HEART PULSE MONITORING AND NOTIFICATION SYSTEM USING ARDUINO

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***Abstract* — As we all know one among the fatal problems which cause the death of humans is respiratory problems. On the off chance that checking our wellbeing consistently, at that point we can identify various sicknesses by recognizing them well in advance. Many individuals have lost their lives to coronary syndromes. Especially at this point time (Corona virus period) doctors cannot physically meet and treat the patients until and unless the situation is critical. So we have developed a system using Internet of Things to assist individuals and help them get immediate treatment. In this system we use a pulse sensor which when a finger is placed on it calculates the heartbeat of the person. In this system there are two segments the hardware which is used to calculate heartbeat and the other is to continuously monitor heartbeat data which is collected in the previous step. This sensor is then interfaced to an Arduino UNO microcontroller that permits checking of the heartbeat value and communicating them to the internet by using Bolt Wi-Fi module. The data is sent an AWS server via bolt cloud which continuously monitors the heartbeat for any abnormalities. The client can set a limit whenever the client's heartbeat exceeds the threshold limit then by using online API services like Twilio we send SMS to the doctor/client stating the patient's current heartbeat. In this way we are providing a solution to monitor the heartbeat of a patient remotely and give an automated response according to the heartbeat.**

Keywords* — *Heartbeat, Internet of Things (IoT), Cloud Computing (CC), Arduino UNO, Bolt Wi-Fi module, AWS server, API's.

I. INTRODUCTION

This covid-19 pandemic has caused many problems to everyone and especially the most affected ones are the patients. Patients whose heart pulse needs to be monitored regularly by the concerned doctors are affected by this Covid-19 outbreak. There has been a communication gap formed between these patients their concerned doctors/caretakers. Due to the implementation of lockdown all over the world the situation got worse for the patients. [1] This is where our idea flourished to help those section of patients whose heart pulse needs to be monitored regularly. [6] With the help of the knowledge, we gained from the concepts of IoT and its applications in medical field, we have researched and studied many research papers related to our problem statement. After reviewing many papers, finally we have chosen one paper, as our base paper and started working on the idea. Our project "Heart Pulse Detection and Notification System using Arduino" mainly focuses on the communication gap between the patients and their doctors. The main aim of our project is to establish a communication bridge between the patients and the concerned caretakers/Doctors. [5] We have used reliable components such as Arduino Uno, which is the brains of the system, heart pulse sensor, which detects the heart pulse of the body, and BOLT Wi-Fi module for establishing a connection to send data through internet. We have used the most reliable VPS service provider which is AWS VPS to run the program(code) required to detect the abnormality present in the heart pulse. For the notification module, we have used TWILIO as our online API service which sends data to the concerned doctor whenever there is an abnormality present in the patient's heart pulse.

We have implemented the following technologies in out project:

1. **IoT** – IoT stands for Internet of Things. It describes the network of interrelated computing devices that are embedded with sensors, actuators, and software for connecting and exchanging data with other devices in a network via internet.[2] The applications of IoT are divided into 4 types they are of 4 types they are consumer, commercial, industrial, infrastructure. In the consumer market IoT is mainly used with the products pertaining to home automation or smart home systems. IoT can also be applied to healthcare systems this type is known as H-IoT. In our project we have used the H-IoT concept to create a healthcare system which monitors and notifies the doctors about the patient's heartbeat whenever there is an abnormality. But there are several privacy and security concerns regarding growth of IoT.

Fig.1.1 Internet of Things

2. **H-IoT** – H-IoT stands for healthcare IoT. This is undoubtedly transforming healthcare industry by delivering healthcare IoT solutions.[10] These implementation benefits patients, hospitals, companies.

- **IoT for Patients** - IoT devices in the form of fitness bands, smart bands give us various data about the patients. These features can be turned on and off according to the requirement of the user. IoT has changed people's life's especially elderly patients by monitoring various aspects of the patients continuously. As shown in Fig.1.2 there are many applications for H-IoT for patients and hospitals.
  For EX- Smartwatches contain various sensors which monitor the data of the person using it. This can be used on patients to continuously monitor their data.

- **IoT for Hospitals** –[9] Apart from checking patients health details continuously there are many more advantages of IoT in hospitals. The IoT devices are very useful for tacking medical equipment like wheelchairs, oxygen pumps, and monitoring equipment. Hygiene is also important with the help of IoT devices spread of infectious diseases. IoT can also be used in asset management like environment monitoring, pharmacy inventory control, humidity, and temperature control, etc.
  For EX- AID(Automatic Insulin Delivery systems) these systems work with CGM's which continuously check the blood sugar level of the patient and calculate how much insulin is needed and can pump out insulin as per the requirement.

- **IoT for Insurance Company's** – There are many opportunities for health insurers with IoT connected intelligent devices. Insurance companies can use the data which is captured through health monitoring devices for underwriting and claims operations using HIoT the insurance companies can check the data which is collected and validate it to provide quick claims and getting to find a clearer picture of potentially fraudulent cases.
  For EX- Insurance company John Hancock uses wearable electronics data to monitor the health of the clients and accordingly providing them with travel coupons, entertainment rewards, etc so that their clients at less risk of claiming the insurance.

Fig.1.2 Health-IoT

This project Heartrate monitoring and notification system using Arduino con be useful in IoT for Patients and for Hospitals for monitoring patient's heartbeat always.

3. **CLOUD COMPUTING** – Cloud Computing refers to providing on demand availability of Computing resources epically data storage and computing power without any direct management by user.[3] This term is used to define datacentres available to many users over the internet. The clouds may be limited to only one organization or to multiple organizations. The cloud providers generally use Pay as you go scheme.[4] We have selected Aws as our cloud because it has a variety of features and follows a pay as you go scheme the cost of using the cloud is limited and with the limited cost we also get a plethora of features to be used in the project which is deployed in AWS server.

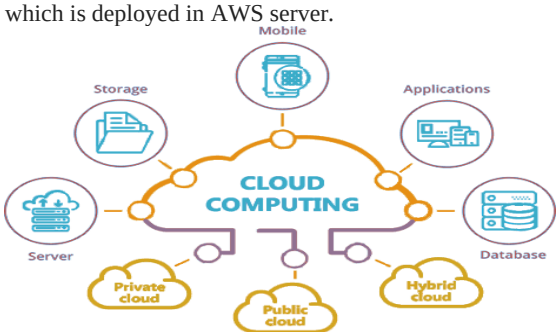

Fig.1.3 Cloud Computing

4. **USAGE OF API'S –** API stands for Application Programming Interface. This allows to applications to communicate with each other. One of the main requirements of this project to send SMS whenever there is an abnormality so in this case, we use a SMS API service called Twilio. Whenever there is an abnormality detected in the AWS server with the help of a program, we can access Twilio and send SMS about the status of the patient.

II. COMPONENTS REQUIRED

As one of the aims of this project is to provide the implementation at low cost we tried to complete the project using minimal but rather very much effective components. The components which we used are:

1. **Arduino UNO Board**
2. **Pulse Sensor**
3. **Bolt IoT Wi-Fi Module**
4. **Jumper Wires (M-M,M-F)**

1. **Arduino Uno Board:**

Arduino Uno Board is an open-source microcontroller board based on ATmega328P microcontroller which is developed by Arduino. The Arduino Uno board (Fig.2.1) contains a set of pins which are used for input/output purposes. There are 14 digital Input/Output pins and 6 analog Input/Output pins. Some pins which are present on the Arduino board are 5V,3.3V, GND, Vin, etc. This board can be programmed by using Arduino IDE by connecting the Arduino to a laptop by using a Type B USB cable or an external power source. This microcontroller is used to program certain hardware devices to perform a specific task. Instead of resetting after every task Arduino Uno is equipped with auto reset feature. Which makes using this very easy and ready is to use.

Fig.2.1 Arduino UNO

2. **Pulse Sensor:**

Pulse Sensor(Fig.2.2) is a plug and play device which is designed to work with Arduino for calculating the heartrate of a patient.[11] There are two surfaces and three pins to the sensor one side contains the LED and ambient light sensor on the other surface we have a circuit board containing noise cancellation and amplification. The three pins are ground, VCC(power supply), signal. When we place the sensor on our fingertip the sensor detects the vein which is present in the finger and whenever there is a blood flow change in the veins, we can calculate the heartbeat as well.

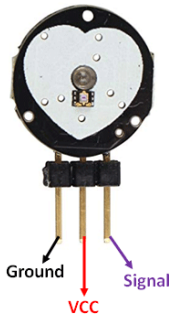

Fig.2.2 Pulse Sensor

3. **Bolt IoT Wi-Fi Module:**

This Wi-Fi module acts as an interface to connect the hardware components to the cloud. This bolt Wi-Fi module(Fig.2.3) is secure and fast. Here there are a few I/O pins which can used according to the user's requirements. There are two lights present which indicate the working of the module. Green light indicates that the module is connected to cloud and orange light indicates that the Wi-Fi is on.

Fig.2.3 BOLT Wi-Fi Module

4. **Jumper Wires (M-M,M-F):**

Jumper wire is just a simple wire that contains connector pins at the extreme ends of the wire which can be used to connect two components into a single working circuit. These can be used without soldering and can be easily interchangable according to the users requirement.In this model we have used M-M (Male to Male) and M-F (Male to Female) variations because it is best suitable for this project.

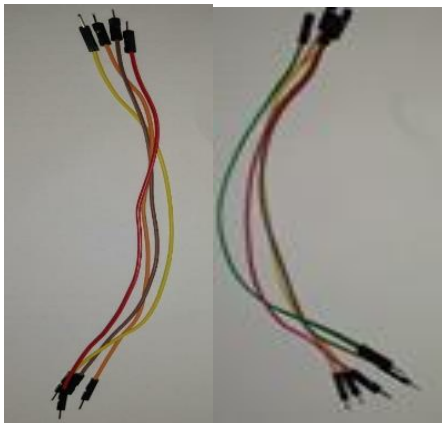

Fig.2.4 Jumper Wires (M-M,M-F)

III. PROPOSED MODEL

Here are the block diagrams and process flow diagram related to the proposed model of the system.

- **Block diagram:**

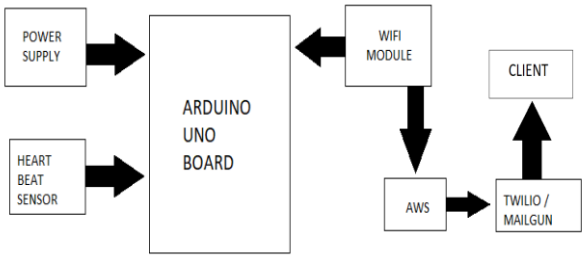

Fig.3.1 Block diagram of this project

- **Flow diagram:**

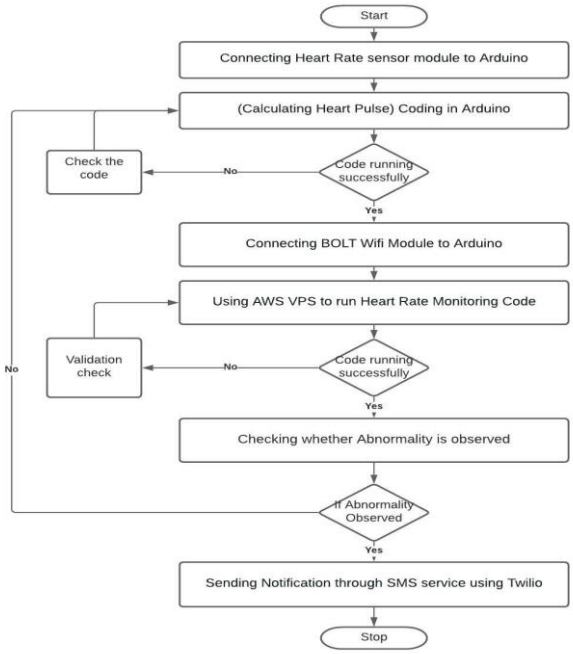

Fig.3.2 Flow chart of the project representing the step-by-step procedure

Step-1: Connecting the Heart Rate sensor module to Arduino

There should be an Arduino programming software introduced in our system prior to associating the Arduino UNO module. Later the pulse sensor, which is utilized to ascertain the pulse of a patient, is associated with the pulse sensor utilizing the associations as demonstrated in **Fig.3.4** . Utilizing the three pins of the sensor(GND,VCC and SIGNAL), it is associated with the Arduino UNO. In the wake of associating effectively, the framework is presently prepared for compilation.

In detail explanation about the working of the heart rate sensor:

The pulse framework contains a diode and a photodiode. At whatever point we place our finger on the sensor, there will be an unsettling influence brought about by the progression of the light produced by the diode. This aggravation is brought about by the progression of blood in that finger. The blood in the finger assimilates a portion of the light produced by a diode and the excess mirrored light beams are then caught by the detector(photodiode). The detector records the reflected beams which are brought about by the unsettling influence made in the light stream by the progression of blood in the finger. The detector shows the yield as a DC signal which is identified with the blood volume and the progression of blood in the finger. This is the manner by which a pulse sensor detects the heartbeat of a body.

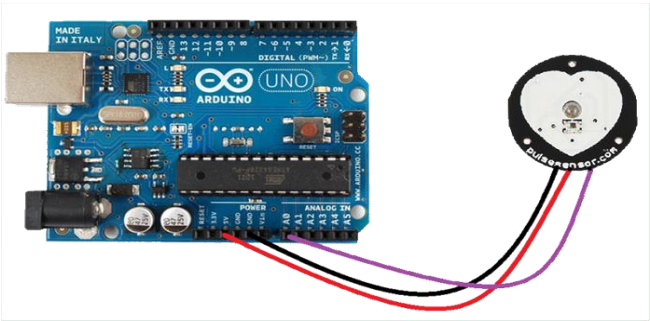

Fig.3.4 Arduino Uno connected to the Pulse Sensor

Step-2: Coding in Arduino (Calculating Heart Pulse)

After successfully connecting the heart rate sensor to the Arduino, the code for calculating the heart pulse must be entered in the Arduino console. Only if the code runs successfully, the process goes to the next step otherwise we need to recheck the uploaded code in the console. The results are shown in the output console.

PSEUDOCODE:

```
//import required libraries
#include <SoftwareSerial.h>
DECLARE pulsesensorpurplepin
DECLARE LED13
DECLARE signal
DECLARE threshold
DECLARE S
SET pulsesensorpurplepin to 0
SET led13 to 13
SET threshold to 550

//Softwareserial is used to allow communication to digital pins
SoftwareSerial mySerial(10,11)

//pseudocode for setup function
pinMode(LED13,OUTPUT);   // pin that will blink to your heartbeat!
Serial.begin(9600);          // Set's up Serial Communication at certain speed.
mySerial.begin(9600);
return

//pseudocode for loop function
SET signal to analogRead(pulsesensorpurplepin)
SET s to (signal/8)
PRINT "Your heart beat is :"
PRINT s
If(signal>threshold) Then
        digitalWrite(led13,HIGH)
Else
        digitalWrite(led13,LOW)
endif
wait for 1000
return
```

Step-3: Connecting BOLT Wi-Fi Module to Arduino

Since the main aim of our task is to make everything robotized, we need a BOLT Wi-Fi module to make an association with the web. The BOLT Wi-Fi module is associated with Arduino and an association between the framework and the web is set up. The connection of BOLT Wi-Fi module to the Arduino UNO is shown in **Fig.3.5** .

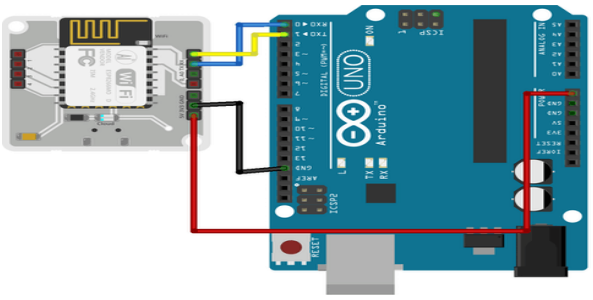

Fig.3.5 Arduino UNO connected to BOLT Wi-Fi Module

Step-4: Using AWS VPS to run Heart Rate Monitoring Code

To run the irregularity pulse checking measure, we need an online virtual private server(VPS). We have utilized Amazon Web Service based VPS which is easy to understand and entirely dependable.

A new Linux server dedicated to that framework to compute the abnormality. Here we need to upload our code to check the variation from the norm present in the heartbeat. As we are dedicating the server to run our process, we can store data in the server i.e. we can review the previous data whenever we need it. This helps the end-client and the adaptability of our project is additionally expanded.

Step-5: Checking whether Abnormality is observed

In the wake of running the code effectively in the AWS VPS, we currently need to check if any irregularity present in the heartbeat. On the off chance that the heartbeat is ordinary and there is no irregularity present in the heartbeat then we need to return to step-2 to compute the heartbeat in the body. This interaction will proceed until the finger is taken out from the sensor. If there's any abnormality observed in the heart pulse, then it carries onto the final step which is the notification module.

Step-6: Sending Notification through SMS service using Twilio

On the off chance that there is any abnormality seen in the heartbeat, at that point the code triggers the notification module. For notification service, we have used Twilio which is online based notification service. In Twilio, we must enter phone numbers of the concerned caretakers/doctors/end users so that whenever there is any abnormality present in the heart pulse of the patient, it will immediately notify them. There will be an API code generated in Twilio which is used to connect the code present in the server to trigger the notification.

IV. WORKING METHODOLOGY

Our project "Heart pulse monitoring and notification system using Arduino" mainly concentrates on the communication gap between the patient and the concerned doctor. We tried to reduce the gap between them by introducing the concept of notification system to the already proposed model. For this purpose, with the help of the knowledge we gained from the IoT course, we have used TWILIO as our online SMS service to send notification regarding the heart pulse of the patient. We have used the similar sensor to detect the heart pulse of the patients which is the pulse sensor. This when we put our finger on pulse sensor there is an LED which emits ultraviolet light onto the finger and detects the vein in the finger whenever there is any change blood flow change in the vein that value is sensed by the ambient light sensor. According to which the heartbeat is calculated. We have used Arduino UNO as our main microcontroller of our system. Using a BOLT WIFI module, we have automated our system by establishing a connection with the internet through this module. All the data which is shown in the Arduino IDE will be collected in the BOLT Cloud which is then connected to a AWS VPS services where a code is written to check the data which is coming from the BOLT Cloud the code is continuously run until the user stops the execution of the code in AWS. Our system checks for abnormality present in the heart pulse of the patient and if there is any abnormality observed then our system sends the message to concerned doctor in the form of SMS with the help of Twilio an SMS API service. In Twilio we have to create an Programming API after creating the API there will be few keys which will be generated which will be used in the code which is present in AWS for the connection of both software.

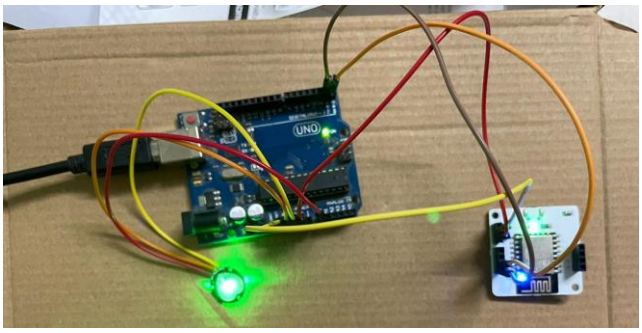

Fig.4.1 Entire implementation of our project

Fig.4.1 shows the entire connections between the components which we have used in the project.

Advantages:

1. Our project is fully automated.
2. Our project has a notification system which sends the message to the concerned doctor/person regarding the abnormality.
3. Since it has VPS service such as AWS and API service such as TWILIO, the previous data records are stored in the cloud. So that the doctor can review them later in the future.
4. Our system is cost efficient. We have tried to minimise the cost of our system as much as possible.
5. Since we have used online API service, there is no need of additional usage of GSM (sim) in our system to send message.
6. We have used AWS Virtual Private Server which is very reliable in market.
7. Our project is user friendly.

We have gathered, studied, understood, and then found the loopholes in our base paper. We have tried to reduce those loopholes as much as possible by improvising the idea and implementing the whole system automatedly.

V. OUTPUTS

i. Heartbeat output:

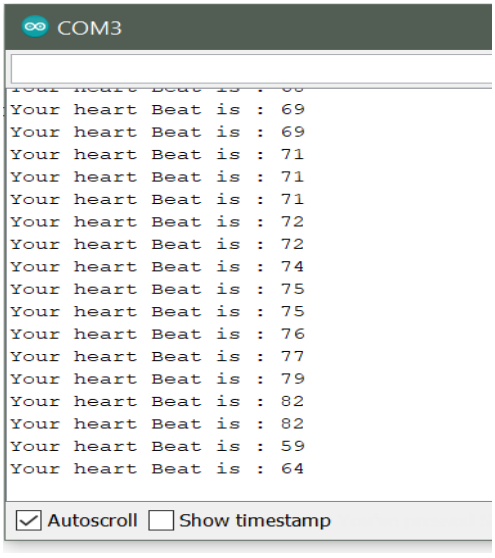

Fig.5.1 Heartbeat readings

In the above **Fig.5.1**, it is noticed that whenever the patient's finger is placed on the sensor, there is a significant variation in the heart beat readings. These readings are observed in the Arduino software console present in our system.

ii. Execution in AWS:

```
[1]+  Stopped                 sudo python3 heart_rate_check.py
ubuntu@ip-172-31-55-178:~$ vim conf.py
ubuntu@ip-172-31-55-178:~$ vim heart_rate_check.py
ubuntu@ip-172-31-55-178:~$ sudo python3 heart_rate_check.py
The current Heartbeat of patient is 50 BPM. And the Sensor Value is 50
The heartbeat is abnormal.Sending SMS
This is the response for SMS  <Twilio.Api.V2010.MessageInstance account_sid
The current Heartbeat of patient is 49 BPM. And the Sensor Value is 49
The heartbeat is abnormal.Sending SMS
This is the response for SMS  <Twilio.Api.V2010.MessageInstance account_sid
```

Fig.5.2 Execution in AWS console

The execution which is done in AWS console using putty is shown in the **Fig.5.2**. It is observed that the heartbeat is abnormal and then the request to send sms is triggered. With the help of an online API service, Twilio, we can send the sms to the concerned doctor/caretaker.

iii. Execution in Twilio:

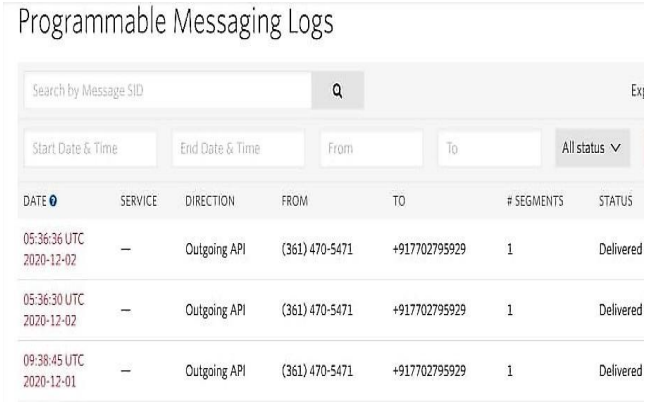

Fig.5.3 Messaging logs in Twilio

Here in the above **Fig.5.3**, we can observe that the messages are sent to the concerned doctors/caretakers regarding the abnormality in heart pulse of the patient. The messaging logs are accessible in the twilio account and the information of succesfully sent messages is available with their separate timestamps.

iv. Client Output:

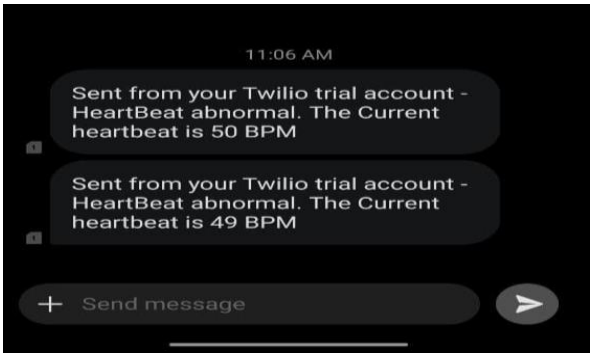

Fig.5.4 SMS received by client

The client will receive an SMS as shown in **Fig.5.4**. The subject in this SMS is a warning regarding the abnormality in the heart pulse of the patient along with the current heartbeat.

VI. CONCLUSION

This covid-19 pandemic has caused many problems to everyone and especially the most affected ones are the patients. Patients whose heart pulse needs to be monitored regularly by the concerned doctors are badly affected by this Covid-19 outbreak. There has been a communication gap formed between these patients and their concerned doctors/caretakers. Due to the implementation of lockdown all over the world, the situation got worse for the patients. This is where our idea flourished to help those section of patients whose heart pulse needs to be monitored regularly. With the help of the knowledge we gained from the concepts of IoT and its applications in medical field, we have researched and studied many research papers related to our problem statement.

The main aim of our project is to establish a communication bridge between the patients and the concerned well takers/doctors. We have used reliable components such as Arduino uno, which is the brain of our system, a heart pulse sensor, which detects the heart pulse of the body, and BOLT Wi-Fi module for establishing a connection to send data through the internet. We have used the most reliable VPS service provider which is the AWS VPS to run the program(code) required to detect the abnormality present in the heart pulse. For the notification module, we have used TWILIO as our online API service which sends data to the concerned doctor whenever there is an abnormality present in the patient's heart pulse. At the end of this project's implementation, we are confident that our project will be useful for the society.

VII. FUTURE SCOPE AND LIMITATIONS

The future scope of our project is to help the doctors by expanding our project through gathering the data (heartbeat readings) of the patients and assisting the concerned doctors/caretakers with foreseeing the irregularity in not so distant future.

Limitations of our project are:

1. As our system is automated, it requires continuous internet connection for transmitting the data.
2. Failure in any hardware component might lead to inaccurate results(outputs).
3. As the results are sent through SMS, the client/ recipient should be in network coverage area only.

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