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Safety and Health Monitoring System for Baby Incubator using IoT

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Abstract: Temperature is an essential element of our surroundings in today's world. Temperature fluctuations may have a detrimental effect on all biological organisms and certain semiconductor materials. This project aims to offer temperature control for specific applications such as baby incubators. The internet of Things (IoT) is having a significant impact on the medical sector in infant incubators. To fulfill the requirement for remote control and monitoring, the use of wireless technologies is increasing. In this scenario, the doctor cannot constantly monitor a baby's pulse rate per minute and the temperature of the incubator. As a result, a doctor who was far away from the baby incubator found it impossible to determine the baby's heart rate and temperature for early therapy. This project describes the creation of a low-cost monitoring system that monitors the heartbeat and temperature of the infant in the incubator. The Arduino Uno microcontroller was used in this project. This project may be tracked with a smartphone and MIT Apps inventor. The data communication module is used to transmit information between people and machines. The communication module of the project is an ESP 8266, and the project requires an internet connection to monitor the parameter. Temperature control is accomplished via the usage of Arduino's programming code. LEDs are used to show temperature changes in infant incubators. IoT web design is used to monitor temperature and heartbeat changes in real time, regardless of location. Last, this project is focused on the idea of developing a Smart Monitoring Incubator System via IoT, which would allow medical staff to monitor their babies even when they are physically separated from them and can feel their every condition from any remote corner of the world.

Keywords: IoT, Monitoring System, Baby Incubator

1. Introduction

In the real world, the Internet of Things (IoT) has can convert convert numbers and data into tangible objects with considerable value and adoption potential. We can utilize IoT to remotely manage household appliances and cars, locate them, and prevent thefts. IoT has gained widespread acceptance

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as a gadget. The Internet of Things may improve many aspects of life and business, such as redesigning highways to prevent accidents, renovating urban information, forecasting catastrophes, limiting the spread of illness, and monitoring sickness. Automated control systems based on the Internet of Things will aggregate scattered data into large data collections.

IoT is a network architecture based on information technology, comparable to the Internet and conventional communication networks [1]. It creates mono-functional objects that can communicate and interact. The Internet of Things is split into two separate categories linked with the Internet of Things. On the one hand, the Internet remains the heart and basis of IoT; on the other hand, an Internet-based extended network may be expanded into any area and serve as a reference for practice, enabling communication between items [1].

In the case of baby incubators, the Internet of Things (IoT) has an important effect on medicine. The use of wireless technologies is growing to meet remote control and monitoring requirements. RPM is the technology for monitoring patients even if they are not at the hospital or clinician. It may improve access to healthcare and services and reduce costs. In certain countries, premature infants are more common than others. Roughly 8% of children born in Malaysia are premature. RPM streamlines patient and physician life, thus increasing baby healthcare quality and reliability.

1.1 Problem statement

Our heart rate only reveals our heart's healthiness. The condition of the cardiovascular system may be determined by it. The heart beats to supply the muscles with oxygen-rich blood. The cell waste is transported from tissues [2]. In the NICU, the temperature was kept between 27778°C and 30°C. The infant can usually maintain a body temperature of between 35 and 37 degrees C, but the incubator is generally modified. Furthermore, the temperature is quickly rising for unknown causes. The preterm infant incubator has many issues, which the doctor is unaware of. In this case, a baby's pulse rate and the incubator temperature cannot be continuously monitored by the doctor. Always display temperature fluctuations and temperature control. The temperature is recorded without putting the infant in the incubator at risk. As a result, the goal of this project is to make it useful to everyone in this context. As a result, a doctor who was far away from the baby incubator found it impossible to determine the baby's heart rate and temperature for early therapy. This project describes the creation of a low-cost monitoring device that monitors the heart rate and temperature of a new-born in an incubator.

1.2 Literature Review

There are now many kinds of projects in an incubator that can monitor baby health. The project approach is to monitor baby incubator temperature and baby heartbeat. This is essential because it monitored the health of the infant. It also makes monitoring using a mobile phone simpler for nurses. An incubator is designed to provide a safe and regulated environment for babies to reside in while their vital organs grow. It is not just a place for newborns to sleep after birth; in some cultures, an incubator is nothing more than a bed for a sick baby. About 4 million babies worldwide die in the first month of life due to low birth weight [3]. In biology, an incubator is a device used to grow and maintain microbiological cultures or cell cultures [4]. The incubator maintains optimal temperature, humidity, and other factors such as carbon dioxide (CO2) and oxygen level in the incubator's environment. Premature infants are those born before 37 weeks of gestation. They are born too early for some organs to mature. Premature babies have an undeveloped digestive system, lungs, immune system, and even skin. The NICU is typically kept between 27.7778 and 30 degrees Celsius, whereas the incubator is usually set between 35 and 37 degrees Celsius. Doctors typically use an electrocardiogram (ECG), a pulse oximeter (which measures both heart rate and oxygen saturation), and a stethoscope to evaluate a newborn's normal heart rate. An ECG records heart electrical impulses. It's a simple, painless test to detect heart attacks and monitor heart health.

2. Methodology

The costly and high-precision components are omitted in favour of cheap and freely available components, Because the whole project is self-funded, the development of a basic prototype is sufficient to go forward with the project. The Arduino Uno microcontroller is used in this project. This project may be tracked using the MIT Apps inventor app on a smartphone. Monitoring devices are made up of three main components: a data sensing module, a data processing module, and a data transmission module [5]. The data sensing module is made up of a temperature sensor LM35 and a heart rate sensor that transforms data into parameters. The data communication module is in charge of transferring data between people and equipment. To monitor the settings, the project communicates through ESP 8266 and needs an internet connection.

2.1 Methods

As illustrated in Figure 1, this project must go through various processes in order to complete the monitoring devices. The first stage is to do research and choose the components, such as sensors and microcontrollers. The project must then develop a standard IoT-based health monitoring device and the monitoring device circuit and prototype. In order to test the prototype, the code must thus be injected into the microcontroller. The project will improve system performance if the prototype is successful. In other words, if there is an issue, it will be redesigned. Finally, gather and analyse data to determine the outcome.

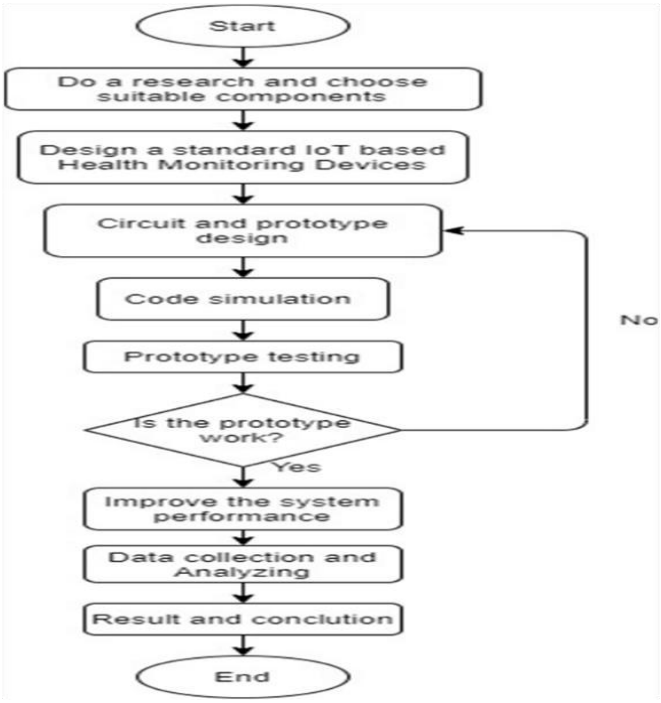


Figure 1: Flowchart of project work

2.2 Software Design

The Arduino UNO R3 is a circuit device microcontroller. For the Arduino to work, a power supply of 5V is required. The ESP8266 is a wireless connection between the controller and the circuit. In the baby incubator the LM35 temperature sensor is utilised for temperature detection. The LED will indicate the functioning of the gadget. To determine infant pulse rates, the heartbeat sensor is utilised. Arduino processes the code and is shown on the LCD display of 16 X 2. Both settings are then sent to an IoT cloud server and shown in an Android mobile application. The IoT server used here is

Thingspeak. The circuit block diagram is shown in Figure 2. The circuit design is designed using the Fritzing software to connect the component. It allows you to build a schematic that can be used in a very professional cable diagram. The heartbeat output pin was attached to the Arduino A0 and the other two to the VCC and GND pins. The output pin for the LM35 is connected to the Arduino A1 and the two other pins also have VCC and GND connections. The LED connects to the Arduino Digital Pin 7 with a 220-och resistor. Arduino was linked with GND pins 1,3,5,16. The VCC is connected to LCD pin 2,15. The 3.3V operating unit is ESP8266 RX. The RX pin of the ESP8266 is connected via resistors to the Arduino pin 10. The ESP8266's TX pin to the Arduino's pin 9. The list of components used in this work is stated in Table 1.

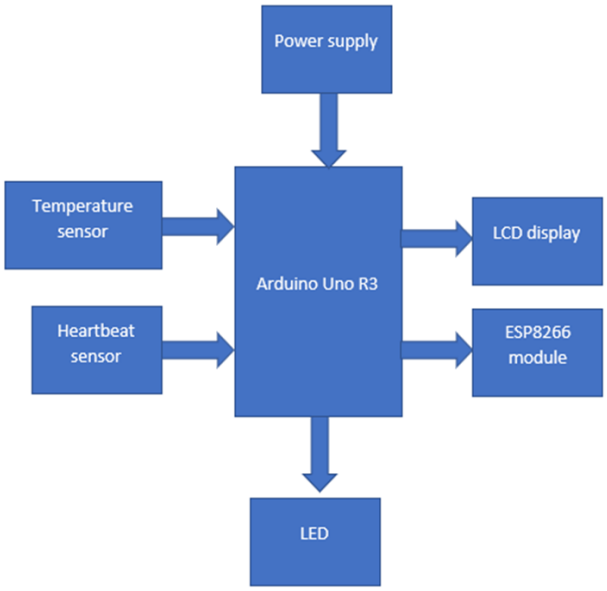


Figure 2: Flowchart of project work

Table 1: List of components

Component	Unit
Arduino Uno	1
Breadboard	1
LCD Display 16x2	1
LED	2
LM35	1
Heartbeat Sensor	1
ESP8366	1
Resistor	4

3. Results and Discussion

This section covers the outcomes of all construction techniques and the functioning of the Prototype. The voltage input to the circuit will be measured using the digital multimeter. The hardware displays the outcome of the prototype's construction. A negligible amount of software is used to simulate the circuit, validate the code, and design the circuit. Essentially, an Arduino Uno, Esp8266, heartbeat sensor, and temperature sensor were combined in a single circuit connection to monitor the heartbeat and temperature in a newborn incubator using the Thingspeak and MIT applications. Furthermore, the software development process teaches important skills such as coding, simulation, and design. The expected outcome of this project is the sensors used, which are a heartbeat sensor and a

temperature sensor capable of detecting the heartbeat of a baby and the temperature in a baby incubator. Following that, the pulse and temperature readings were shown in the Thingspeak cloud and MIT applications. When the temperature rises over 37 degrees Celsius, the LED blinks, and the MIT apps notify us that the temperature has reached a particular level. The MIT App Interface is shown in Figure 3.

Figure 3: MIT App interface

3.1 Hardware and IoT

The heartbeat and temperature monitoring gadget is intended for use in a baby incubator. It will connect to the Arduino and will be able to monitor heart rate and body temperature. The Internet of Things is rapidly changing the healthcare industry. In this project, we built an IoT-based Patient Health Monitoring System using the ESP8266 and Arduino. In this project, As an IoT platform, ThingSpeak was utilized. ThingSpeak is an IoT application and API open-source Web of Objects which can store and retrieve data from objects via the Internet and a Network of Local Area (LAN). This Internet of Things device can read the heart rate and determine the temperature of the environment. It continuously monitors the pulse rate and ambient temperature and sends data to an Internet of Things platform. In any minute, the android displayed the heartbeat measurement. The temperature and heartbeat graph are shown in Figure 4 and 5, respectively.

Figure 4: Temperature graph

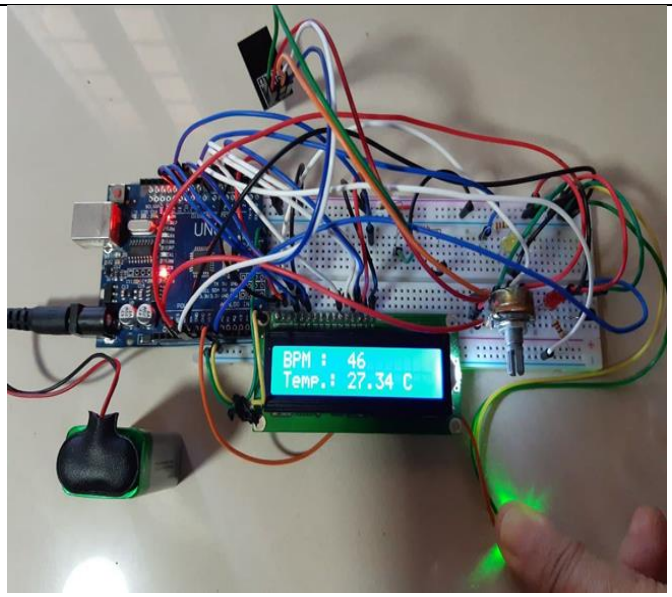
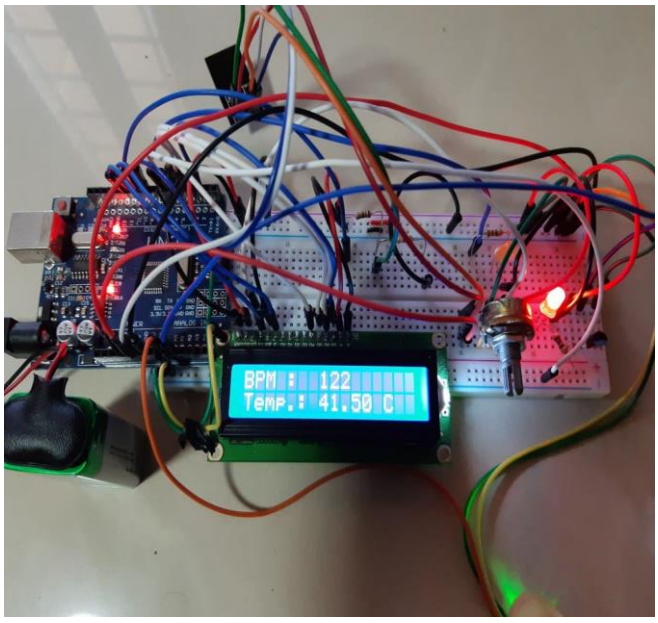
Figure 5: Heartbeat graph

3.2 Circuit Testing

The circuit has been fully installed in this section, as shown in Table 2. This circuit's installed components include an LED, A LM35, a heartbeat sensor, an Arduino Uno, an LCD screen and a Wi-Fi module for ESP8266. This circuit requires a 5V power source. The female, male wire is used to connect the component. The circuit is turned on, and the led on the component is illuminated. Prior to

putting a real circuit on the prototype, circuit testing is conducted to ensure that all components function correctly. During the test, the circuit is illustrated in Table 2.

Table 2: Result of Sensor Test

Sensor	Circuit image	Description
Heartbeat		Heartbeat sensor was able to detect a heartbeat of the baby in the incubator.
Temperature LM35		Temperature sensor was able to detect the temperature of incubator. The LED was light up when exceed 37 °C

3.3 Prototype Testing

To begin, connect a computer and a mobile phone to Wi-Fi or mobile data. Second, attach a 5V DC power source to the Arduino DC power connector to power the board. It was essential to monitor the Arduino board's progress using a serial monitor from the Arduino IDE software. When the ESP8266 connects to the internet, a serial monitor shows the heartbeat, temperature, and IP address of the host api.thingspeak.com.The serial monitor of Arduino IDE is shown in Figure 6.

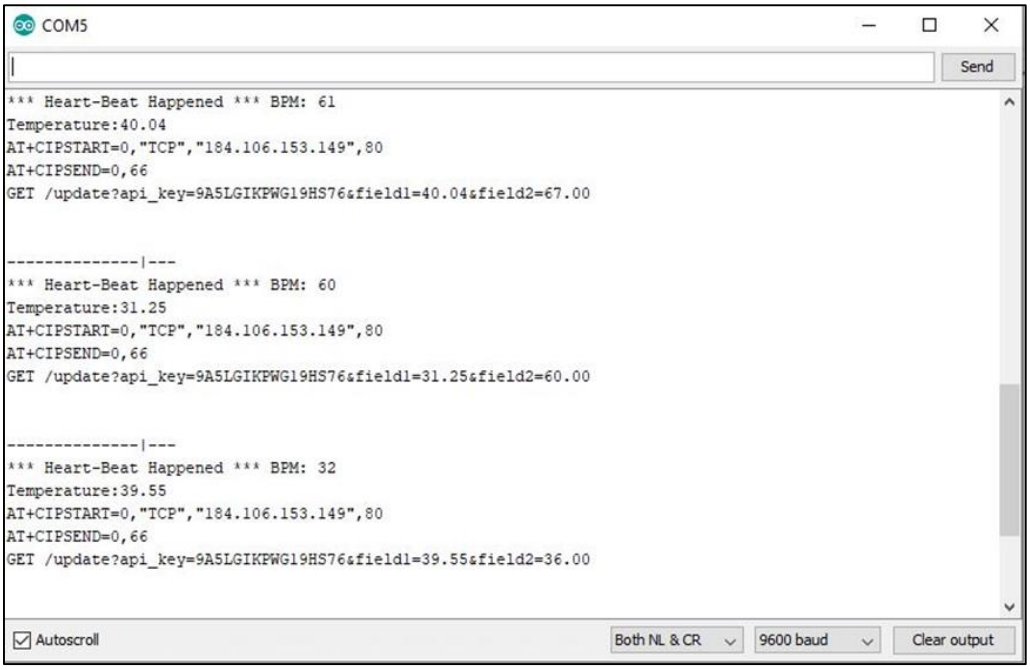


Figure 6: Serial monitor of Arduino IDE

When the heartbeat and temperature sensors are activated, the data is sent to the Arduino board's serial monitor. Following that, the next data is sent to the Arduino serial monitor, and the process is repeated for the following data. Figure 7 shows the serial monitor of the Arduino board after the sensor was activated.

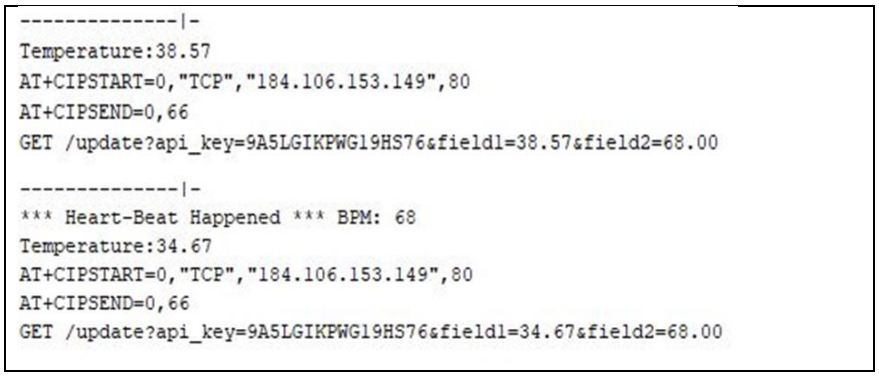


Figure 7: Serial monitor of Arduino board when the sensor was triggered

Next, both of these pieces of information will be sent to Thingspeak.com. Internet of Objects (IoT) application and API for storing and retrieving data from things via the Internet or a Local Area Network using the HTTP protocol. It constantly measures the pulse rate and ambient temperature and transmits data to an Internet of Things platform. The heartbeat and temperature results using Thingspeak is shown in Figure 8 and 9, respectively.

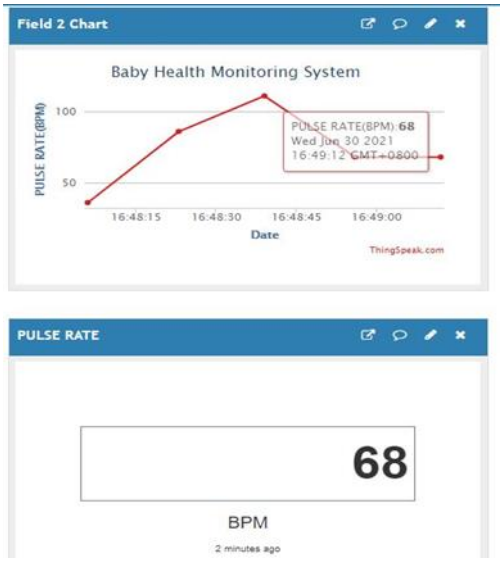


Figure 8: Heartbeat result using Thingspeak

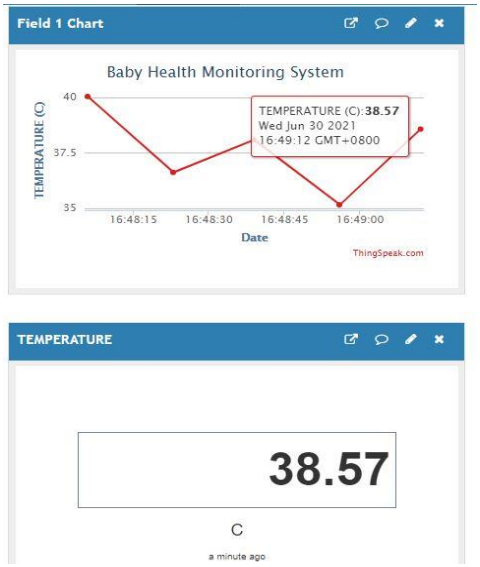


Figure 9: Temperature result using Thingspeak

Following that, MIT APPs Inventor was used. The Android app, created using MIT App Inventor, receives temperature and heart rate information from the ThingSpeak server. Check that the Arduino board is turned on so that it may send the most current data to the ThingSpeak server. When, the MyBabyHealth Apps starts, it will start gathering and displaying the most current data from ThingSpeak server. The MyBabyHealth Apps interface is shown in Figure 10.

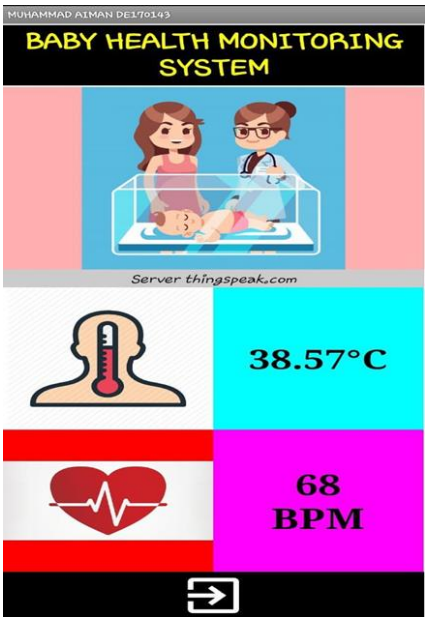


Figure 10: Value at MyBabyHealth Apps

4. Conclusion

Finally, this system is intended to monitor the infant's vital signs, such as heartbeats and body temperature, utilizing wireless technology that is both more comfortable for the baby to wear and more accurate and precise than other sensors now on the market. The first goal is accomplished via the development of an IoT system capable of transmitting cardiac rate data and temperature. The circuit is completely constructed and success may be conceived. The second objective is to develop an Android app that monitors the heart and temperature of the infant in the incubator using the MIT App Inventor. The data will be transmitted to Thingspeak, and the Thingspeak channel will be able to share the view with everyone. The final goal is to evaluate the efficacy of the suggested system prototype. As a

consequence, we can conclude that our IoT innovation project for infants will be very helpful to poor countries. This will certainly change the way infants are watched in hospital settings, especially in urban areas.

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