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Smart Health Monitoring System of Patient Through Internet of Things

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ABSTRACT
Information interchange, machine-to-machine connection, and data transfer are all made possible by the Internet of Things in healthcare. Real-time health monitoring using health care bands allows us to keep track of our health and receive notifications in the event of an emergency. Identity of physical activity, vitals, and fitness measures is possible with smart healthcare bracelets. One solution is to use IoT to monitor the patient's health and present data to doctors or medically trained workers, as it is difficult to check the patient for 24hrs. So, using non-invasive sensors, such as pulse, respirations, body temperature, body position, it is possible to detect things like glucose levels, ECG, and so on. These sensors are connected to an Arduino board, that receives data from the sensors, including biological data, and sends it to a server. Here, the "Thingspeak" called new cloud is used to store the observed data on the server. The information from this server may be seen by experts and other paramedical workers using the Thingspeak android app. As a result, using this Digital health monitoring system reduces the time and expense of assistance by reducing the effort of experts.

Keywords—Internet of Things (IoT), Arduino Uno, Thingspeak, ECG and heart rate (HR).

1. INTRODUCTION

The Internet of Things (IoT) is a system of internet-connected gadgets that communicate with the outside world via integrated sensors and actuators. The quantity of web devices is rapidly expanding due to its vast uses in numerous fields such as healthcare, agriculture, sports, and security. The IoT industry is constantly expanding, and by 2025, worldwide IoT market revenue is estimated to reach over 1.6 trillion US dollars (USD). Wearable sensor devices with IoT capabilities have emerged as a potential technology for applications such as continuous wireless monitoring of important physiological parameters including heart rate (HR) [1].

Technology is employed extensively in healthcare, not just for sensing equipment, but also for communication, recording, and presentation. It is critical to keep track of many medical factors. As a result, the Internet of Things (IoT) is the most current advancement in healthcare communication [2]. The Internet of Things (IoT) is employed in a wide range of applications and serves as a stimulant for healthcare. The ATMEGA328 chip is often used as a gateway in this project to link to a variety of sensors, including temperature, pulse, MEMS, and oscillation frequency sensors [3]. The microcontroller gathers transmitter data and sends it over Wi-Fi to the network, allowing for real-time measurement of health-care variables. At any time, the doctor has access to the information. The data will be sent through a password-protected ESP8266 Wi-Fi module that will be encoded using standard AES128 [4]. Users/doctors will be able to examine the data by registering into the online document. As a function, this gadget may be able to immediately give temporary medication. With low power, simple setup, excellent performance, and rapid reaction times, this system is incredibly efficient [5].

The Internet of Things is used to communicate data about health factors. The Internet of Things (IoT) is a system of physical devices that are linked together and exchange data via sensors, actuators, and a network connection [6]. According to the most current report of the Medical Council of India (MCI), Eighty percent of the 10.4 lakh experts are now serving the patient at the same time. It is estimated that 8.32 lakh specialists are

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actually available to provide dynamic patient assistance. In India, the ratio of experts to patients is roughly 1:1568 compared to the World Health Organization's guideline [7]. The Nursing Council of India has roughly 11.65 lakh medical caregivers registered. Only 42% of them seem to be in dynamic service. According to the guidelines, the ratio of attendant patients in critical care units should be 1:1, general care units should be 1:3, and emergency rooms should be 1:6. This is why there is such a severe shortage of medical personnel.
To rectify the shrinking patient-nurture proportion, we'll need twice as many nursing professionals as we have now. As a result, it is evident that there is only one doctor for every 2000 patients, necessitating a twofold increase in paramedical staff. It is impracticable to increase the number of patients and specialists while also increasing the number of paramedical employees [8]. The IoT technique is used in the Smart Health Monitoring System to reduce the efforts of doctors and paramedical workers. The modern healthcare industry's objective is to give superior to people in in a much more cost-effective and patient-friendly manner. As a result, there is a need to improve patient monitoring equipment in order to increase patient care efficiency [9]. The medical world is currently confronted with the most serious issue: the requirement for health care providers to be present at the patient's bedside. In our fast-paced world, keeping track of our health is becoming increasingly difficult, therefore everyone expects to be informed about their health via smart technology that is both accessible and effective[10].

2. METHODS AND MATERIALS

Self-monitoring has become increasingly important in recent years for maintaining overall health. Smart healthcare bands allow us to track a person's vital signs and send an alarm in the event of an emergency [11]. The entire health is monitored via vital signs, and appropriate action is indicated. Some medical monitoring devices have previously been created to enable the collecting of vital signs from patients and their transmission to a central location, allowing clinicians to simultaneously monitor many patients in various places. Many previous systems, on the other hand, did not allow the observed patients to leave the hospital [12]. As a result, the smart health care band assists us in remotely monitoring the patient. The mobile or online application will save and update this information [13].

By creating a Heartbeat/Pulse/BPM Rate Monitor with Arduino and a Pulse Sensor in this project. The pulse sensor may be connected to an Arduino to track heartbeat, pulse, and BPM rate [14]. Capillary tissue volume increases as a result. Between two heartbeats, however, the amount of blood inside capillary tissues decreases. The phase transition between heartbeats has an impact on the amount of light that travels through these tissues. A microcontroller can be used to determine this. The pulse rate is measured easier thanks to a light mostly on sensor module [15]. The intensity of daylight reflected changes due to amount volume blood in the afferent arterioles when we place our fingertip on the pulse sensor. This variation in light emitted and absorbed as a pulse may be measured using the pulse sensor's output. This pulse may then be habituated to measure heartbeat and programmed to read as a heartbeat count with Arduino as shown in fig 1.

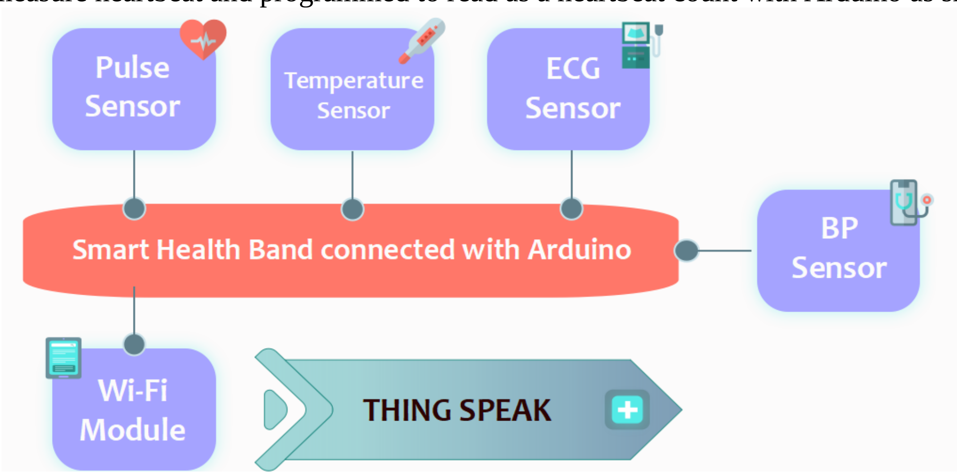

Figure 1: The smart health care system's architecture unit.

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Here developed an IoT-based Patients Healthcare Monitoring System using the Pulse sensor (AD8232), temperature sensor (LM35), BP sensor (AMS5915) and ECG sensor (AD8232) as well as this work required the use of an Arduino and Thing Speak as IoT platform. Temperatures and heart rate may be measured with this Internet of Things device. It continuously monitors heart temperature range and transmits the information to an Internet of Things environment.

3. PROPOSED METHODOLOGY

The detection layer, the transport layer, and the application layer are the three layers that make up the overall design of IoT applications. The pulse sensor device is used to measure the patient's heart rate. It features its own visualizer for displaying the heart rate waveform, BPM, and IBI. The accelerometer ADXL335 was used to determine the patient's body position and blood pressure has measured by BP sensor AMS5915. It shows whether the sufferer is resting, sleeping, walking, leaping, or front-bending, as well as the other states. The Electrocardiogram and Electromyogram were recognised using the AD8232 Heart-Rate Observing Sensor.
On a daily basis, the serial monitor in Arduino is being used to validate physiological data from various sensors. With the aid of an Ethernet shield or an ESP8266 Wi-Fi Module, we transport data to the cloud using the Arduino in the Transport layer. We make it available in the cloud using the open cloud server "Thingspeak" so that it may be viewed from anywhere on the planet. On the Thingspeak server, we create an account and a distinct route with the name of our program. To connect the data to the cloud, we acquire a unique id and API-key when we construct the channel. This API key is utilised while programming in Arduino so that data may be transferred to the server and retrieved using a unique API key at the application layer as shown in fig 2.

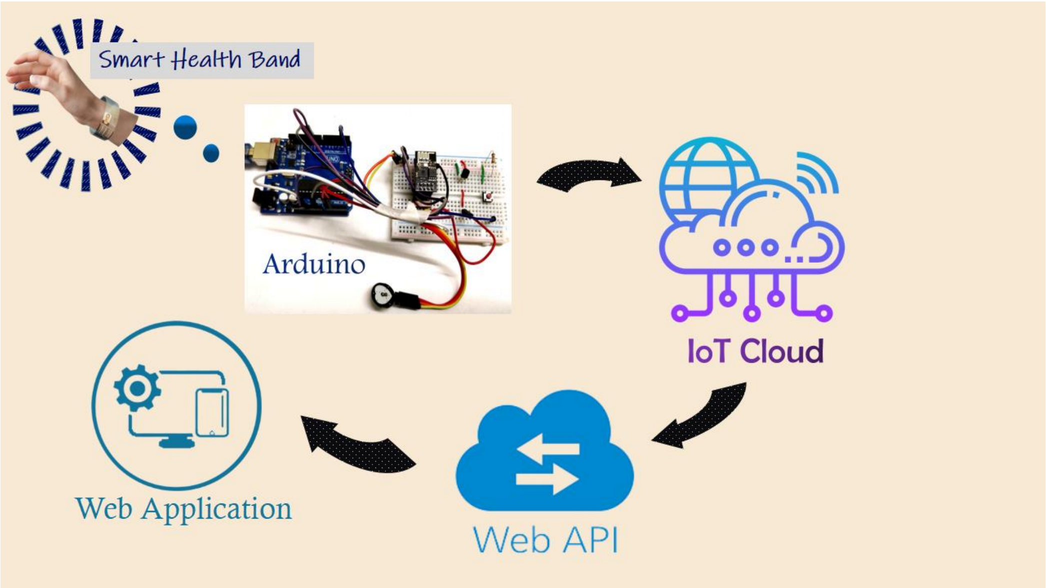

Figure 2: IoT Design Framework.

A three-layered Internet - of - things light-weight sensor device that may be worn as a bracelet monitors the health signs of 19 potentially infected people in real time. In the case of incident or a breach of identity rules, this device locates potentially contaminated people and alerts those who are concerned. As shown in above figure, the implemented architecture system includes three tiers to handle the required requirements.

3.1 Wearable IoT layer

This layer collects two types of data: GPS sensor data & medical data for covid-19 symptoms. According with application design, this layer consists of a microcontroller that uses an IoT core to collect data from connected sensor modules. A GPS sensor is used in the IoT-designed application to gather all of a patient's geographical data, identify the patient's location in real time, and store the data to the cloud.

3.2 Cloud layer

This layer takes the data from of the microcontroller and saves it in the API interface. The website was designed with cloud flare for genuine speed and security. Cloud flare is a network architectural, app, and team management platform. The fact that it includes a built-in firewalls that secures all data is one of the most important features of this resource. It enables the user to create a safe and internationally trusted network for the app. Cloudflare's global network also saves all clinical condition, contact information, and location information. API interfaces are used to send email and SMS notifications to investigators and patient family and friends in the times of the incident so that they can respond appropriately.

3.3 Web frontend layer

The key goal of this layer is to connect with a domain that protects information assets and trustworthiness while taking actual information from a cloud-based technology. The microcontroller receives and analyses these actions and information before sending it to the top of the atmosphere for storing and retrieving as needed. The patient's data is critical for analysing the trends of potentially infected patients' present data. It may also be used to give preventative therapy to possibly infected people by monitoring them and responding to any urgent measures in protecting patients' health in an emergency, as well as geofencing them to prevent disease spread.

4. PATIENT MONITORING ELEMENTS

4.1 Pulse Sensor using OLED and Arduino for ECG Display

Arduino, together with IoT & Gear Arrangement, is rapidly changing the healthcare industry, thanks to a slew of health care legislation regulation start-ups. We'll make an ECG monitor with a transmitter, an OLED, and an Arduino in this project. A 0.96″ OLED Display with 128x64 resolution will be used to display BPM and ECG waveforms. The I2C OLED uses only two wires for serial communication: SDA and SCK.
The research's many features are implemented by the Arduino Sketch running on the device. These functions include reading sensor data, translating it to strings, sending it over I2C, and displaying the measured pulse rate on an I2C OLED Display as shown in fig 3.

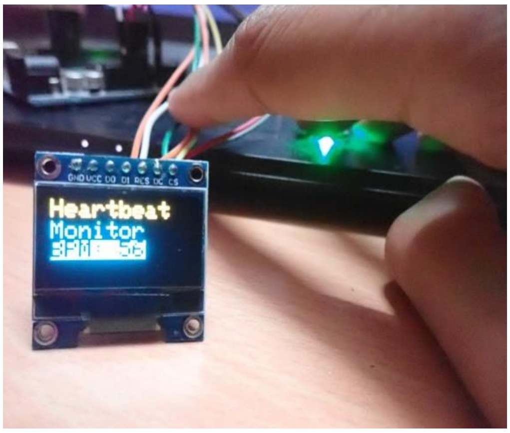

Figure 3: OLED Display

The IoT-based Patient Heart Rate Monitor, which uses ESP8266 and Arduino, is depicted in this basic block diagram. The LM35 Temp Sensor monitors external temperature, whereas the Sensing Element measures BPM. Finally, data may be seen from anywhere in the globe by subscribing to the Thingspeak channel.
ThingSpeak is a fantastic tool for IoT-related projects. Here using ThingSpeak's Channels and website pages to regulate and manage our system via the Internet. To begin, go to https://thingspeak.com/ and register as shown in fig 4.

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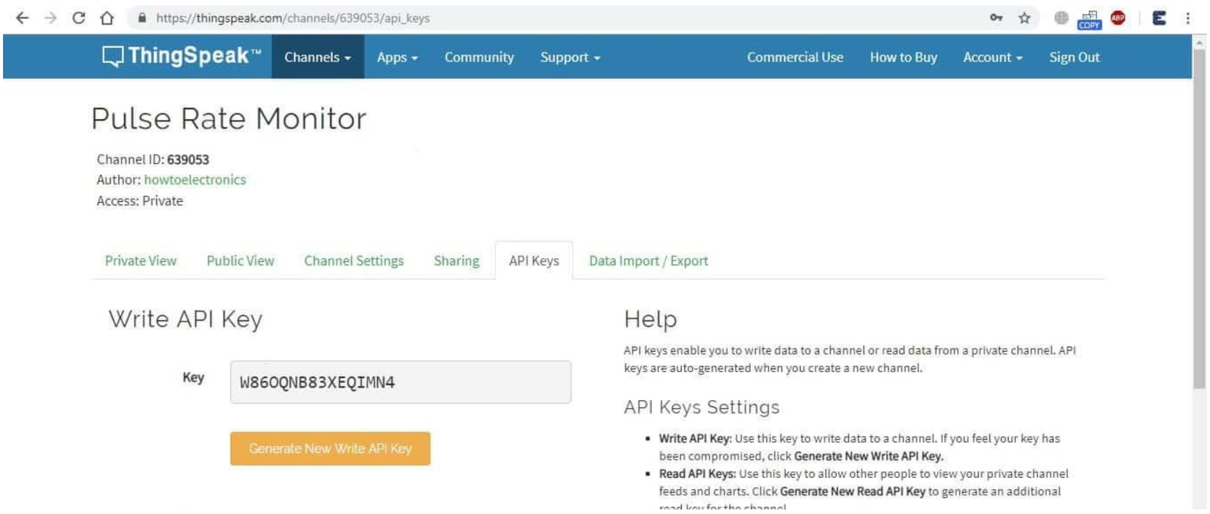

Figure 4: Pulse Rate Monitor in Think speak

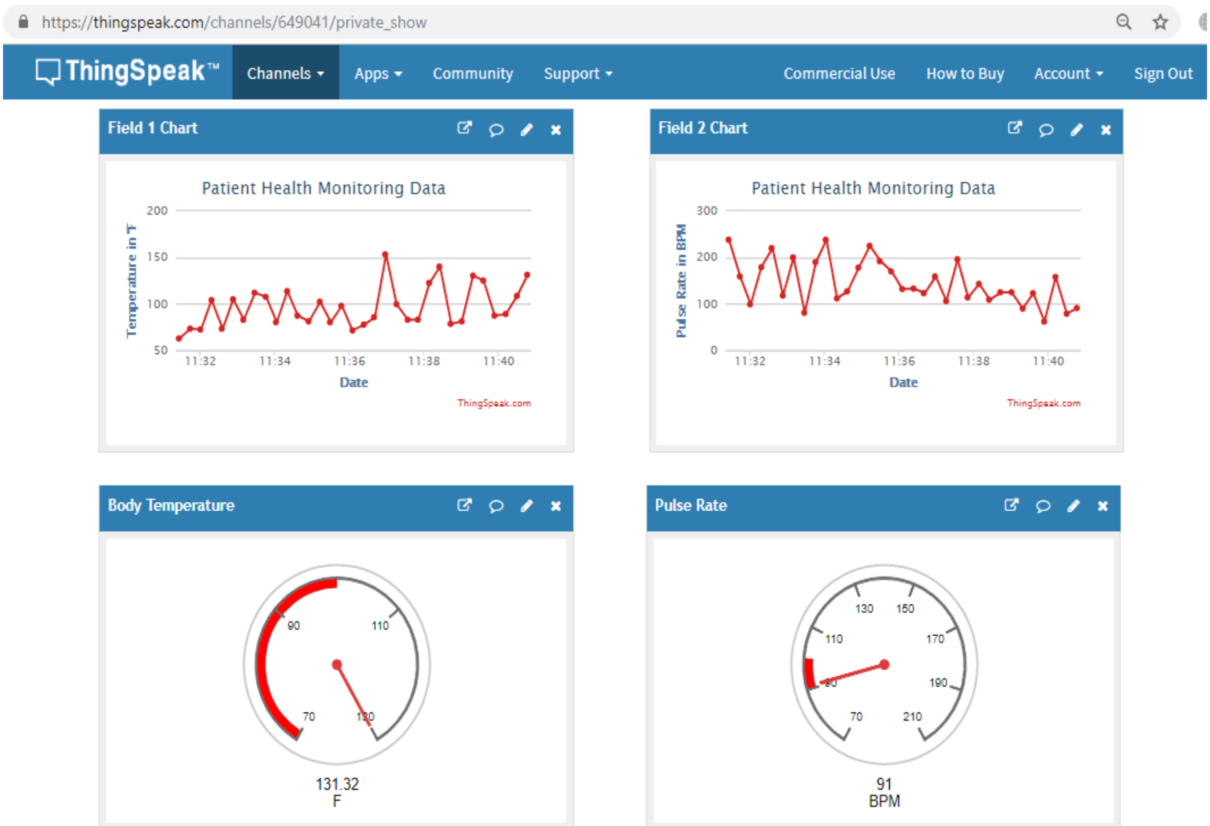

Figure 5: Patient Health Monitoring Data

Smart Wristband is a wristband-worn gadget that monitors the patient's vital signs and geolocation, ensuring their safety while fighting the infection at home. The gadget is operated by an Arduino MKR GSM 1400 and includes an IR temp and heartrate sensor that collects vital data about the patient's health. The virus progresses as the temperature rises and the heart rhythm becomes erratic as shown in fig 5. Smart Wristband seeks to achieve this and feed the data live and safely to the hospital observing the patient, so the patient would not notice these changes right away.

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The hospital will also have accessibility to a dashboard that will show the health of all of the patients being watched at a glance, as well as a thorough report on each patient's condition. Machine learning algorithms are also used in the app to estimate the patient's temperature and heart rate in the near future, so the hospital knows what's coming and when to admit the patient. The patient also gets access to a smartphone dashboard that displays their heart rate, temperature, and when their wristband needs to be charged. Smart Wristband is a low-cost, flexible, open source solution for monitoring the progress of patients sent to identity with weak strains of the virus and notifying medical professionals if a patient requires treatment using machine learning and a simplified dashboard interface.

4.2 Data Collected

The gadget collects data every 5 minutes. This is performed to offer a reasonably live image of the patient's status while consuming the least amount of battery power feasible. The gadget records vital and location information. By analysing the temp and heart rate data, it is possible to determine if the patient's current state is degenerating. According to studies, a fast heart rate and a high fever are signs of the infection. If these vital signs deteriorate over time (e.g., the temperature steadily increases), the patient's condition may be deteriorating. Although the sufferer may not have been aware of this until later, the gadget will detect these indications as they arise.

The gadget may be readily attached to the patient's wrist, on either left or right hand. It has a heart rate sensor and an infrared temperature sensor that protrude from the bottom of the device and touch the patient's skin. Without causing pain, these sensors deliver exact readings. Note that the sensor should be put in a location such as beneath the arm in a pad for greater temperature accuracy.

The gadget will check if the patient is wearing the device using the raw data output by the heart rate sensor. When the sensor comes into touch with skin, it produces a very precise pattern of data, and the absence of this pattern indicates that the gadget is not being worn. The initial step is to assemble all of the necessary components. The necessary components and services as shown in fig 6.

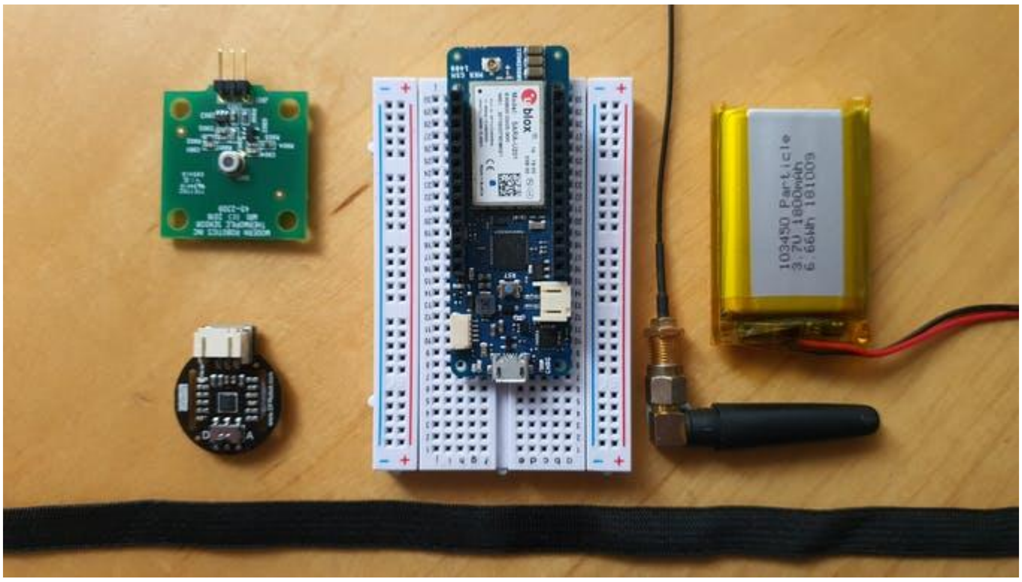

Figure 6: Hardware Components

Connect the hardware components to the Arduino according to the circuit design then upload data. Open Serial Monitor to observe what's going on inside the code.

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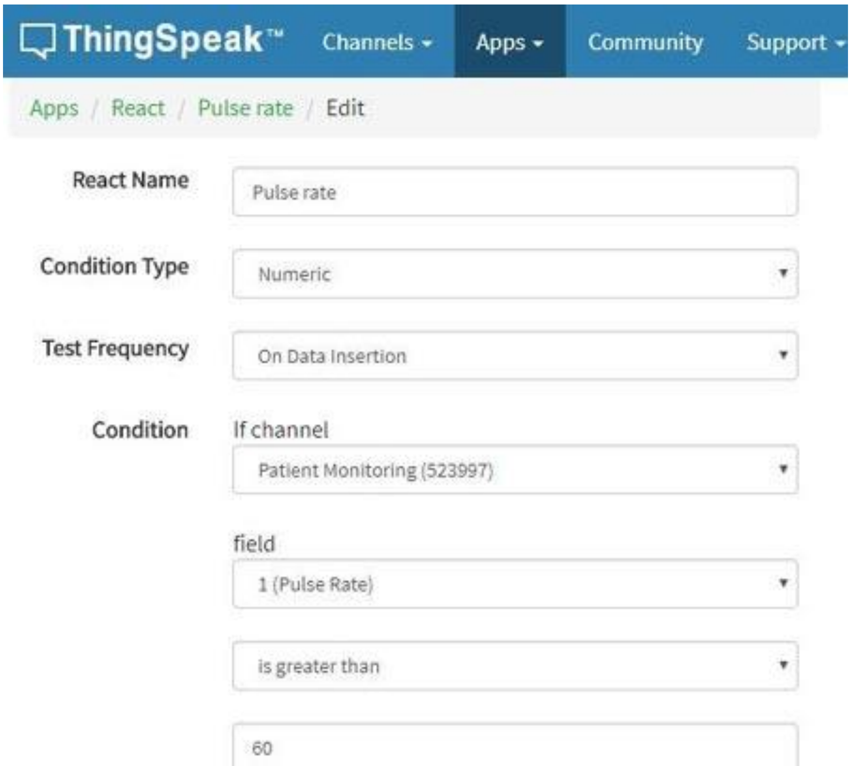

Figure 7: Attributes

From the Action drop-down option, choose ThingHTTP and press Enter as shown in fig 7. Save React after selecting "Run action each time condition is met." Data in Google Sheets on Google Drive will be updated after the timing duration you defined in the timer setting as shown in fig 8.

Patient Info

	A	B	C	D	E
1	Date	Patient Name	Pulse Rate	Body Temp	BP
2	june 2, 2022	anu	217	51	98
3	june 2, 2022	bavi	127	53	99
4	june 2, 2022	chitra	220	50	97
5	june 3, 2022	ram	222	54	76
6	june 3, 2022	janu	209	62	95
7	june 3, 2022	ravi	121	86	98
8	june 5, 2022	sekar	103	83	73
9	june 5, 2022	raji	209	99	95
10	june 6, 2022	kavitha	212	79	94
11					

Figure 8: Patient Information

5. CONCLUSION

In previous works, the sensors used to monitor the patient's condition were not as accurate, but the sensors we used here are fundamentally precise and ideal for intelligent continuing monitoring. The doctor may monitor the condition of the patient 24 hours a day, seven days a week, thanks to Thingspeak, a new android app and open source cloud, and any dramatic changes in the patient's condition are notified to the doctor or paramedical workers via a toast notification. Furthermore, because the data is saved on the Thingspeak server, the patient's state may be tracked from any location on the globe. In addition to just studying the patient's past information, we may use this information for rapid understanding and treating the patient's health by appropriate specialists. In a future version, developing a 3D printed casing would be desirable. The device's size may also be drastically lowered, making it much more comfortable.

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