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Catholic Health Band

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ABSTRACT

With the forge ahead of technology being produced, the future looks scintillating for the field of medicine. The internet of things, generally referred to as IoT, has made its existence known unequivocally in the field of the medical sector. The Internet of things is a framework that can move information over a network without expecting human-to-human interactivity. Remaining in accordance with the IoT vision we propose a smart Catholic Health Band which relies on different technologies, specifically RFID, WSN, and smart mobile, cooperating with one another by means of a Constrained Application Protocol/IPv6 over low-power wireless personal area network/representational state transfer network infrastructure. Catholic Health Band is a real-time monitoring wearable device with sensors, which can be carried out by patients. It also perceives drop downs and disruptions which can be immensely useful for the elderly suffers and convalescents. These sensors transmit information about patients' fundamental signs to social insurance suppliers in authentic time. Any changes in temperature, circulatory strain (blood pressure), heartbeat, and pulse are in a split second passed on to specialists or attendants, who would then be able to give prompt ministration. The aim of this paper is to create a brilliant gadget from contrivance utilizing the Internet of Things associated with a cellular message to the caretaker or guardian.

Keywords: Accelerometer, Body Temperature Sensor, Cuffless Blood Pressure Sensor, ESP8266 Wi-Fi Module, Analog to Digital Converter channels, Node Micro Controller Unit, Pulse Sensor, ThingSpeak Cloud.

I. INTRODUCTION

In this field of globalization, in which reforms are made every day to supplant or reduce human work, through the project . it helps to contribute to the modernization of the world , it is essential to get a quick fix to the regular human problems. So while we were probing for a problem to solve we opted for health care systems which could be a major area where we could work on. A mix of embedded devices, software, and sensors are referred to as the Internet of Things as in [1]. When one of them is admitted to the hospital, the patient's family will be distressed about his/her health condition. by incorporating the IoT used in new innovative technologies to document patients ' health situations, panic can be minimized. Our objective is to design a device such as in [2] and to add additional features so that almost everyone can use this gadget to monitor one‘s health status and send a message to caregivers and family members based on observable variations in health evaluations and substantial or distinct body movements of the host. Embedded system is the most advisable domain which can help us to reach our requirements. The health data can be measured according to the patient ’s condition by using e-health sensing platforms, the equipment will be automatically controlled by the arduino Microcontroller and Wi-Fi integrations we use [3]. In this, we will examine the patient’s Pulse rate, Body Temperature, Blood Pressure Rate and major differences in Hand Movements with sensors connected to the person. We used Node MCU as our major component as it is Arduino compatible and doesn’t require much process to connect as it has in-built Wi-Fi and good enough ADC channels in it with more RAM and ROM memory compared to Arduino Mega and Arduino UNO.

To screen the Patient’s well being in the finest manner we made a Mobile App named as “HEALTH BAND”, which fundamentally stores all the information of the readings of patients. [4] We associate

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ThingSpeak Cloud to the Mobile App and the Wrist Health Band. For that we need to associate our Node MCU with ThingSpeak Cloud. ThingSpeak is an open data platform of API that assists our device to communicate with the ThingSpeak Cloud through the API key. We associate ThingSpeak Cloud to our application we created by calling the other API key into the App in particular the JSON API key. The Application saves all the readings to its information base which causes the patient to have a total record of his/her well being. Correspondingly, we do the equivalent ThingSpeak Connection cycle to our LED screen as it shows the abnormal changes and cautions.

II. LITERATURE SURVEY

With the furtherance of modernizations in health care in recent times, there are a bunch of ways to monitor the patient's health. While scrutinizing these different methodologies that were proposed to be used daily, Misra et al . , 2018 in [5] proposed a system that records patients' health through sensors and stores the records. The small and portable sensors used in this system help us to carry everywhere to notice a person's health status regularly. An automatic alarm generation will be given using SMS or email notification if the sensors detect unusual recordings of health parameters if a person skips his medicines. This gadget determines heart rate, respiration rate, blood pressure, body temperature etc. Potharaju et al.,2018 in [6]. We tried to implement advancements from this procedure that are friendly for those persons who can't supervise on one's own after a certain age and to the people who are forbidden to get out of bed or any paralyzed victims. The device we designed can be connected to the caretakers mobile or any family member mobile app and through the sensors as shown in Figure 1, it sends notifications if the person needs some ministration. This smart assistance device gauges various modules of body temperature, heart rate, blood pressure, and some major sudden body movements of the patient. This could be utilized for all victims having disparate kinds of health issues, not confined to only paralysis patients . This is for every individual who requires medication & attention all the time as well as this gadget is a Wrist band and is designed in such a manner that it looks like a normal digital watch that would be inter-connected to an app in the mobile phone which shows the different health readings of patients and stores the values or readings for every single reading it records.

Hamim et al. ,2019 in [7] proposed a device which was built with three sensors together using Arduino UNO and Raspberry Pi which acts as cloud storage.These sensors determine the records of patient regarding heart pulse, body temperature and galvanic skin response and transmits data to the database in the cloud An app was developed that access the readings from the database which depicts a graphical representation of the readings in it. Complete examination of signals is obtained from imbalances in physical and environmental changes to acknowledge the performance of used sensors. And even the physician can prescribe the medications through the app so that the patients and elderly people can get instant attention without delay.

Jie et al. ,2018 in [8] suggested that with the growth in the duration of many social groups, it is profoundly vital to inspire both psychological and physical health, in view of the increasing figure of the inhabitants being impaired by persistent illness in order to sustain a healthy way of life. A viable approach has been monitoring health, mobile system integration and ultimately noticing routine life practices. Across several sectors, notably in integrated therapy, the Internet of Things (IoT) is garnering exponentially rising prominence via a conceptual standpoint. For instance, the body sensor area network (BASN) within the IoT infrastructure has been extensively deployed for incorporeal remote monitoring of patients. As a research paradigm to diagnosing osteoporosis, Salman et al.,2018 in [9] ECG surveillance has been widely embraced. This publication's significant contribution typically includes: it asserts a conceptual schema for real time personalized health screening, which is the WISE (Wearable IoT-cloud based health monitoring framework). In lieu of real time health navigation, WISE endorses the BASN architecture as in Mirza et al.,2017 in [10]. Numerous adaptive projectors, including rhythm, metabolic rate and glucose level scales have been incorporated. Moreover, several traditional health tracking devices require cellular devices as a hub for statistical analysis, simulation and dissemination, which as a matter of fact influence the typical everyday utilization of the mobile phone. Although the data recorded from BASN is communicated explicitly to the server in WISE, a flimsy screen could be ingrained as an effective alternative for swift browsing of real time information as in Gayathri et al.,2018 in [11].

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SkubicMajorie et al.,2015 in [12] have built an embedded health analysis based on monitoring health systems, In-Home sensor is built on a health change detection model which records and captures the behaviour of the environment. The model extracts and studies the features from the in-home sensor data. The features are extracted from the motion sensor. The main aim of the model is to detect the very early changes in the health status for the bed ridden patients. The basic network of the model includes the sensors attached to the patient with an integrated data storage, an alert message is sent to the clinicians using a web portal or a mobile device. Passive infrared motion sensors and bed sensors are used in order to capture the sleep patterns and motion in the specific environment. The motion sensors record the patient's general activities and the bed sensor the events of measuring the events of pulse, respiration etc in rest mode. Gundlapalli et al.,2013 in [13] incorporated the feature selection process used various classification algorithms, the alert parameters as well as the sensor data is chosen as a base data for analysis.

Alfian et al.,2018 in [14] included a record of patient's statuswhich played a major role to keep track of a person's sugar levels at sporadic times which would succor in knowing their need for victuals or some glucose. The main reason is, to check the blood sugar levels we would require a small pin to penetrate to the patient’s body all the time, and also it requires the substitution of a few segments of the equipment at short intervals which enhances the additional price for the sufferer and his family. Also, the price of the final product might be a bit high for the lower-middle-class people, but we aim to pick the sensors that are best and also low in cost. The pros are that this looks similar to the digital watches we put on and with this, they can record their health status round the clock and take the vital medication and help them improve themselves. The Wrist band also contains a LED Screen that shows abnormal readings, time & date, and gives an alarm if the victim does not follow medication. The disadvantages are that we cannot include a Glucometer, in our proposed methodology. Rao et al.,2019 in [15]

III. PROPOSED METHODOLOGY

In our daily life, we come across many health issues majorly due to the fluctuations of different health measures in our bodies. We now, especially concentrate on the particular sufferers who are forbidden to move away from Bed either because they are paralyzed or because of any other health issues of Old Aged people who cannot get off the bed and for people who are handicapped. To make this process of measuring different levels in our body easy, we are designing a Wristband that contains the sensors we require in making the well-being of the patient much understandable and approachable.

We are using different health sensors like the Pulse sensor, Temperature sensor, Blood Pressure sensor, and Accelerometer as depicted in Figure 1. The pulse sensor is used in calculating the Pulse rate i.e; Heartbeat rate of a person at different points of time. This Pulse rate sensor consists of a light-emitting diode and a detector. Our heartbeat causes vibrations in our blood flow and the quantity of light absorbed during this blood flow results in calculating the Heartbeat Pulses. This is how the pulse rate is computed by the sensor which we use namely REES52 pulse sensor. The similar kind of Pulse sensors are found in our digital watches or finger clips that are used in hospitals.

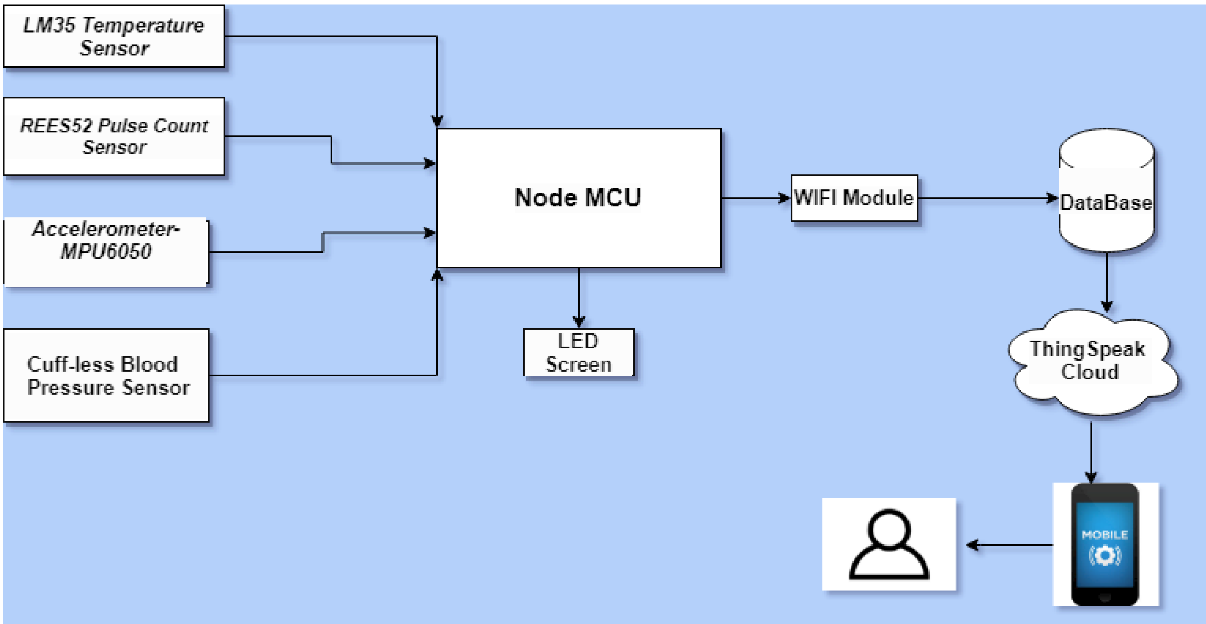

Figure 1: Architecture of Catholic Health Band

Figure 1 describes how all the sensors we took i.e; REES52 Pulse Sensor, LM35 Temperature Sensor, Cuff-less Blood Pressure sensor, and MPU6050 Accelerometer are coupled to our Node MCU which consists of 8 ADC channels. A power supply of 3.3v is given to Node MCU which distributes the power to the sensors when needed. And we now add the LED Touch screen that will feature the things we require in it. In the end, the ESP8266 low cost standalone wireless transceiver is connected which directs the data to the IoT cloud.

The Temperature sensor we are using is the LM35 Temperature sensor as it gives much more efficient results than the other Thermistors and sensors we use because it doesn’t need at all outermost calibration. LM35 means a linear monolithic 35 temperature sensor which is referred to as many analog module components kept on a single piece of silicon. When there is a difference in amplified voltage in the sensor then our device generates an analog signal which is directly proportional to the temperature. This voltage output we get is changed into the temperature in Celsius.

We are using a cuff-less blood pressure sensor that came into existence latterly which doesn’t need any cuff in calculating the BP level. We all know how important it is to keep track of our Blood Pressure levels because a decrease or increase in these levels makes a huge amount of difference in a person's health and also food habits should be modified based on our readings of Blood Pressure. So, to make the process of calculating BP levels much easier, we now can use the cuffless BP sensor. This sensor uses the Pulse Wave velocity technique which helps in calculating Blood pressure by measuring pulse at 2 different points along an artery. This process helps in easy calculation of Blood pressure values numerous times a day.

An accelerator is actually used to calculate major body vibrations or movements of a sufferer. This is mainly for the Paralyzed Patients or for old aged bed forbidden people which helps us in knowing and understanding the reactions of their body for medicinal changes or food changes or any other change in habits at different spans. This also helps when a patient shows major body movements which in turn results in their health improvement or any other reaction they suddenly face. This is a plus point in keeping track of the patient's reactions which helps in their detailed health report. This sensor contains a piezoelectric crystal element that is combined to amass, this tends to a force of acceleration and compresses the crystal’s mass which results in producing an electrical signal which is proportional to our level of force applied. This is how our MPU6050 Accelerometer works and helps.

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We also include a LED Touch Screen of 1.7" to this which displays the Time along with Date, Abnormal changes in readings and triggers an alarm or vibration to the patients in case of any major changes happening in their body and reminds the patient about Medication.

We are using the Node Micro Controller Unit, also known as Node MCU which is an open-source firmware and development kit that helps us in the process of constructing or prototyping the IoT platform containing 8 ADC(Analog to Digital converter) channels. Though the Arduino Mega or Arduino UNO is amply appropriate because of its pros in having an option of a large number of sensor connections, we are using the Node MCU as it has inbuilt Wi-Fi and we do not need much effort in connecting to the
system, also it is an Arduino compatible. Comparatively, the RAM and ROM of Node MCU are indeed preferable than Arduino UNO and Arduino Mega. Also, this comes with a micro USB port that is more
available than other connectors, and also the board size of Node MCU is small which makes our device much feasible to use. This uses Lua scripting Language and openly accessible projects like Spiffs. Node MCU runs on ESP8266 Wi-Fi SOC which is a self-contained system on a chip that is integrated with TCP/IP protocol, which in turn helps in giving microcontroller access permission to our wifi network. This helps in handling the connection of the gadget along with all the wireless devices inter-connected to it. It modulates the radio waves and sends the data to the next component in the router.

Now, that all the connections are made, our final product is made like a wristband that can be feasibly used by putting it on the patient's hand. As our main target is all the out of bed forbidden patients like the paralyzed or handicapped or Old aged people, this Wristband would be free to use as it does not give any weird kind of feel for the patient as well as having sensors attached to the wrist helps in efficient and accurate results. This looks similar to any other wristwatches, but the only difference is the size of the device.

Since, the sensors used, accepts an analog signal as a put in the parameter, to transmute the analog feed-in into a digital production an Analog to Digital channel extender is used. One of the sensors is associated straight to the Node MCU, while the additional two sensors are fronted to the ADC. The ADS1115 ADC is the renowned title of the Analog to Digital extender. This helps in the accuracy of the results. This acts as an on/off switch that is assimilated to one of the digital pins of the Node MCU, since it accepts a digital input of either 1 or 0, where an on state is designated by 1, and the off state by 0.[6] The chief motive of using an uncomplicated button is to utilize it for the frequent necessity of the patient since it can specify a news of the patient's health by an easy press rather than by any indication. It is pinpointed on the index finger and can be exploited by a thumb finger, which eases its use.

Now, To keep track of the Patient's health in the finest way we designed a Mobile App that lets the patient's Caretaker as well as the family understand all the changes and improvements his body is facing and can keep a track of their health through this mobile application.This remains regular with the IoT vision with which we propose a Catholic Health Band that is built on numerous technologies like Radio Frequency Identification(RFID), Wireless Sensor Networks, and a Smart mobile, that operates internally accompained with all other through a Constrained Application Protocol (CoAP)/IPv6 over low-power wireless network connection (6LoWPAN) with Representational State Transfer network infrastructure. We created an App named "HEALTH BAND", which necessarily stores all the data of the readings of patients.

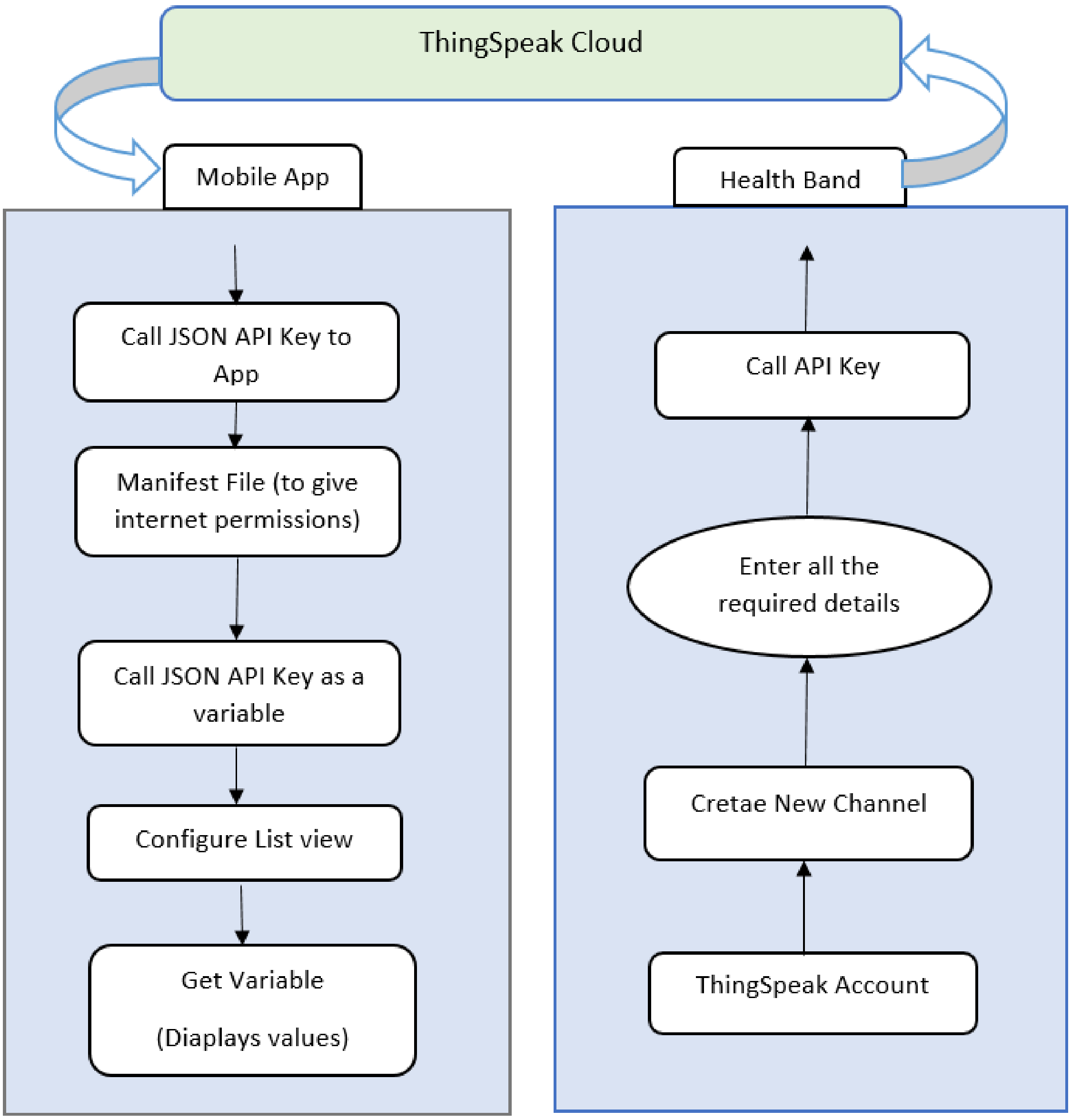

Figure 2: Flowchart on how to connect ThingSpeak Cloud to the Mobile App and the Health Band

Figure 2 shows how to connect a Thing Speak Cloud to the Mobile App and the Health Band, for that we have to connect our Node MCU with ThingSpeak cloud, we should open a New channel in ThingSpeak and Enter all the channel details like Name, our sensor-related details. Then with the assistance of the API key, we call our Node MCU and set it in an infinity loop and configure it in such a way that it takes readings for every 10 seconds of time span which will be directed to our ThingSpeak Cloud.

ThingSpeak is an open data platform of API that helps our device to communicate with the ThingSpeak Cloud through the API Key. We can put the data either private or public and also the ThingSpeak Server lets us collect, store, visualize, analyze, and act upon the readings.ThingSpeak cloud helps us in looking into the live data. An Application Programming Interface(API) key plays a major role because that acts as an important bridging that identifies its user, developer, or helps in calling a program to a website.

Now, We connect ThingSpeak Cloud to our Application we developed by calling the other API key into the App namely the JSON API key. We should be giving internet permissions through Manifest File where all the permissions are given, here we call JSON API key by considering it as a variable.All these values need to be taken into a list, so we create a list using the Configure list view and use the get variable function in that list view then all the values get displayed in the list view in the App. The fundamental coding to develop the Application will be made along with the App gives Alarms and Notifications when there is an abnormal change in the patient's readings and gives the medication that we specify in the code.Also, we link a few numbers to the Application like the Family Members and CareTaker, which the App uses when there is an deviations in a patient's health issue and notifies them with a Text message. The Application saves all the readings to its database which helps the patient to have a complete record of his/her health. Similarly, we do the same ThingSpeak Connection process to our LED screen as it shows the abnormal changes and alarms.

3.2 SENSORS USED

3.2.1 Node MCU

NodeMCU Devkit consists of ESP8266, which is a low-cost wifi enabled chip. Since Node MCU is an open-source firmware tool it's hardware can be edited, modified, or built. This kit contains Arduino like pins on the board(Analog and Digital) and supports serial communication protocols. Usually, to get started with Node MCU we download the firmware from the software development platforms for the various ESP8266 modules and development boards and then develop the application for NODE MCU by using Lua scripting language, it is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266 or through Arduino IDE to compile an Arduino C/C++ file in which the ESP8266 will build a binary code for NODE MCU to execute.

a b c

Figure 3: (a) Accelerometer- MPU6050, (b) LM35 Temperature Sensor, (c) ESP8266 WIFI Module

Figure 3(a) shows the Accelerometer-MPU6050 sensor that we used in observing the major and abnormal body actions,gestures of the patient. The movement or vibration caused to the person's body in turn makes the mass to squeeze a piezoelectric substance which produces the electric charge that is proportional to the force caused to the body.
Figure 3(b) is the LM35 Temperature Sensor that we are using to measure the temperature of a person in both Fahrenheit and Celsius degrees. The temperature sensor works with a simple principle of increase or decrease in the voltage over the terminals of a diode.When the temperature rises, the voltage increases and that drops the voltage between base of transistor terminal and emitter's diode.
Figure 3(c) is ESP8266 WIFI Module that is capable of hosting an application or off loading all WiFi networking functions.

3.2.2 Accelerometer- MPU6050

An accelerometer as depicted in Figure 3(a) can be used to compute the acceleration exerted upon the sensor. It is a gadget that will measure acceleration forces such as inclination or vibration measurement. The acceleration is up to 2 to 3 axis components that help in net acceleration. The reactions can be of static force due to tilt orientation or force exerted upon the sensor- dynamic/movement detection. The MPU6050 estimates the 3 axis acceleration, as well as 3 axis gyroscope. It measures acceleration with a minimum full-scale range.

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3.2.3 LM35 Temperature Sensor

A temperature sensor as depicted in Figure 3(b) is a device that is utilized to predict the degree of hotness or coldness of an object. A LM35 temperature sensor computes the temperature more accurately than the thermistor. Its minimum input voltage is 35V and the maximum input voltage is -2V, typically the input voltage is adjusted up to 5V, the set off temperature range is from -55C to 150C. The output voltage is directly proportional to the temperature. The scale factor is .01V/C i.e a 0.01V increase in one-degree rise of temperature. The sensor doesn't need any external calibration, it has an accuracy of +/-0.5C at room temperature. It is a low-cost sensor and LM35 drain current is less than 60uA, in which it draws only 60 microamps from its supply and possesses a low-self heating capability.

3.2.4 ESP8266 WIFI Module

ESP8266 is a Wi-Fi enabled system on chip (SoC) module evolved by the Espressif system as demonstrated in Figure 3(c). It is predominantly utilized for the evolution of IoT (Internet of Things) embedded operations. It is a 3V wifi module. Its utmost functioning voltage is 3.6V. ESP8266 module is a low expenditure standalone wireless transceiver that can be used for endpoint IoT developments as in [16]. To act as an interface with the ESP8266 module, the microcontroller calls for a set of AT commands. The microcontroller interacts with the ESP8266-01 module utilizing UART to possess a specific Baud rate.

3.2.5 REES52 Pulse Count Sensor

The number of times heartbeats per minute determines the heartbeat of the person. Biometric Pulse Rate or Heart Rate detecting sensor is the sensor that allows you to count the number of pulses and the frequency of a signal on any pin. Heart Beat can be determined based on optical power variation as light is dispersed or consumed throughout its path through the blood as the heartbeat changes. The heartbeat sensor is constructed on the concept of photoplethysmography. It evaluates the change in volume of blood through any organ of the anatomy or body which results in alteration of the light intensity through that organ (vascular region).[17]

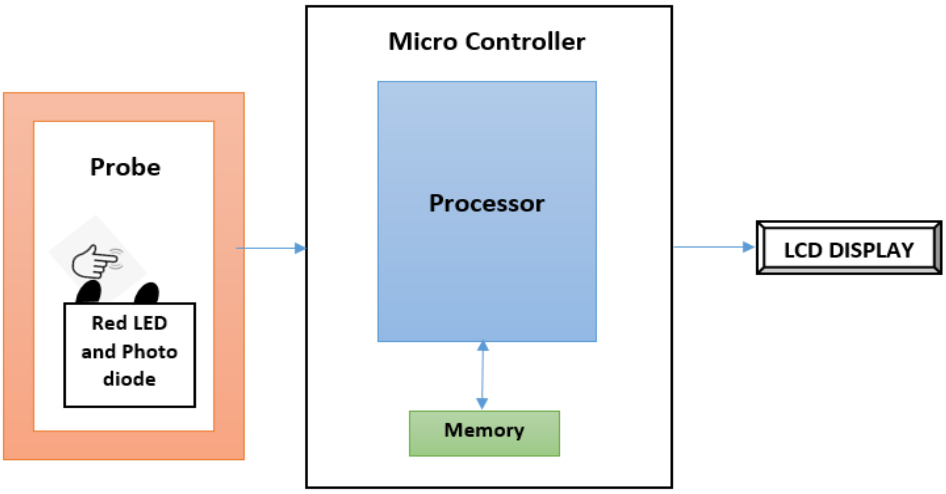

Figure 4: Working of a Pulse Count Sensor

Figure 4 depicts the Working of a Pulse Count Sensor.When a probe is given as the input to the Red LED and a Photodiode then the signal moves to the Microcontroller that contains a Processor as well as Memory bank. Now, the signal sent is taken as a request by the microcontroller in addition to the pulse count sensor commence to work and in turn gives the reading on a LCD display.

3.2.6 Analog Channel Extender-ADS1115

The ADS1115 features 860 samples/second, has broad supply voltage range: 2.0V to 5.5V and interfacing is done via I2C
Its applications vary from sensor interface, process control, Battery operated systems, data acquisition.
AADS1115's is an Analog Channel Extender that is programmable to provide 16-bit precision over 12C. It has four input channels or two differential channels. It is an extender, with Analogue to Digital Converter. It merges high performance along with low power consumption i.e continuous mode 150 µA.

3.2.7 Cuff-less Blood Pressure Sensor

Cuff-less Blood Pressure Sensor is familiar to determine Blood Pressure. It attributes high accuracy and uses low power. The BMP180 provides a range of up to 300 to 1100hpa with a precision down to 0.02 hPa in advanced resolution mode. It has high potency and its stability is long-lasting. The supply of the voltage can range from 1.8V to 3.6V. The analog together with digital supplies (VDDD and VDDA) are tied to a single header pin, but are independently decoupled. The input/output lines can be receptive up to 5V. Also, this is much handy to use.

3.2.8 Power Supply

For the power supply, we use a 9v battery regulated by operating a 3.3-volt regulator. NodeMCU needs a power supply of 3.3v and all the rest of the sensors draw power from the NodeMCU. Also, we can also use a miniature power bank for the unit.

3.2.9 LED Touch Screen

The 1.7” TFT LCD Touch Safeguard for Arduino TFT driver is based on S6D112 with 8-bit data and 4-bit control interface. Arduino 1.7” TFT LCD Touch shield V1 is an Arduino UNO/ Mega adaptable, many-hued TFT exhibit/display with touch-screen and SD card socket as well. It is available and feasible in an Arduino shield compatible pinout for attachment. The TFT driver is formed on ILI9325D with 8 bit data and a 4-bit control interface. The Arduino 1.7” TFT LCD Touch shield can work with both 3.3V and 5V. Therefore, it can be exhibited on Chipkit UNO32 and Simplecortex as well.

IV. RESULTS

As our health band considers different kinds of patients, the results can be discussed in three different ways based on the more use of App, watch, or both for that category of patient. The App notifies when:
The Blood Pressure levels of patients are 130mmHg or higher in systolic and when 85mmHg or higher in diastolic.
The heartbeat rate is 100bpm or higher and also when it is 60bpm or lower (while resting).
The Body Temperature is greater than 38° c and lesser than 35° c.
When the individual’s body gives major and different movements.
These readings will be taken into view while we write the code and will be chosen as upper and lower limits of the readings. If we get values beyond or ahead of these values then they get notified about the particular change in their body and will be given immediate medication.

5.1 For a Patient Admitted in Hospital

A victim might instantly get admitted to the hospital for several reasons like fall off in blood content in the body or platelet count fall down or getting weaker because of BP levels or Glucose levels and many more. When they get admitted we can attach this wristband to their hand and have a note of all the readings and know the attested cause for the patient's health issue in a much better way and give required medication as early as possible. In things, the outcomes will be taken from the app as we have to take a note on the fluctuations that happen which might not be that abnormal at that time. We also use the Switch, if patients want to convey something they can just press the switch and they get the medical attention.

5.2 For a Patient Forbidden to get out of Bed(old aged or paralyzed victims)

In general, these categories of patients need more assistance as they won't be in a state to tell if they are hungry or if they require medical attention. We here use this switch where a bed rest taking person can just press the button to give an indication that he needs help. This will be mainly useful for a paralyzed patient or people who cannot speak which easily helps them to give a signal. Also, We use App here because the family members and caretaker can always look into a patient's health readings changes and provide them with necessary medication. This will be a handy thing for the family members to understand the health of the patient.

5.3 For a Patient on Daily Medication

There will be patients with a health issue but can head their routine life with it, for them both Mobile Application and the Wristband with screen is useful. During their daily routine, if they feel any difference in the body, they can just check the app and know the differences and also if they are engaged with their work, the App and the watch both remind them to take the medication and food on time. If they are going through some abnormal body changes the watch notifies that and the Application sends the notification to the linked Family members mobiles. This also lets them analyze and make daily routine changes to get themselves out of the health issues.

We took the inputs by manually measuring the reading of our peers at college with our device i.e; Catholic Health Band Vs. Thermometer and Pulse Count Sensor. We compared them and made Tables and Graphs for each of them that clearly conveys the preciseness and accuracy of Catholic Health Band's readings.

S.No	Age	Temperature (Thermometer) C	Temperature (Thermometer) F	Temperature (Catholic Health Band) C	Temperature (Catholic Health Band) F
1	7	37.06	98.7	37.04	98.67
2	10	36.67	98	36.43	97.5
3	12	37.11	98.8	37.24	99.0

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4	13	36.94 98.5	36.84 98.3
5	15	36.72 98.1	36.79 98.2
6	15	36.81 98.2	36.88 98.35
7	17	36.83 98.3	36.95 98.5
8	21	37.06 98.7	36.86 98.3
9	22	36.94 98.5	36.92 98.52
10	24	36.72 98.1	36.70 98.17
11	27	37.06 98.7	36.98 98.5
12	29	37.06 98.7	37.06 98.7
13	30	36.81 98.2	36.76 98.1
14	37	36.83 98.3	36.82 98.37
15	39	37.06 98.7	37.08 98.7
16	45	36.94 98.5	36.93 98.5

17	52	36.72 98.1	36.56 97.82
18	67	36.81 98.2	36.83 98.2
19	72	36.83 98.3	36.85 98.31
20	78	37.06 98.7	37.01 98.7

Table 1: Comparison of Temperature Readings(C & F) of Different Age Groups of People with Thermometer and Catholic Health Band.

Table 1 shows the results comparison of Temperature of different age groups of people measured in Thermometer versus the Catholic Health Band in degree celsius and degree fahrenheit. This clearly shows how accurate the temperature readings are in our Catholic Health Band and helps for a better understanding as it also displays two point decimal values. Generally, the Thermometer readings revolve around a few sets of input values but we made sure to concentrate on every decimal point measurement in our device. This itself differentiates the use of Catholic Health Band which is much handy and precise.[18]

S.No	Age	Pulse Rate(Using Pulse Oximeter) (in bpm)	Pulse Rate(Catholic Health Band) (in bpm)
1	7	80	80
2	10	76	75
3	12	76	77
4	13	88	88
5	15	72	71
6	15	68	69
7	17	85	86

8	21	90	91
9	22	75	77
10	24	69	70
11	27	72	72
12	29	92	93
13	30	83	83
14	37	63	63
15	39	79	78
16	45	69	70
17	52	74	75
18	67	81	82
19	72	72	72
20	78	65	66

Table 2: Comparison of Pulse Rate Readings(in bpm) of Different Age Groups of People with respect to Pulse Oximeter and Catholic Health Band.

Table 2 conveys the Pulse Rate readings of multiple sets of age grouped people that are taken with Pulse Oximter and then with Catholic Health Band. They have been compared below and found to have differences in few readings taken. Almost half of the readings are the same and the remaining have minor differences of 2 or 3 bpm. This happened because we are using the same Pulse rate Sensor that will be used in an Oximeter.

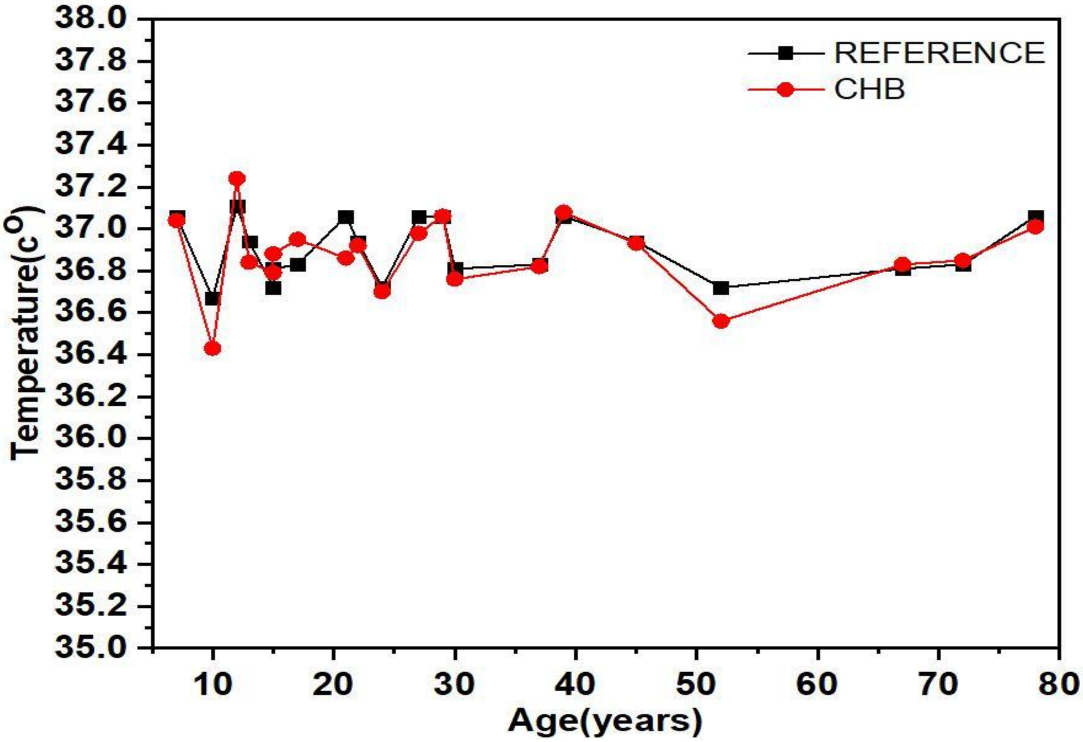

Figure 5: The Body Temperature Graph(Multi-Line Plot) of Thermometer and Catholic Health Band

Figure 5 is a multi line plot graph where the X-axis variant we considered is Age and the Y-axis variant is Temperature. HereBy, the Temperature is compared with two different devices. One is the former gadget readings i.e;Thermometer and the other is our Catholic Health Band. The data is taken from table 1 has an error of 1.03% and the cause of the difference between the former's device data and the current device data is that for each data retrieval, capability limitation of the prototype makes the device unable to measure properly and accurately when the user is moving actively. [19]

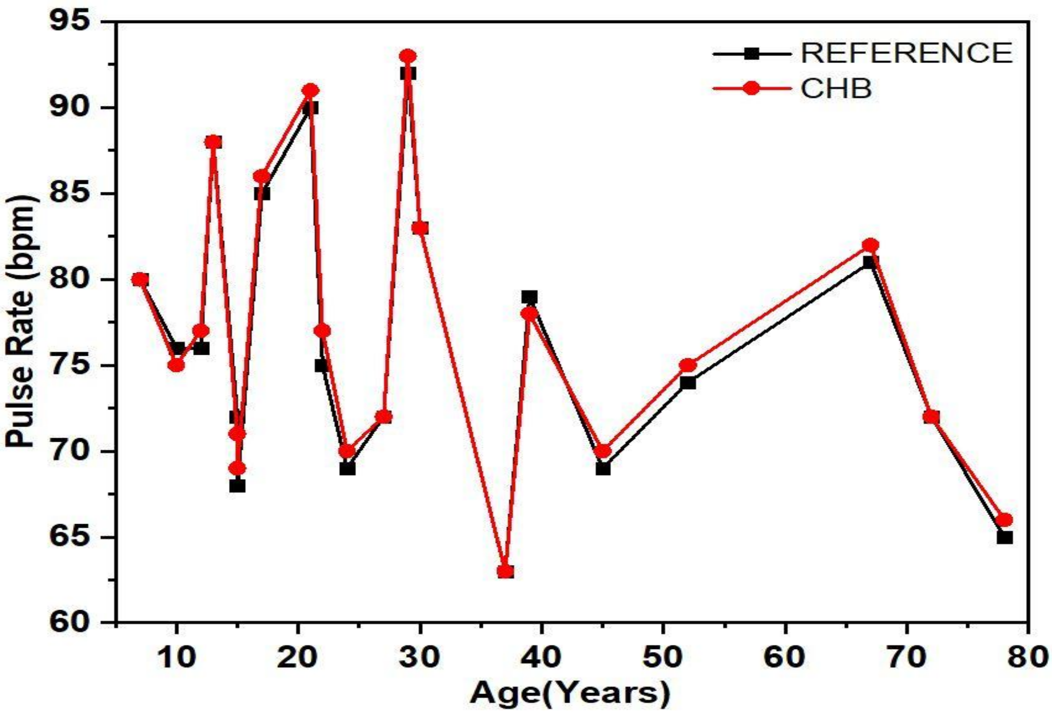

Figure 6: The Pulse Rate Graph of Oximeter and Catholic Health Band

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Figure 6 is a multi line plotted graph where the X-axis variant is Age and Y-axis variant is Pulse Rate measured in bpm. The comparison between the pulse rate taken from Pulse Oximeter and Catholic Health Band is indicated in Table 2 and in this Figure 6. The average error is 0.7% which is very minimal. [20]. Although, we are using the same tool to measure, there will be a minimal difference in the values between the former gadget and our device as the measurements should be taken in a resting position because the movements in the person's body results in minor changes of the readings taken.[21]

V. CONCLUSION

On this basis, we conclude that the Catholic Health Band we designed to monitor the health issues, is useful for different kinds of patients, and also the same device can be utilized in many other ways based on the sufferer's category and necessary. The device is designed in the manner that it can send a notification from the IoT ThingSpeak cloud to the caretaker or family member about their health improvements or disturbances or requirements. As mentioned in the results, we have a minimal error of 0.7% for Pulse Count measurements and 1.03% for Temperature readings which is because of the capacity ability limitation of a prototype.
The advancements we include are that the kin and attendant of the patient will be sent notifications about the patient's abnormal health conditions, making a device that is feasible to use, special sensors used for specific health types, and a database in the app that stores all the readings. Regardless, future research could continue to explore what other health sensors can be added into this to make it much efficient to use and how we can make the device more accurate. They can also concentrate on decreasing the size of the Health band by the furtherances that might come in the further path-breaking technologies.

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