench top model closely matched the theoretical moment during simulated positive shoulder elevation. However, a larger moment up to (12.5% larger) was required during simulated negative shoulder to stretch the spring to its initial length due to spring hysteresis and friction losses.

**ii )"Mobile-based Environment to Facilitate Rehabilitation of Adults Post-Injuries" proposed by Maha M. Khalil Afifi et al – IEEE, 2020.**

They have developed two serious mobile games to facilitate post-injures rehabilitation, which utilize smartphone's accelerometer sensor to control the game. Since the proposed system depends on User Centered Design (UCD) approach, two prototypes were tested. The First Prototype targets elbow and shoulder joints. To cover these mentioned joints' exercises, the game is developed into three levels: first-level targets elbow extension. The second one includes two sub-levels; first one targets wrist supination/pronation, second sub-level combines both wrist supination and elbow extension. In the third level, the patient must perform wrist supination/pronation, and elbow flexion/extension. Second prototype includes three different games which target wrist supination/pronation, forearm supination/pronation, shoulder flexion, shoulder horizontal adduction/abduction, and elbow flexion/extension. As a pilot evaluation many visits to a rehabilitation center were arranged, the therapist confirmed that the game its usability.

**iii ) "Assessment of Upper-extremity Joint Angles using Harmony Exoskeleton" proposed by Ana C. De Oliveira, James S. et al –IEEE, 2021.**

They have characterized Harmony's anatomical joint angle tracking accuracy towards its use as an assessment tool. We evaluated the agreement between anatomical joint angles estimated from the robot's sensor data and optical motion capture markers attached to the human user. In 9 healthy participants we examined 6 upper-extremity joint angles, including shoulder girdle angles, across 4 different motions, varying active/passive motion of the user and physical constraint of the trunk. We observed mostly good to excellent levels of agreement between measurement systems with CMCip>0.65 for shoulder and distal joints, magnitudes of average discrepancies varying from 0.43◦ to 16.03◦ and width of LOAs ranging between 9.44◦ and 41.91◦.

**iv ) "Stroke Rehabilitation based on Intelligence Interaction System" proposed by Pornphom Piraintom el al – IEEE, 2020.**

This existing system detected a stroke patient by using a 3D camera, which is the Intel Real sense D415, to place at the end of the patient bed for extracting the patient from the bed by measuring the distance between the patient and bed. From the segmentation result of the patient, the proposed system evaluates the rehab posture of the patient by detection from the simulated skeleton to calculate from the changing degree of the shoulder joint, elbow joint, and wrist joint. In addition, the proposed system uses the capabilities of artificial intelligence to check the accuracy of physiotherapy patients and show to the patients how to perform physical therapy correctly.

**V ) "Smart watch as a Kinesthetic System for Shoulder Function Assessment" proposed by Srinivasan Jayaraman et al – IEEE, 2020.**

Smart watch to capture the direction of movement, velocity and ROM of the shoulder joint. ROM is the available amount of movement of a joint in different directions which can be either passive, active or active assisted. With the collected dataset and the proposed method, ROM could be estimated with a 9◦ error. Shoulder function or motion identification was validated by two different methods: i) rule engine and ii) machine learning approach. Rule base engine method was able to successfully identify the motions.

## 2.Existing system

In this existing system presented a wearable hand gesture recognition and finger angle estimation based on modified barometric pressure sensing Barometric pressure sensors were encased and injected with VytaFlex rubber such that the rubber directly contacted the sensing element allowing pressure change detection when the encasing rubber was pressed. A wearable prototype consisting of an array of 10 modified barometric pressure sensors around the wrist was developed and validated with experimental testing for three different hand gesture sets and finger flexion/extension trials for each of the five finger. In this existing system, WISN composed of three inertial modules were placed on the trunk, upper arm, and forearm of human for assessment of shoulder ROM in real time. Each inertial module consists of an ARM-based 32-bit microcontroller, a triaxial accelerometer, a triaxial gyroscope, a triaxial magnetometer, and a controller area network (CAN) transceiver. The measured accelerations, angular velocities, and magnetic signals generated by the human shoulder movements are transmitted to a personal computer via a Bluetooth wireless transmission module.The proposed shoulder ROM estimation algorithm includes the procedures of data collection, signal preprocessing, quaternion-based orientation estimation, and shoulder joint compensation. In order to evaluate shoulder ROM accurately, accelerations, angular velocities, and magnetic signals are integrated into a quaternion based complementary nonlinear filter for minimizing the cumulative errors caused by the drift of the inertial sensors.

## III.THE PROPOSED MECHANISM

Microelectronics and high level integration provide in combination with simulation and modeling of embedded systems new approaches in biotechnology and medical therapy. The integration of intelligent systems as well as sensors and actors in an adaptive hardware/software-platform increases flexibility and provides a scale able measurement and identification platform.

### i) proposed system

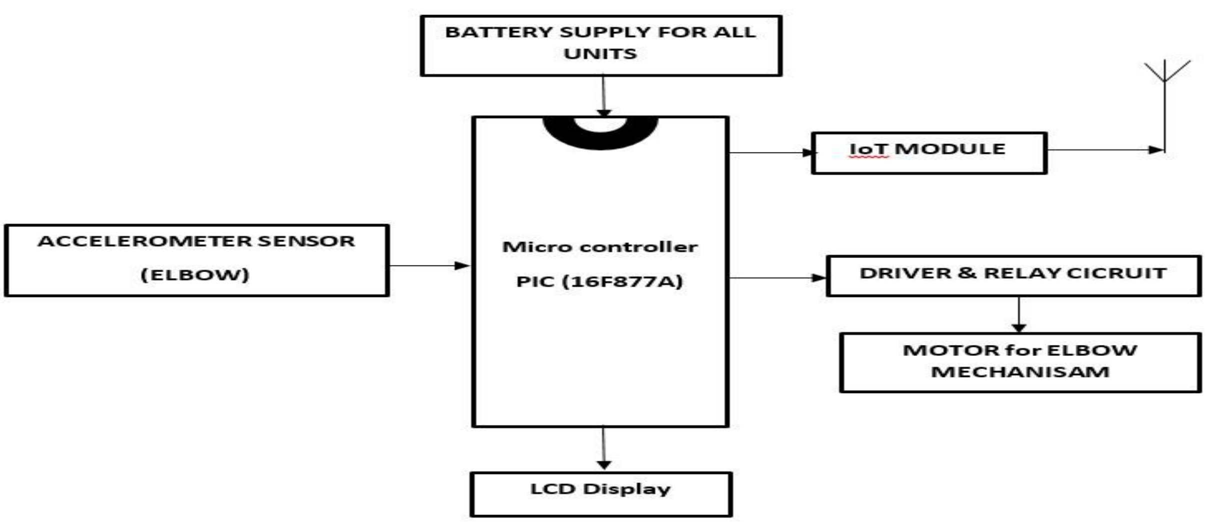

**Fig 1: Block diagram of propopsed system**

Based on modeling and simulation methods, different applications, like bio signal identification, prosthesis control and rehabilitation monitoring, offer completely new treatment and therapy options. In this paper we focus on the platform extensions of the modular gesture movement acquisition and identification platform by using Internet-of-Things modules and introduce new applications for rehabilitation monitoring and evaluation of motion sequences. The proposed system allows the user/doctor/ physical therapist to control the prosthetic hand anytime from anywhere by using smart mobile phones or PC. The user/doctor can control the lower limp via internet by using mobile application and monitor parameters The data is received by IOT module is collected by the microcontroller which is PIC (16F877A) Microcontroller. Node MCU searches for the pre-set SSID (Service Set Identifier) and connects automatically to the Internet. The user gets these data in his mobile application via internet server and then decides his action to control leg. The cayenne application provides the facility to read sensor data and control appliances easily on pressing the suitable button in application. Node MCU gets the instruction via internet server and provides output signal to the actuator circuits. When the relay is turned on, the appliances get the power from 12DC source. The switching circuit used for turning DC motor to ON/OFF for limp movement.

## A) Axis Accelerometer

An accelerometer is a device that measures proper acceleration; proper acceleration is not the same as coordinate acceleration (rate of change of velocity). This is placed in wrist of patient knee & ankle. The ADXL335 is a triple axis MEMS accelerometer with extremely low noise and power consumption - only 320uA. The sensor has a full sensing range of +/-3g.Board comes fully assembled and tested with external components installed. The included 0.1uF capacitors set the bandwidth of each axis to 50Hz. and onboard regulator 3.3volts by three accelerometers respectively and transmitted to a receiver via RF wireless protocol to control electrical load. An automatic gesture segmentation algorithm is developed to identify individual gestures in a sequence.

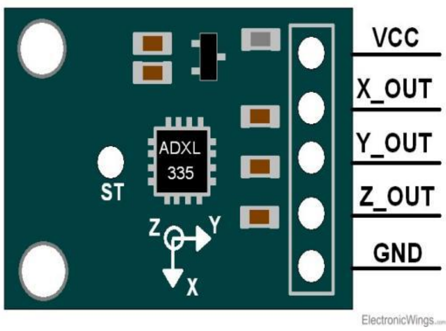


**Fig 2: Axis accelerometer**

## B) PIC (16F877A)

Port A has 8 Pins in total and it is an analogue Port. All Pins in Port A are analogue.

Port B also has 8 Pins but these all are digital Pins.

Port C is also a digital Port having 8 Pins.

Port C Pins are also used for Serial Communication.

Port D has 8 Pins and all are digital Pins. Port E has 3 Pins.

## C) ULN 2003

4 channel relay connected with 2 DC motors. The ULN2003A/L and ULN2023A/L have series input resistors selected for operation directly with 5 V TTL or CMOS. The ULN2003 is a monolithic high voltage and high current Darlington transistor

arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads.

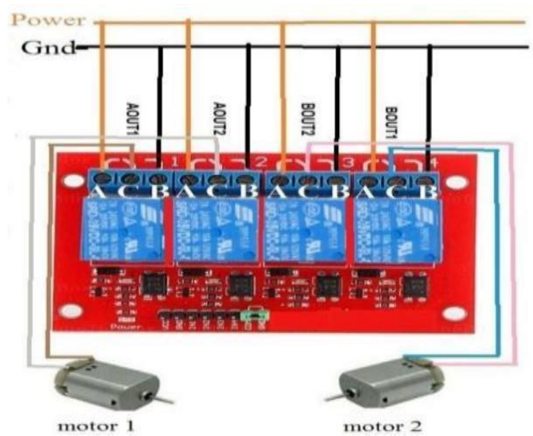


**Fig 3: ULN 2003**

## D) DC motor

In this project the motor is used to control prosthetic hand which is connected with the driver relay circuit. The 2 terminals of the motor is connected with the relay and the relay is operated according to the instructions mentioned in the program. The dc motor is operating voltage 12 dc voltage and ground. The motor ON/OFF status will be controlled by micro controller which is programmed in prior programming manner. 3 DC motors are used in our prosthetic hand - prototype design.

**Fig 4: DC motor**

## E) Relay

Relay is nothing but it is the electromagnetic switch. Relay allows one circuit to switch another circuit while they are separated. Relay is used when we want to use a low voltage circuit to turn ON and OFF the device which required high voltage for its operation. For example, 5V supply connected to the relay is sufficient to drive the bulb operated on 230V AC mains. Relays are available in various configurations of operating voltages like 6V, 9V, 12V, 24V and so on. Relay is divided into two parts, one is input and other is output. Input side is nothing but a coil which generate magnetic field when small input voltage is given to it.

## IV. PERFORMANCE EVALUATION

### 1. Waveform

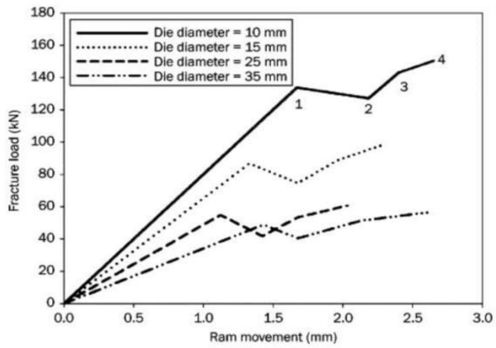


**Fig 5: Waveform for hand movement**

### 2. Results and Analysis

The prosthetic device were programmed to give movements to the hand of the patient. There are two degrees of angle movements attached to the device such as 30 and 45 degrees. Each degree the hand will be movement at 5 times. The doctors, can easily to give the movement in patient hand and also to store the hand movement waveforms and data for future references with use of IOT module. The emergency switch also attached to the device.

**Fig 6 : Prosthetic device**

## V.CONCLUSION

We designed a hand wearable device for patients with paralysis. The user can select between two different modes, active or passive. In addition, the device can perform different types of therapy exercises. It can also monitor the user's health like the temperature, pulse, ECG and oxygen. For the future work, the wearable device can be installed for both hands. Also, the numbers exercises and health sensors can increase. More studies should be done about the recovery time speed. Moreover, the patient can do the theVrapy exercises through fun interactive games using Virtual Reality technology. The wearable device should be tested on patients to prove the effectiveness of this rehabilitation system.

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