

# Analysis of rehabilitation process by using IOT system

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**Abstract:** Rehabilitation is treatment for stroke patient in healing process to restore range of motion of joint and strength of muscle. Usually, rehabilitation therapy help stroke patient move more independently after illness, injury or surgery. Integrating the Internet of Things (IoT) features into rehabilitation monitoring system greatly to improves the rehab activity monitoring process such as a doctor or therapist can easily to monitor stroke patient progress and performance because all stroke patient data automatically upload into Things peak IoT Platform during rehab activity by using internet connection. Moreover, Things peak IoT Platform is an open source of Internet of Things (IoT) analytics platform services that allows to visualize and analyze stroke patient live data stream in the cloud

**Keywords:** Rehabilitation, EMG, Robotic, Sensor and Engineering software

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## 1.0 INTRODUCTION

“One of the challenges is the rehabilitation of the elderly, which consumes time, resources, and manpower. The trend of community facilitation of rehabilitation treatment has become popular. Compared with the traditional local hospital rehabilitation, community-based smart rehabilitation is aiming at providing convenience, effective treatment, adequate interaction, and quick reconfiguration to make the maximum use of the medical resources according to patients’ specific requirements possible.” [2].

“The advantage of measuring physical parameters using IoT devices instead of conventional ones is that the connected intelligent IoT devices can carry out measurements independently, and carry out a specific action based on the measurement results. Also, the results of measurements are available via Internet and can be recorded in electronic form, enabling medical personnel to monitor patient’s state from any location at any time.” [3] “Advantages of adopting cloud-based infrastructures in healthcare and rehabilitation are many. The hospital, clinic or institute independent healthcare professional, or even the patient, doesn’t have the problem of software integration as any problems, updates, performance and maintenance are addressed by the vendor’s expert team who ensure a secure service accessed via HTTP.” [4].

Internet of Things (IoT) is a new technology to measure physical objects condition by using internet connectivity and enable objects embedded with electronics to collect and exchange data through internet connection such as real time monitoring system. Rehabilitation is the Process of healing to restore range of motion of joint and strength of muscle for stroke patient. Usually stroke patient body will paralyzed and have disability until six month after the surgery. Rehabilitation therapy very important for stroke patient to heal damaged nervous system of body. Integrating Internet of Things (IoT) technology in rehabilitation therapy can have potential to replace the various method of classical rehabilitation process and can improve rehabilitation productivity

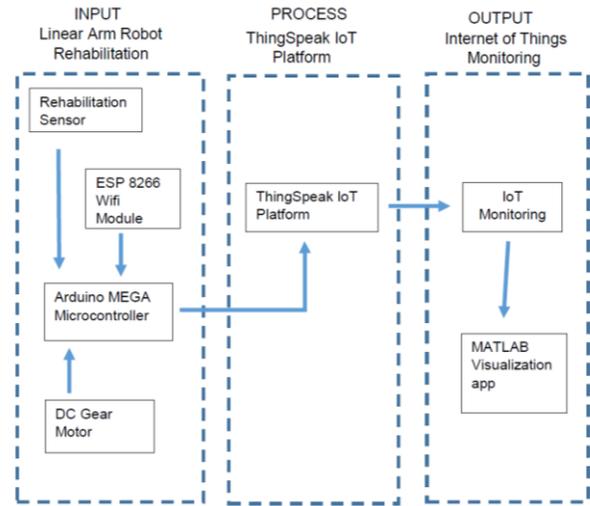
The advantage IoT technology in rehabilitation is can carry out independent of measurement when stroke patient doing rehabilitation therapy such as rehabilitation sensors connected to internet and all rehabilitation sensor data automatically upload into IoT platform server. Moreover, measurement result of stroke patient data are recorded in electronic form through internet and therapist or doctor can monitor stroke patient condition from any location at any time via web browser. Rehabilitation Monitoring System through Internet of Things is a new concept to improve rehabilitation industry productivity and replace the classical of measurement in rehabilitation process become

easier to monitor stroke patient condition. The connectivity rehabilitation monitoring system through the internet of things can increase accurate data of collection and minimizing on error of 2 measurement. Improved accuracy of data collection can give highly trusted among patient. Rehabilitation is treatment for stroke patient in healing process to restore range of motion of joint and strength of muscle. Usually, rehabilitation therapy help stroke patient move more independently after illness, injury or surgery.

Rehabilitation therapy can also know as the process help paralyzed of patient body to improve the body movement become normal such to achieve highest level of function body movement, independence and quality of life possible. Current rehabilitation therapy service do not have real-time monitoring system facility to measure stroke patient condition during rehab activity. The classical of method of measurement in the rehabilitation therapy is stroke patient are recorded manually. This problem cannot enable therapist or doctor give care provision timely for stroke patient and also the rehabilitation treatment outcomes are not improved.

**2.0 Method**

This research will cover the details of the methodology that is used to make this project complete and working well. A rehabilitation monitoring system through internet of thing (IoT) consists three main phases of methodology such as Linear Arm Robot Rehabilitation to collect stroke patient data, Thing Speak IoT Platform to analyze data and IoT Monitoring to monitor stroke patient performance.



(b) Block Diagram

Fig. 1: Methodology of Project

**2.1 Linear Arm Robot Rehabilitation**

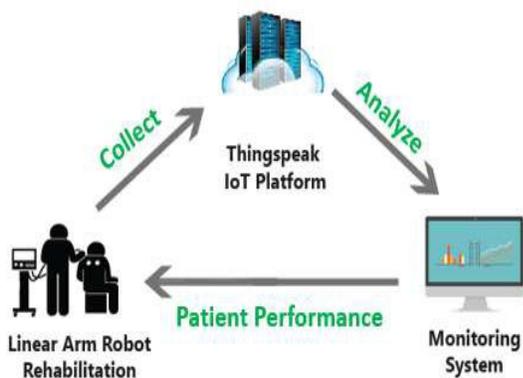
Linear Arm Robot Rehabilitation are used to increase the efficiency rehabilitations process for stroke patient such as healing process to restore range of motion of joint and strength of muscle for wrist and elbow stroke patient. Linear arm robot hardware, rotation movement and rehabilitation sensors used in this paper. Figure 2 shows the 3D design rotation for linear robotic arms.

**2.2 Linear Arm Robot Hardware**

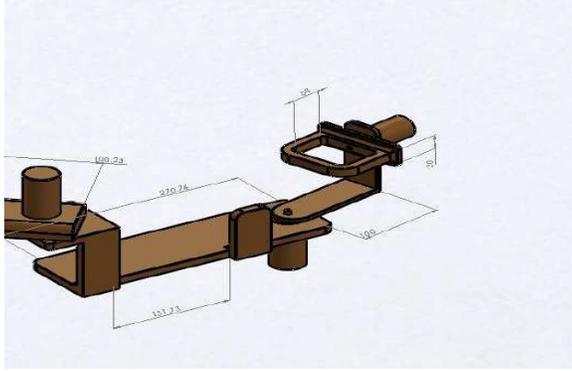
Linear arm robot hardware very important part for rehab activity of stroke patient. Based on the table 1, show the linear arm robot hardware used in this project. Fig2 (b) shows the robotic attach on arms handicap patient during rehabilitation.

Table 1: Rotation movement of linear arms robot

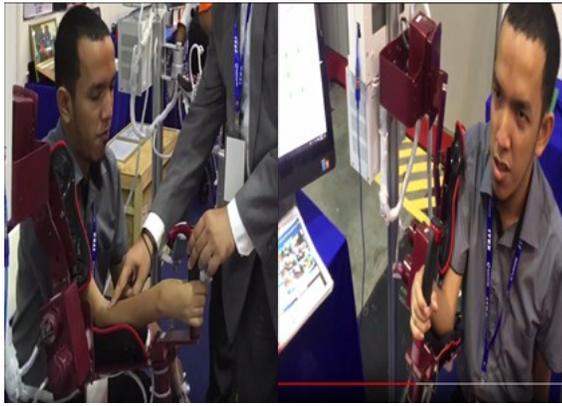
S/n	Part of rotation	Range of rotation angle (°)
1	Wrist 1	0 to 45
2	Wrist 2	0 to 45
3	Elbow	0 to 90



(a) Thing Speak IoT Platform analyze data and IoT Monitoring to monitor stroke patient performance



(a) 3D Solid work



(b) 3DOF robotic arms.

Fig2: Rotation Movement of Linear Arm Robot

### 2.3 Rehabilitation Sensors

Rehabilitation sensors is used to measure stroke patient condition when doing rehab activity by linear arm robot rehabilitation such as wrist angle, elbow angle, muscle strength and heart rate. Based on the table 2 show the type and function of sensor used in this research.

Table 2: List of rehabilitation sensor.

S/n	Type Of sensor	Function of Sensor
1	Electromyography (EMG) sensor	To measure muscle strength for stroke patient.
2	Flex Sensor	To measure wrist and elbow angle of stroke patient.
3	Pulse Sensor	To measure heart rate when stroke patient doing rehab activity.

### 2.4 Thing Speak IoT Platform

Thing Speak is an open source IoT analytical platform service that provide collection, visualize and analysis live data streams in the cloud. Thing Speak can instant visualization of data displayed from rehabilitation sensor devices. All sensor data collected can view and analyze via IoT Platform. IoT Platform framework for this project contain three processes to send sensor data into the Thing Speak IoT Platform such as ESP 8266 Wi-Fi module, Write application programming interfaces key (API key) and Channel data.

### 2.5 ESP 8266 Wi-Fi Module

The ESP 8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give Adriano MEGA microcontroller access to Wi-Fi network. The ESP 8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP 8266 module comes pre-programmed with an AT command. AT command is a set of instruction code to control ESP 8266 Wi-Fi module. A few type of AT command used for this project to send rehabilitation sensors data into Things peak IoT Platform.



Fig 3: IoT Platform Framework

## 3.0 RESULTS

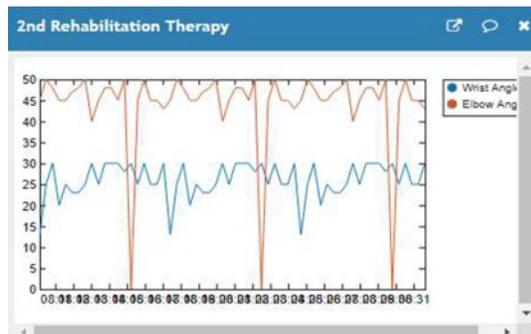
### 3.1 Stroke Patient Therapy Progress Analysis

Stroke patient therapy progress analysis used to visualize the stroke patient wrist angle and elbow angle during the day of rehab activity. For example, therapist or doctor can view the stroke patient data according the number of attempts rehabilitation therapy. From this analysis, the angle of movement wrist and elbow stroke patient progress can be determine such as how many rehabilitation therapy stroke patient need to achieve wrist angle and elbow angle target.

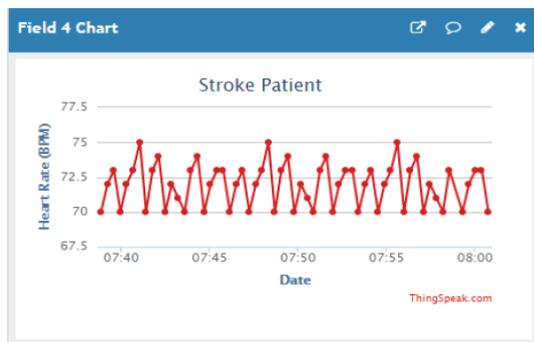
### 3.2 Live Data of Rehabilitation Therapy

Live Data Rehabilitation Therapy is real-time monitoring data of rehabilitation sensor collected from Linear Arm Robot Rehabilitation when the stroke patient doing rehab activity such as flex sensor, electromyography (EMG) sensor and pulse sensor. There are four type of live

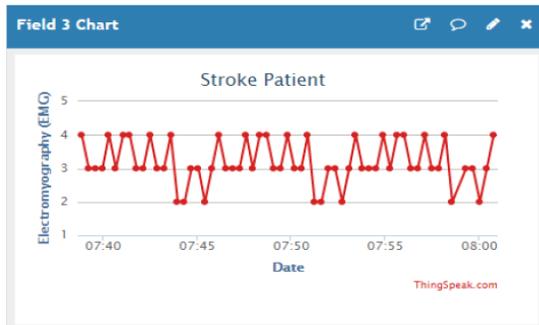
data of rehabilitation therapy displayed in Thing Speak IoT Platform:



(a)



(b)



(c)

Fig 4: 1st Attempt of Rehabilitation Therapy

### 3.3 Stroke Patient Performance Analysis

Fig 4, shows three difference type of measurement on Stroke Patient during rehabilitation, the mapping focus in degree, heart rate and EMG. The data collection is content and continue monitoring by using Adriano microcontroller transmit to “IoT” Mat lab. The Performance Analysis used to visualize and analyze stroke

patient wrist angle and elbow angle performance before and after rehabilitation therapy according by the total number of rehabilitation therapy by using Linear Arm Robot Rehabilitation.

For example, doctor or therapist can view the overall performance stroke patient and how many rehabilitation therapy have done to increase stroke patient wrist and elbow angle position movement such as to determine stroke patient performance before and after rehabilitation therapy.

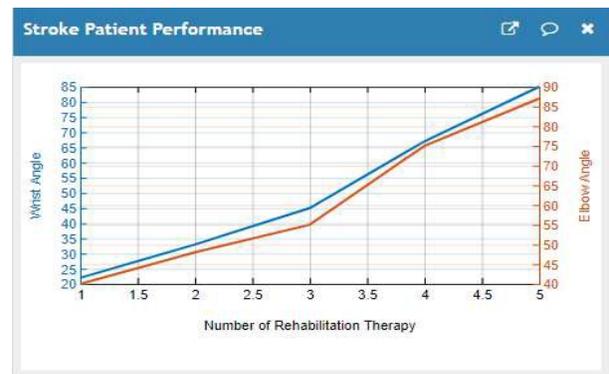


Fig 5: Stroke Patient Performance Data Graph.

Overall, the project is seen as very successfully according to project objectives. This is because the project is ready to be developed in a timely manner. The project is implement not only created to meet the demands of the university in the final year project (FYP). In fact, this project is good for market commercialization because stroke disease is the second largest cause of death in Malaysia, as it affects approximately 40,000 people each year.

Moreover, stroke rehabilitation therapy by using robotics are still limited in Malaysia and most rehabilitation therapy using robotics technology developed by other countries. Based on the project objectives, this project to integrate the Internet of Things (IoT) technology in rehabilitation monitoring system. Rehabilitation are Very important healing process to restore range of motion of joint and strength of muscle for stroke patient. Integrating the Internet of Things (IoT) features into rehabilitation monitoring system greatly to improves the rehab activity monitoring process such as a doctor or therapist can easily to monitor stroke patient progress and performance because all stroke patient data automatically upload into Things peak IoT Platform during rehab activity by using internet connection. Moreover, Things peak IoT Platform is an open source of Internet of Things (IoT) analytics platform services that allows to visualize and analyze stroke patient live data streams in the cloud

#### **4.0 Conclusion**

Things peak also provide instant visualizations of stroke patient data posted by ESP 8266 Wi-Fi module during rehab activity. With the ability to execute MATLAB code in Things peak IoT Platform, stroke patient data can perform online analysis of the data such as stroke patient therapy progress analysis and stroke patient performance analysis. Finally, rehabilitation monitoring system based on Internet of Things (IoT) technology, which will enable the implementation of effective linear arm robot rehabilitation to update recovery progress for stroke patient. This project ensure the achievement is not only useful and practical, but provide an opportunity for the public to explore more about this project towards the advancement for the future.

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