# Wearable and Portable System For Real-Time Activity Recognition Using IOT and Cloud

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***Abstract:*** In many approaches towards Real time activity recognition system they use RFID, camera, Man power-supervising, body sensor networks, are used to achieve 1. Ease-of-use 2. Coverage, 3. Privacy preserving issues. It is a technique that can be used to make people feel convenient similar to the behavior of normal people. Flex sensor is such a device, which accomplish the above task with great degree of accuracy. It can mimic the behavior of a natural human movement with low cost light weight flex sensors. With IOT technology and cloud we can analyses data very fast give reply action with great precision. We use IOT and cloud to give this app more accuracy and latency free with great coverage area and reliable system with easy to use. Our prototype system use low cost flex sensors and ardiuno kit connect all this with IOT and cloud to increase efficiency of application location independent system to Access sensor data from anywhere- any time. Our prototype system use low cost flex sensors and Arduino kit connect all this with IOT and cloud to increase efficiency of application location independent system to access sensor data from anywhere any time.

***IndexTerms* - Flex Sensor,HMMs,ADS,IoT,Cloud.**

## I. INTRODUCTION

The mainly purpose of this system is to monitor the movement of user's hand and knee during work. In the beginning, we want to use the system to identify the specific behavior with bending situations. Integrate the data, and output to the mobile/PC to inform users about their knee and hand movement in a period. Second, we hope that the system can be helpful for patients and labor. We think the system can let patients clearly see the recovery with the rehabilitation, instead of feeling it themselves. By comparing data which are stored every time they used the system/ Patients and doctors can have more discussions about the therapy and other related issue. For labor the activity will shows the labor is working or not on job. In recent years, many different combinations of sensor and actuator have been used in our lives, from the toilet lighting sensor, robot / robot arm use ... and so on. They are popular in our lives. The purpose of these products is to make the public life can be more convenient. It is technology to enhance the quality of our lives. The new system is looking forward to the use of a variety of different sensors to create a combination of different effects.

An IoT solution gathers information from the available sensors, people and/or electronic devices. If the data source, application, user or place of implementation are related to the healthcare industry, it is called an e-health solution. These kinds of applications provide a novel approach to the healthcare system, which bring new and better services such as constant monitoring of patients and remote consultation services. All of these services provide a faster and reliable healthcare industry with almost zero waiting time, changing the classical approach of the healthcare system from a reactive service to a preemptive industry.

## II. MOTIVATION

In our daily life we utilized our hand to do many tasks. Application like robotic, design, manufacturing, art and entertainment, information, visualization sign language understanding, medicine, health care etc. Every year, millions of people worldwide experience problems because of traumatic brain injuries degenerative disease articulation traumas. Rehabilitation aims to restore patient's physical, sensory and mental abilities affected by injuries, diseases and disorder, and to support the patient to compensate the deficit that is not medically treatable. In recent year, researchers have been focusing on hand gestures detections and been popular for developing applications in a field of robotics and extended in the area of artificial or prosthetic hands that can mimic the behavior of a natural human hand. The adoption of robotics system would reduce the healing time and in the future would allow the tele-rehabilitation management giving the patient the ability to perform exercise at home. This project all the utilizes a similar approach for the detection of the movement of the finger, however we have tried to extrapolate the idea in a slightly different perspective and have come up with a small yet significant application in the field of bioengineering. This project can be used for the speechless patients with half of their bodies paralyzed and who are not able to speak but are able to move their fingers. The aims and objectives of this project to develop an economical and simple solution for the detection of finger gestures using the sensorized glove permits to measure 10 joints of one hand.

## III. LITERATURE REVIEW

Several researches. In Zhou Renet al. [1] we see Robust Hand Gesture Recognition Based on Finger Earth Mover's Distance with a Commodity Depth Camera. In the other paper of Zhou Ren et al.[2]titled as 'Robust Part-Based Hand Gesture Recognition Using Kinect Sensor', Kinect Sensor have provided new opportunities for human interaction. Lee[3] and Bhuiyan[4] discuss the gesture recognition for human robot interaction and human robot symbiosis. Sanshzar Kettebekov et al.[5] offers a novel "signal-level" perspective by exploring prosodic phenomena of spontaneous gesture and speech co-production. It alsopresents a computational framework for improving continuous gesture recognition based on two phenomena that capture voluntary (co-articulation) and involuntary (physiological) contributions of prosodic synchronization. Ishikawa et al. [6] discusses different categories for gesture recognition. Markov models are used for gesture recognition by Byung-Woo Min et al.[7] and Andrew D. Wilson et al.[8]. Toshiyuki Kirishima et al. [9] present comprehensive framework that addresses two important problems in gesture recognition systems. An augmented reality tool for vision based hand gesture recognition in a cameraprojector system is described by Attila Licsar et al. [10] . A methodology using a neighborhood-search algorithm for tuning system parameters for gesture recognition is addressed by Juan P. Wachs [11]. A novel method is introduced to recognize and estimate the scale of time-varying human gestures by Hong Li et al. [12].

There have been many previous prototypes made in one such paper it is proposed that in the early days the integration of wearable sensors was achieved by running wires in pockets created in garments for the purpose of monitoring. Such systems by design were not suitable for long term health monitoring. So Recently developed wearable system which integrates individual sensors into the sensor network by relying on modern wireless communications technology is used.[14] In the second paper which we have surveyed it is presents the result of a pilot study to assess the feasibility of using accelerometer data to estimate the severity of symptoms and monitoring patients with the Parkinson diseases at home because every time is not possible for the doctor to monitor the patient who are suffering from Parkinson diseases and it is due to the loss of brain cells that produce dopamine. Early signs and symptoms of Parkinson's disease include tremors or trembling, slow movement, body rigidity and stiffness, and problems walking. There are five stage of Parkinson's disease for which there is no cure.[15]

In the third paper focuses on studying and implementing a system for measuring the finger position of one hand with the aim of giving feedback to the rehabilitation system. It consists of a glove where sensors are mounted suitably configured and connected to an electronic conditioning and acquisition unit. The information regarding the position is then sent to a remote system. The objective of this paper is to provide a sensorized glove for monitoring the rehabilitation activities of the hand.[16] In the last paper of survey it is proposes a rehabilitation device to help patients with wrist problem to do rehabilitation treatment at home without therapist assistance. The device uses a single hand pedal mechanism that contains an accelerometer to measure acceleration exerted by the user's wrist motion in pitch and yaw movements. Preliminary experimental results show the usefulness of the proposed device where the movement of accelerometer sensor attached on the device corresponds to the actual movement of the wrist. Furthermore, the uniqueness of this device is the portability and low-cost design. Several researches have been done the joystick based, gesture based and chain based control mechanisms. The process involved here are the user is expected to wear them in one form or undergo training in using them. However the gesture based interfaces are highly effective and are crucial for them to recognize the actual gestures accurately. They also proposed a new device based on the Doppler effect for the recognition of one hand gestures and the device consists of Acoustic Doppler sonar (ADS) including some of the Ultrasonic transmitting and three receiving purposes. By using a transmitter that emits an Ultrasonic tone that is reflected by the hand whereas the reflected tone that depends on the Doppler frequency shift on the current velocity on the hand. The velocity of the hand in multiple directions as the functions of time and the signals are captured by the three receivers used to recognize the specific gestures. The accelerometer based gesture recognition systems are using the continuous hidden Markov models (HMMs).

An accelerometer based gesture recognition system that uses only a single 3- axis accelerometer to recognize the gesture here are hand movement. Other method are also being designed a wearable gesture captured device and then gesture based interface for a mobile phone are realized to demonstrate the feasibility of gesture based interaction in the mobile communication. The sensors are used to develop the sign language recognition and human computer interaction. The Intelligent wheelchair is controlled by using Adaboost algorithm. The major advantage of this algorithm is the human body is limited and the environment situation is noisy the intelligent wheelchair is control by the head gesture. Here the prototype has been validated with the five healthy subjects such as screening, virtual environment driving and driving session with the wheelchair.

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## IV. EXISTING SYSTEM

### 4.1 Sign Language Recognition

In this work execution of the main device was done by the utilization of sensors like 9-Flex sensor, MEMS 3-axis accelerometer. Flex sensors are mounted with all five fingers of the hand and another four flex sensors are mounted on the palm side of the hand. Flex sensors are mounted on each joint of all five fingers. Due to hand movement, the bending of the flex sensor changes the resistance of the sensor and this change in resistance is fed as input to the microcontroller. Here first flex sensor is mounted on the thumb finger, second flex sensor is mounted on index finger on dorsal side of hand, third on the middle finger, fourth on the ring finger, fifth on the little finger and number six, seven, eight, nine are on palm ventral side of hand MEMS accelerometer monitor any tilted position in hand which is mounted on the dorsal side of the hand. A small circuit is designed to supply the power to these sensors and these are also associated with microcontroller. The data coming from these sensors is input to the microcontroller. In a microcontroller, a program is composed for every pattern such as for alphabet 'A' a specific range is decided and this range is decided by doing many experiments. If user wants to tell a word like 'APPLE' then he/she must follow International Sign Language (as shown in Fig. 1) in which he/she first draw the 'A' sign then after 10 seconds 'P' then respective he/she draw the 'P' 'L' & 'E' then user stretch straight the all his/her fingers there must be gaps in between his/her all fingers, and then final is send to Bluetooth which further transfer to smart phone. What's more, the message will appear on the smart phone screen [13].

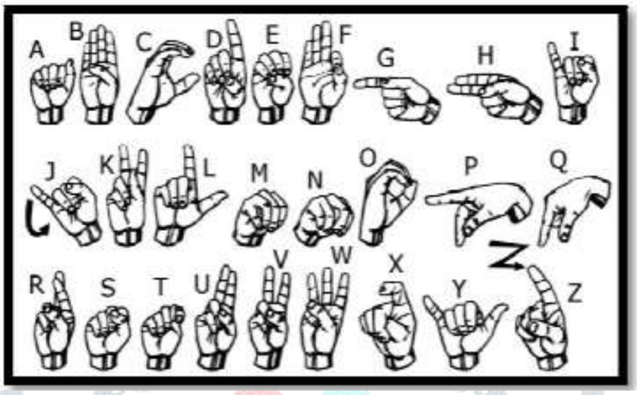


Figure 1 International sign language

Figure 1 shows work we designed mainly two types of cost effective flex sensors using different material like Cu & Al. We are transferring the data generated from microcontroller to smart phone. This designed device will be helpful for disabled people. Regarding future improvement in this project we can make more optimize device for which we require a specific smart phone application (app) that easily connect with microcontroller and receive the data. Then it can process the data and converts into voice.

### 4.2 RF-based Activity Recognition

Different from wearable sensor-based solutions, RF-based approach has been proposed to perform activity recognition in a device-free manner. In this paradigm, the user is required to wear no or minimum number of devices to perform activity recognition. Instead of using sensor data, fingerprints of RF signal patterns are used to recognize the users' activities. Recently, backscatter technology has attracted much research interest due to its low-cost and low-power properties. Active research has been conducted on high-throughput low-power sensing and communication and large-scale backscatter systems. Much research work has been conducted using backscatter RFID technologies for activity.

### 4.3 Real-Time Activity Recognition

Many previous systems perform activity recognition in an off-line manner [35]. Off-line recognition algorithms cannot achieve real-time recognition because they require the complete activity trace to perform recognition. The data collection time of such off-line recognition systems, which is also a part of the system's recognition latency, is long and uncontrolled. As a result, a real-time activity recognition system must be able to perform on-line activity recognition [36]. Different from off-line approaches, our system is can perform accurate activity recognition in real-time. Real-time activity recognition systems are more practical in supporting everyday applications such as emergency response and smart reminder. In [36], the authors discuss the performance of a real-time activity recognition system that considers both the recognition accuracy and recognition latency given two delay bounds. They propose a hierarchical, online activity recognition system that can perform best-effort soft real-time activity recognition. They system achieves an average recognition delay of 5.7 sensing periods and an average recognition accuracy of 82.87 percent. Different from this work, we discuss the problem of real-time activity recognition with a single delay bound which must be achieved [37].

Figure 2 Data Collection [37]

In this concept the use of RFID for activity recognitions. Above diagram shows the data collection from different work which carried out by different person such as riding bike, cleaning table, vacuum cleaning and cleaning window.

## V. PROPOSED SYSTEM

As the diagram shows a person wear 4 sensors two on hands and two on legs. The bending values from all sensors values will store on locally in text file. The text file values can also be stored in Google Drive also. By using HC-05 device the values can be appears on mobile phone. After getting all value the values stored on cloud also by using Internet by this way IOT concept may implement successfully.

Figure 3 General Diagram

Figure 4 Block Diagram

Block diagram shows the flow of project. Uses Arduino microcontroller to access values of sensors, HC-05 is also connected for the purpose to access values on mobile phone. Values stored on Google Drive, Cloud and with the help of these values graph also generated.

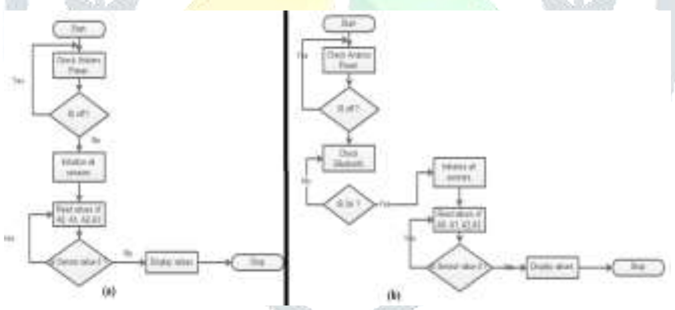

Figure 5 (a) Read Sensor Values from Arduino (b) Flow chart to read sensor values using HC-05

Fig 5 (a) shows the flow of read to sensor values from Arduino. If Arduino is ready to and checked then sensor values will be appears on serial monitor. Fig 5 (b) read the sensor values using HC-05 for android phone. The values will be appeared on mobile phone using readymade application and own app. Fig 6 (a) shows the flow of read values with mapping the threshold values will decide the movement of hands and legs respectively. Fig 5 (b) depicts the values with threshold and storing on locally, into Google Drive and on Cloud.

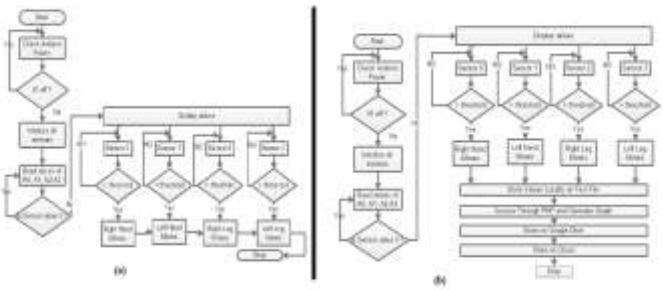

Figure 6 (a) Flow Chart to read sensor values with threshold (b) Flow chart for sensor values representation and storing.

## VI. RESULTS AND DISCUSSION

### 6.1 Arduino and Flex Sensors Interfacing

Here Flex sensor is connected to analog pin of arduino A0,A1,A2,A3. The bluetooth device is connected to arduino as shown in figure below. The values generated by flex after bending and before bending can be monitor.

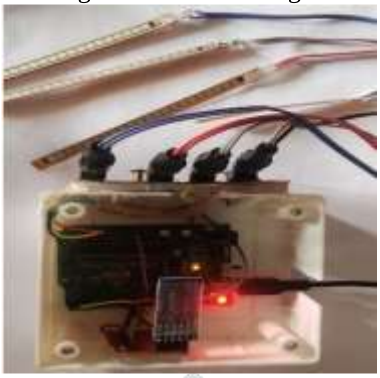

Figure 7 Arduino and Flex Sensors Interfacing

### 6.2 Flex Sensor Values on Mobile phone using Readymade Application

The Bluetooth device is connected and can be accessed using mobile phone, just pair with android mobile phone and use the readymade application which is available on Google Play "Bluetooth Terminal" the values display on mobile phone continuously. Here the value is getting in coded format that means start with "#" , middle end with "$" and end with "~" this is only purpose to access values by using our own application.

### 6.3 Sensor Values on Mobile phone using own Application

In this we are using own application and getting the values of flex sensors.


Figure 8 (a) Readymade and (b) Own Android App

### 6.4 Graphical User Interface

The GUI is based on simple web page developed using PHP and HTML. Here mentioned all the graphical outputs with values. The mapping graph and without mapping also shown. Individual graph also plot and provided links in GUI.

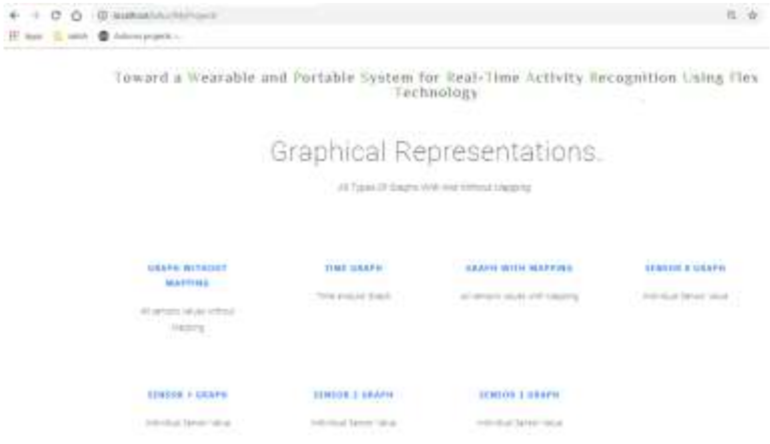


Figure 9 Graphical User Interface

**6.5 Store Serial monitor data in text file**
By using Cool Term tool the data on serial monitor of arduino can be saved using text file. The file can be store anywhere as we want.

**6.6 Graphical Representation of sensor values without Mapping**
Here the values getting without any processing, as fetched values from serial port will get here and we plot graph using these values without mapping.

**6.7 Graphical Representation of sensor values with Mapping**
Here fetched values can be processed by using Map() function in arduino, generally the sensor values ranges from 0-1023. But by using Map() we can limit the values range from 0-255 only. Here graph also generated with mapping.

**6.8 Time Graph**
As per the fetching time of sensor values the graph generated shown below.

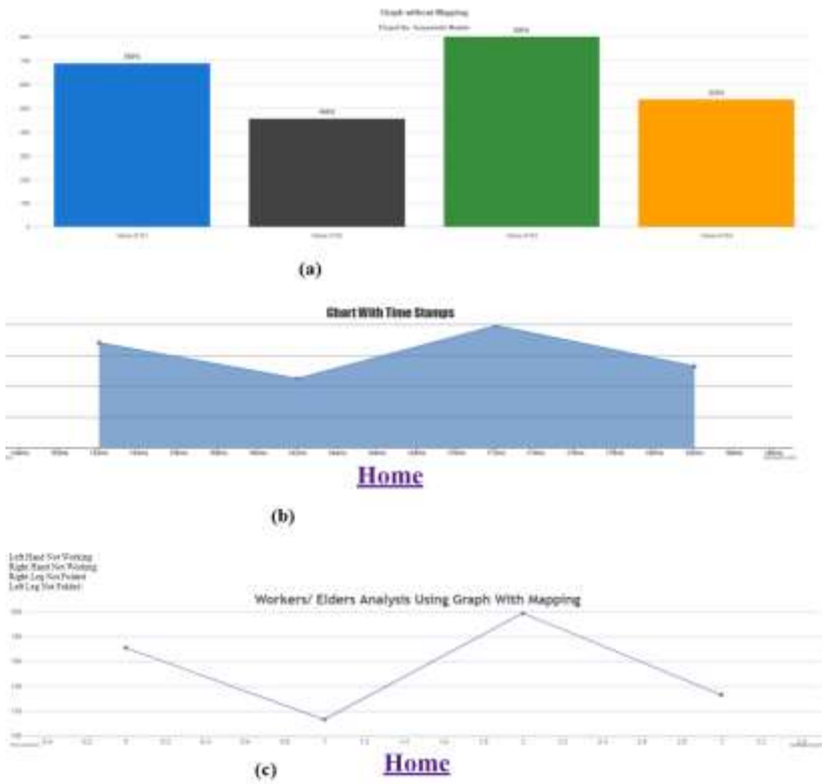


Figure 10 Graph With (a) Without Mapping (b) With Mapping (c) Time Chart

### 6.9 Individual Sensor Graph:

Figure 11 Individual Sensor Values

### 6.10 Upload data on Cloud

The data can be uploaded by using PHP on Cloud as shown below


Figure 12 Uploaded Data on Cloud

### 6.11 Output of Movement


Figure 13 Output of Movement

### 6.12 Comparison Between RFID and Flex Sensor

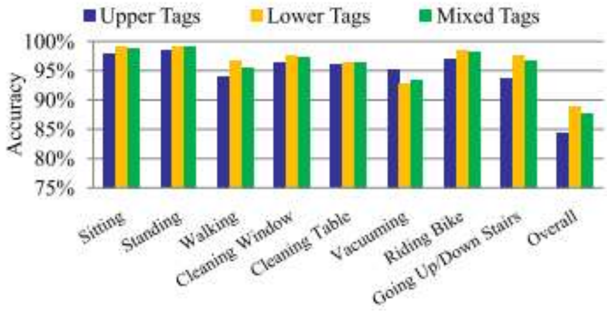


Figure 14 RFID with Antenna Readings [37]

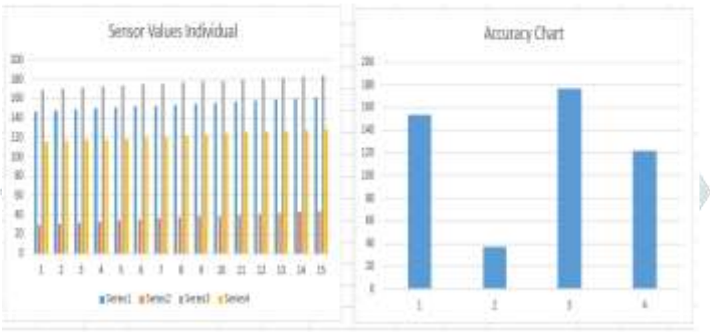


Figure 15 Flex Sensors Readings with Accuracy

The fig 14 depicts the charts values with RFID and with its antenna. In this graph the overall values or accuracy is less that 90% as shown in figure. In the fig 15 the values shows respective to flex sensors and the accuracy is greater than 95%. As shown in figure the Flex Sensors first maximum values is 160, Flex Sensor second is 40, Flex Sensor third is 180 and Flex Sensor four is 120. As depicted in graph the accuracy is greater than RFID. In RFID if antenna signal goes down then values will not appears, but in flex sensor there is no any antennas. The maximum values can be changed as per platform. Here the average of values are taken for getting effective accuracy of sensors.

## VII. Conclusion

A step-by-step approach in designing the microcontroller based system for measurement and control of the parameters has been followed. The results obtained from the measurement have shown that the system performance is quite reliable and accurate. This project is useful for labors and paralyzed patient tracking with any language which fills the communication gap between patient and doctor for elders and to track activity of labor. This system gives signals to analyze the activity of them to the receiver side. It is portable device and it requires less power for operation. This system has application in robotic, gaming, sign language etc. A flex sensor is introduced as a non-destructive method for quantitative finger hand bending measurement. The bending measurement is based on the flex sensor, as the sensor is flexed, the resistance across the sensor increased. The mapping was done automatically when wearing it on body. The feasibility of this method is to detect hand bending movement and leg bending in real time via GUI using PHP has been demonstrated. For instance, the flex sensors at hand and legs the bending position has shown very good results with more than 90%.

## VIII. Future Scope

As future work a proposal is to implement other types of communication systems that could work together with the existing ones. For example, create a webpage where we can scroll through all the data produced in multiple people's real time while sharing the information with other medical institutions. Another proposal is to implement algorithms for noise and motion artefact signal suppression and to implement advanced algorithms for data treatment and aggregation.

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