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Real-Time Bone Fracture Monitoring System Using IOT

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Abstract

As we all know bone is the major part of the human body. It provides the ability to move. Bone fractures are common in the human body. Even though the external fixation process is being followed widely there are so many complications arising which are significantly decreasing the treatment efficiency by increasing the period of recovery process and cost. The major reason is the inability to have continuous insight into the healing process and knowing how much pressure the fractured bone is taking during the recovery process for various patients' activities. In this paper we are proposing a system that will have capability to continuously monitor the fractured bone in real time for excess pressure and misalignment. This data is stored and made available for doctors to identify the condition and treat the patient if necessary.

Keywords— IoT Internet of Things, Meme sensor, Continuous Monitoring

I. INTRODUCTION

IOT- Internet of Things has grown rapidly over the years and this technology is helping to address so many problems and giving the best solutions in various domains like environment, healthcare and others. The main functionalities that IoT technologies facilitate are trend identification, data tracking, event detection and other.

These help in automatic and continuous sensing of any activity or property and thereby control future activities based on results of the data processed. This is a major requirement for making remote healthcare a success. The most important is having the real time patient monitoring systems that will basically help the doctors to improve diagnostics (based on data collected in real life situations, in a relevant time range), to identify clinical emergencies and to monitor the therapeutic process.

Many different signals of physiological origin can be tracked like pulse, respiration rate, temperature, heart rate, heart rate variability, arterial blood pressure, skin temperature, skin conductance, blood alcohol concentration and others.They can be combined with environmental properties like air temperature, humidity, atmospheric pressure and location data to feed the processing algorithms which can infer the features indicative to a person health status[1].

This data we collect from the sensors in raw condensed or processed form can be accessed by the physician on demand. To a certain extent, Such insight can reduce the need for periodical outpatient controls. Obviously, this can positively affect the cost of healthcare and even reduce

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possible inconveniences for the patient. Furthermore, IoT devices can be used as a closed-loop control system, namely, in addition to sensors and transmitters, it can host actuators, which can be used to further decrease the cost of the therapy process. Various types of actuators can be added to IoT devices, or act as independent units, namely device triggers, alarms, pacemakers, drug dispensers, insulin pumps, etc[2][3].

This paper explores the use of IoT technologies in the field of orthopedics. Motivation was related to resolving some issues of using external orthopedic fixation devices for healing bone injuries and in leg extension treatment.

The present existing system used is taking the x- ray images of the bones to identify fractures for every time, but it takes time, also the cost of taking x-rays many times is high and it does not always give accurate output.

One more method is use of image processing techniques to detect fractures. Even though it produces accurate results again we have to provide bone images for the analysis. This process is too costly and doesn't have the continuous monitoring feature .So to overcome that problem we introduce a new system that will be cost effective with continuous monitoring.

II. Sensors Used

A. Force Sensor

A Force Sensor is a sensor that helps in measuring the amount of force applied to an object. By observing the amount of change in the resistance values of force-sensing resistors, the applied force can be calculated.

Force sensors are available in a wide range of sizes and can be used to detect forces from fractions of an ounce to hundreds of tons. They are used in a wide range of products and applications such as bathroom scales, musical instruments, medical applications, automobiles, and process control in manufacturing facilities. In our application it is used to find the amount of pressure applied on the bone[1].

Fig 1 Force Sensor

B. Temperature Sensor

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes.

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The DS18B20 is a 1-wire programmable Temperature sensor from Maxim integrated. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. The constriction of the sensor is rugged and also can be purchased with a waterproof option making the mounting process easy. It can measure a wide range of temperature from -55°C to +125° with a decent accuracy of ±5°C. Each sensor has a unique address and requires only one pin of the MCU to transfer data so it is a very good choice for measuring temperature at multiple points without compromising much of your digital pins on the microcontroller.

C. MEME SENSOR

Accelerometers measure linear acceleration. They can be also used for specific purposes such as inclination and vibration measurement. MEMS accelerometers embed several useful features for motion and acceleration detection, including free-fall, wakeup, single/double-tap recognition, activity/inactivity detection and 6D/4D orientation.

Fig 2 Meme Sensor

During its early stage, the MEMS chip had two parts. One part included the main structure of the chip and the other part included everything needed for signal conditioning. This method was not successful as the total space taken by the device was larger, and thus the different parts of a single chip needed multi-assembling procedures. The output obtained from such a device had less accuracy and the mounting of such a device was difficult[6].

As the technology became more advanced the idea of integrating multi-chips was applied to produce a single chip MEMS with high performance and accuracy.

The main idea behind this technology is to use some of the basic mechanical devices like cantilevers and membranes to have the same qualities of electronic circuits. To obtain such a concept, a micro-fabrication process must be carried out. Though an electronic process is carried out, an MEMS device cannot be called an electronic circuit. MEMS duplicate a mechanical part and have holes, cantilevers, membranes, channels, and so on. But an electronic circuit has a firm and compact structure. To make MEMS from silicon process, the manufacturer must have a deep knowledge in electronics, mechanical and also about the materials used for the process[2][3].

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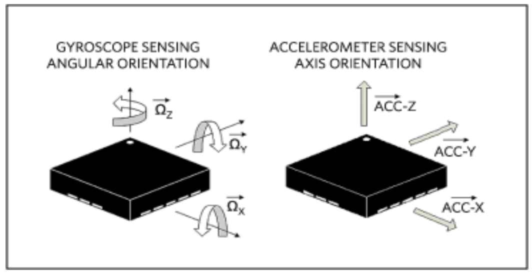

Fig 3 Meme Sensor Operations

III. PROPOSING SYSTEM

A. PROPOSING METHOD-

We are proposing a method that has the ability to continuously monitor the fractured bone and notify immediately if there is any excess pressure applied or misalignment due to the patient's actions. We are fixing the MEME sensor that will help to identify the position of the fractured bone[5]. If there is any misalignment there will be change in the coordinates of the MEME sensor output. Also we have a pressure sensor placed on the bone if there is any excess pressure applied on the fractured bone this sensor will help to identify the amount of pressure applied. The same data is sent to the processor and if the values are more than the threshold it will alert the patient and as well as the doctor.

Data from the pressure sensor and MEME sensor will be monitored continuously so that the respective patient can know if he is applying more pressure on the fractured part and it will help to speed up the recovery process. An additional Temperature detecting module is also added so that the doctor can know the temperature when he is setting up the module inside the patient.

All the data collected from the sensors are stored in the cloud. This will help the doctor to understand the recovery process and this will also help to treat the patient remotely if necessary.

B. Block Diagram

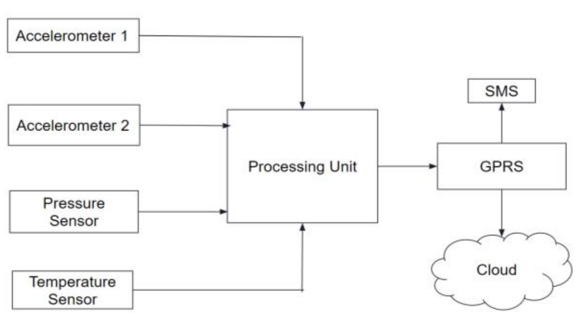

Fig 4 Block Diagram

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C. Flow Chart

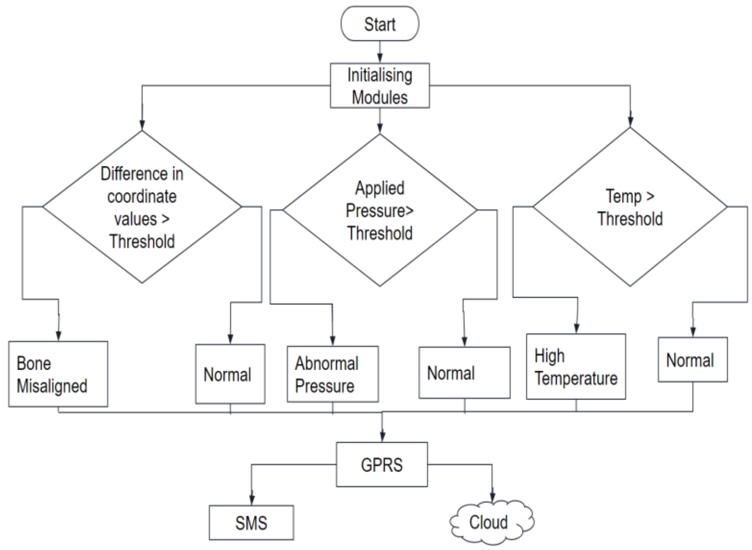

Fig 5 Flow Chart

D. Working

Firstly, when the power supply is provided the microcontroller arduino uno is initialized with the program written on it. We have three types of sensors connected to the processing unit one Force sensor, two Meme sensors and one Temperature sensor. A GPRS module is connected for transfer of information out of the device. Also the LCD connected will help to display the necessary information sent by the processor based on various actions carried out by the patient[7][8].

Temperature sensor connected always monitors the temperature of the bone and sends this data to the microcontroller. This helps the doctors to find out the bone temperature while fixing the bone and during the recovery process.

As we have connected the force sensor when an excess pressure is applied on the bone the sensor detects the amount of force applied and sends that information to the microcontroller. The microcontroller checks the values whether it is greater than the limit or not. If the values are higher than what it should be an alert message is displayed on the LCD screen indicating the pressure on the fractured bone is more or else the message on the screen would be no excess pressure applied.

Two Meme sensors are fixed on either side of the fracture. These sensors help in finding out where there is any tilt or misalignment at the fracture position of the bone. The two sensors send the coordinates to the microcontroller and based on the relative position of the sensors the bone is classified as misaligned or perfectly aligned. For the perfectly aligned bone the distance between two meme sensors should be always constant. These coordinates are also displayed on the LCD screen and a message based on the condition of the bone is also displayed[4][5].

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All the data collected is sent to the cloud storage with the help of the GPRS module. This data is displayed on the website and doctors can access the data anywhere and will help to treat the patient remotely.

IV. RESULTS

The coordinates of the two accelerometers i.e. meme sensors will be uploaded to the website named Thingspeak.

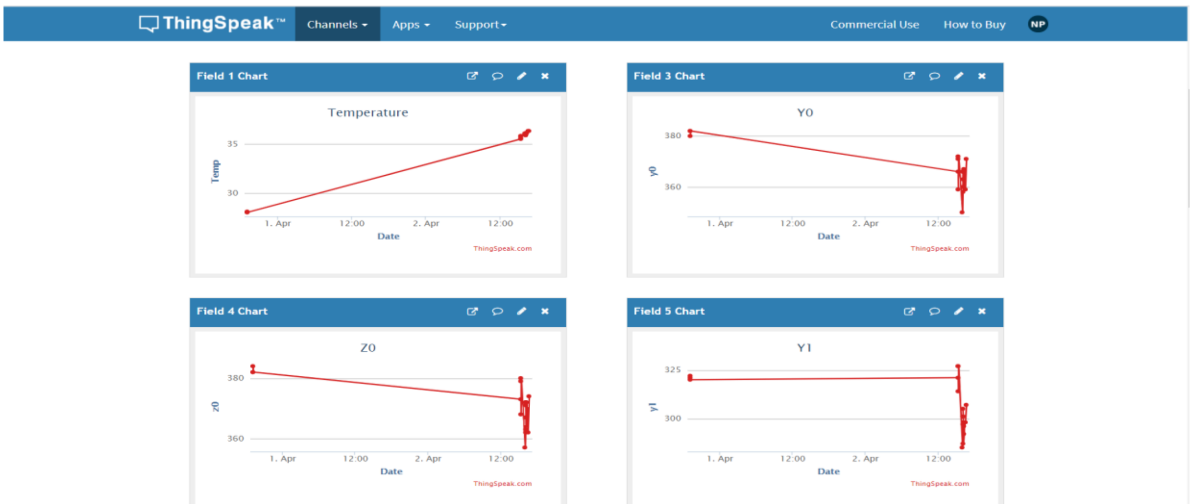

Fig. 6 Graphical representation of sensor values

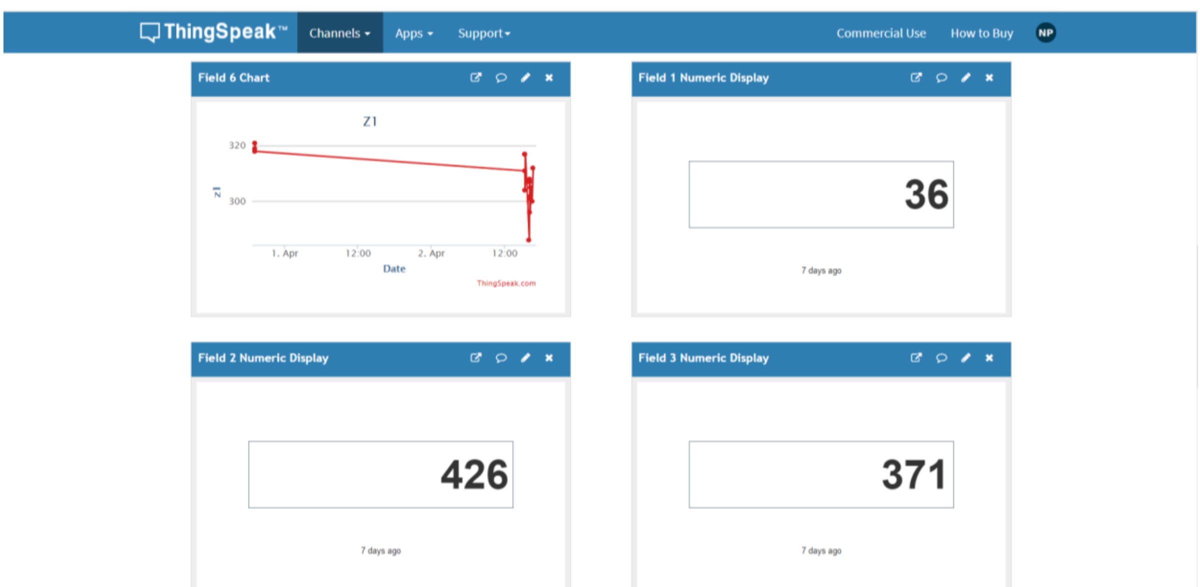

Fig 7 Actual values of the sensor output

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The Temperature graph shows the temperature of the system which is built in, Y0 and Z0 are the coordinates of the first meme sensor, Y1 and Z1 are the coordinates of the second meme sensor. Those two values are closely monitored like the distance between the two meme sensors are calculated and it has to be constant in order to make the healing process faster.

Both graphical and numerical representation is shown in the above figures. Numerical representation is used to show the present values and graphical representation is used to represent the past values as the past data can be used for the analysis.

V. CONCLUSION

The above proposed idea i.e., real time bone fracture monitoring system will highly help in making the recovery process of the fractured bone faster compared to all methods available by monitoring the bone continuously. This system would help to identify the excess pressure or misalignment of bone during the recovery period due to the patient's actions and be intimate to take necessary action[9].

The device makes it possible to make real-time observations on behavior of the patient with fractured tibia in a homecare. Those observations can be easily used to: Alert (in a real-time) the patient on the activities of high risk, namely intentional or incidental running, stairs climbing. Advise (in a real-time) the patient on adjusting the prescribed behavior or exercises, for example, increase or decrease load of the fractured leg during the walk or stand with crutches[10].

The system also consumes less power and is a cost effective solution compared to taking x-rays each time to assess the condition of the bone. The data collected is also stored in the cloud that will help the doctors to access and treat the patient remotely.

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