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INTERNET OF THINGS (IOT) BASED WEARABLE HEART RATE MONITOR SYSTEM

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Abstract: Heart disorders are the leading cause of mortality worldwide. Around 80% of fatalities occurred in poor and middle-income nations. If present trends continue, it is anticipated that 23.6 million people would die from cardiovascular disease by 2030 (mostly as a result of heart attacks and strokes). With the increasing popularity of technologically advanced wearable devices, there is a greater chance to deliver an Internet of Things (IoT) solution. Regrettably, for persons who are suffering from an unexpected cardiac arrest, out-of-hospital survival chances are dismal. Heart rate, fluctuation in heart rate, changes in temperature of the body, Sugar levels, Blood pressure, and oxygen levels in the blood are important indicators that need to be checked on a regular basis in those who have heart disease. The objective of this research is to implement a smartphone application that can monitor these metrics for cardiac patients who need ongoing monitoring. The monitoring system employs wearable sensors to continually assess numerous properties. When the patients' predefined parameters reach the limit range then an alert message or email will be delivered to a doctor or any close family member. The heart rate module's data may be saved and retrieved in the future for medical use. Because of this wearable technology, patients may be mobile within a personal social setting, allowing them to lead their lives with assurance.

Keywords: *Internet of things, Heart Disorders, Sensors, Oxygen Levels, blood sugar, PPG signal, Arduino controller*

I. INTRODUCTION

The "Internet of Things" (IoT) is the term used to describe a system of interdependent electronic devices, appliances, and other physical items that may connect to one another and share data and information over the Internet or other communication networks. Others have argued that the term "Internet of Things" is misleading since it implies that all gadgets must be permanently connected to the Internet.

One of these crucial prospects is the use of e-health services, which are connected to us all. The healthcare industry is seeing a daily increase in the number of IoT applications. More and more individuals are dying from heart attacks. A cardiac arrest may occur whenever blood flow to the heart is interrupted. Many individuals die because we don't catch their heart attacks quickly enough. As part of this research, we develop an IoT-based system that monitors heart rate to identify potential cardiac issues (Internet of Things). A lack of facilities makes it impossible for rural residents to get preventative medical attention. This causes premature mortality in certain regions. In addition, as the global population ages, the elderly will need more medical care as families change.

There is a high mortality rate associated with chronic cardiac disease due to the heart's extreme weariness during sleep. For these patients, we need continuous monitoring devices which are more expensive and need some experience to use these devices. For these patients, a wearable smartwatch is more useful to monitor their heart conditions.

The IOT is a whole newfound reality that drastically changed the lifestyle we've adopted. It is also a method of developing health care by providing better preventative and individualized services. The purpose of this study means to grow an IOT method that is used to monitor heart conditions. By using this device, the patient can monitor their heart function values such as heart rate, oxygen levels, sugar levels, blood pressure, temperature, etc. Nowadays there are so many devices available in the market that are cheap and very efficient in performance.

II. LITERATURE REVIEW

Because of the rapidly expanding sector, the health monitoring system is a major reason nowadays. There is a constant requirement to maintain the infrastructure up to date in an ever-expanding sector.

Genaro et al. (Gennaro Tartarisco et al., 2012) created an individual well-being analysis based on the patient's indications. A massive amount of information is obtained and used to investigate the patients' illnesses and risks. Franca investigated improvements in the new age of frameworks, which included the development of ceaseless observing parts involved in monitoring patients, as well as changes in work procedures and the effectiveness of medical individuals. He emphasized the many distant improvements and the advantages of using such innovations for faster compatibility (Delmastro, 2012).

Tao et al. developed a foundation for wear-sensing elements to screen advancements for patients. A system that has been established matched a border zone of less than 5% in terms of restricting error prices in the captured values (Liu, Inoue and Shibata, 2009). Stefano et al. found a system for monitoring advancements in patient health that detects falls and responds to supervisors' requests for assistance(Abbate et al., 2012).

Cristina et al. devised a method to manage a patient's human services information acquired across many geographic locations (Turcu and Turcu, 2013). Specialists, doctor's offices, and research centers, among others, have access to the information. To confirm the therapy information of patients.

Jerian et al. created a radio wave development of astute systems that identify sterile items and alert medical personnel who come into touch with infectious things to wash their hands(Shi et al., 2012). According to (Nayeemuddin et al., 2019), physicians should place more value on healthcare management since it reveals a patient's physiological state. The goal of their approach is to provide an accurate online representation of a patient's health by zeroing down by screening and tracking basic physiological data to focus on a particular problem. The information is used by a social security administrator to provide critical feedback. It's LabVIEW-programmable and has a microcontroller and data validation unit. An electrocardiogram (ECG), body temperature, blood pressure, and pulse rate are all measured. One major benefit of the proposed structure is the increased precision with which human physiological data may be studied. It's possible that the gadget's wearability could be improved.

Kyeonghye Guk et al. highlight their care for the global population's growing old and the measures things need to be done to prevent or monitor a wide range of diseases, both chronic and acute, as a pressing social issue in their study(Guk et al., 2019). This equipmentis used for diagnostic and health monitoring, therefore they also help with this. Some examples of wearables include body implants, attachments, and accessories. They look at how developments in semiconductors, recyclable waste, and nanomaterials have affected the development of wearables. Point-of-care diagnostics that include data storage and analysis might be a major step forward in the field.

S.S. Abarna et al.,analyze the key jobs, which involve many sensors as well as the capability of the device to communicate with a healthcare provider(Das et al., 2022). The gadget may capture data and communicate it to a carer or doctor, and it can also display it. They also highlight the importance of statistics and keeping track of a wide range of medical conditions. The information is always available to the doctor(Siddhant Thakur Thakur and Devarshi Patel Patel, 2021) and (Majumder et al., 2019).

III. METHODOLOGY

A. Objective

Properly informing patients at home is difficult. Patients of advanced age or those who have had a stroke need longer hospital stays. Sometimes the expense of a hotel stay may add up. If the nearest hospital is far away and the patient's condition is critical, it may be too late to save them. Information about patients is not stored indefinitely and sharing it takes time.

The plan is to create a lower transmission module for an integrated IoT system that will allow for the collection of vital signs including heart rate, oxygen levels in the blood, sugar levels, blood pressure, and body temperature without interfering with regular smartphone use. To better predict and/or recognize abrupt cardiac illnesses, additionally, this research examines using computers for learning purposes for the analysis of sensor data.

B. Problem Identification

Inaccurate or drastic changes in Physiological indicatorssuch as heart rate and oxygen saturation, sugar levels, hypertension, and body temperature may have devastating effects on our health. Whether in the doctor's office or on the treadmill, keeping tabs on your heart rate is essential. It's impossible for a person to keep an eye on things inside their house if they're not there, especially if an elderly or ailing relative is inside. The patient's condition may be monitored from anywhere using an internet-connected smartphone, and if something untoward should happen, the carer can react quickly. So, any sightings of the patient outside of the house should be treated with extreme suspicion. Regularly checking a patient's heart rate, oxygen saturation, glucose concentration, blood pressure, and body temperature is very challenging for doctors, yet they must do so in a hospital setting. The doctor may utilize this to check the patient's vitals on a regular basis and access past records.

C. Working Principle

Modern wireless communications are the backbone of our system since they allow for little user effort and unrestricted mobility while exercising.

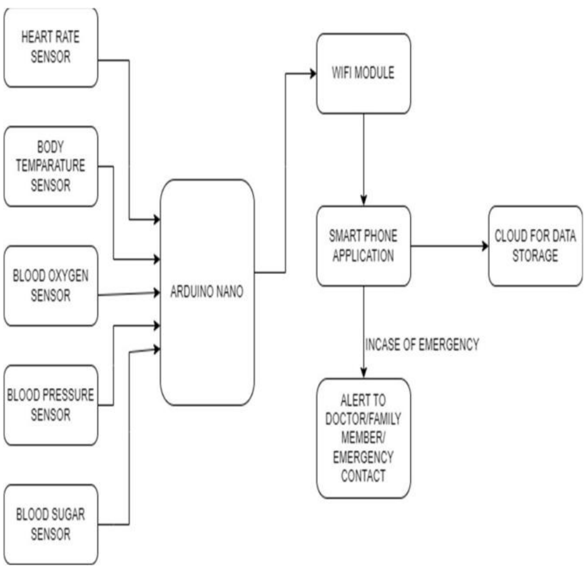

Figure 1: Block Diagram of Smart Heart System.

Figure 1 is a block diagram detailing this setup, we've also made use of small, lightweight, and user-friendly smart IoT devices like smartphones and wristbands. Before integrating the sensors, we conducted a battery of trials to learn how to detect and distinguish between normal and abnormal readings for measurements of the patient's vitals (heart rate, blood pressure, temperature, glucose, and oxygen saturation levels).

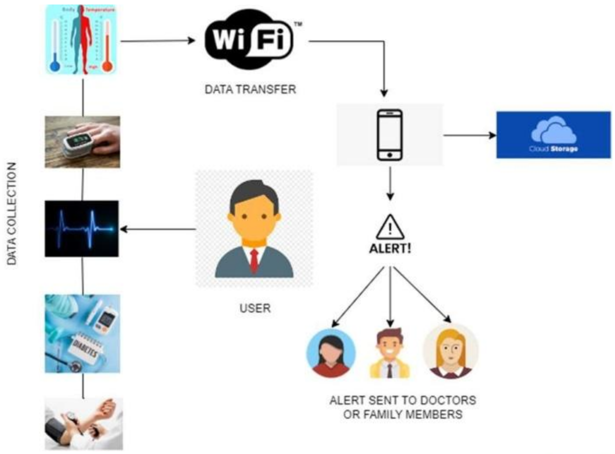

Figure 2: System Architecture.

As shown in figure 2, the integrated sensors are worn by the participants. Everyone has an iPhone that they always have on them. Sensors monitor vital signs such as heart rate, blood sugar, blood pressure, pulse oxygen, and body temperature in real-time as a person goes about their daily routine. In order to assess whether the user's status is normal, the smartphone will receive the data through a low-power Bluetooth connection channel, process the information, and then display the results.

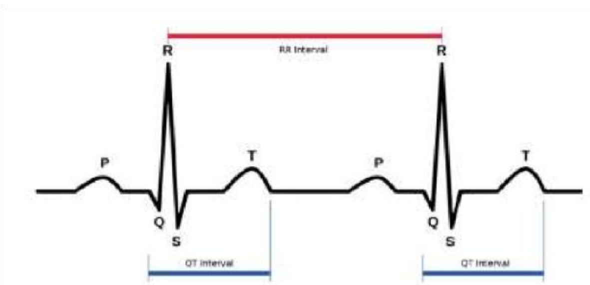

Figure3: PPG Signal.

As can be seen in figure 3, photoplethysmography (PPG) is an easy optical technique used to detect alterations in blood volume in the periphery. This is a simple and inexpensive way to gauge how much flesh is exposed. This method yields crucial insights into our cardiovascular system. The clinical physiological field makes frequent use of monitoring and assessment, and recent technological advancements have sparked fresh interest in it. PPG employs low-intensity infrared (IR) light. When it passes through living tissue, light is absorbed by the bone, the skin's pigment, and the veins and arteries. PPG sensors may be able to detect variations in blood flow as light intensity fluctuates due to the greater absorption of light by blood than by surrounding tissues. PPG voltage signal is inversely proportional to blood flow via arteries. Although this technique can detect even very small changes in blood volume, it is unable to provide a quantitative measure of blood volume.

The PPG signal is influenced by a number of factors, including variations in arterial blood volume due to heart activity and vein blood volume, a part of DC exhibiting tissue optics, and low-energy light swings throughout the physical form. The position of the gauge site and frictional forces are two of the most important aspects of PPG readings. The arteries show greater variability in blood flow than the veins do.

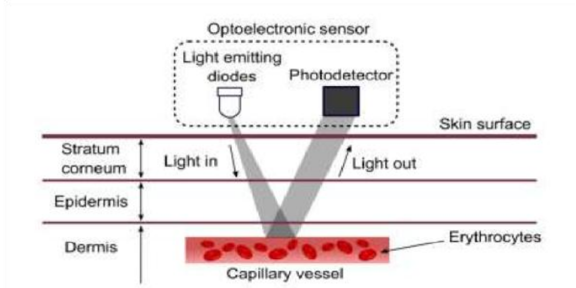

Figure 4: Working Of Pulse Sensor.

With heart rate monitor that has sensors and a circuit consists of can monitor your heart rate. The Pulse Oximeter's sensor area, an infrared (IR) LED, and a photodiode are clasped together, as shown in figure 4. Connecting the sign to the Microcontroller requires a Control Circuit consisting of an op-ic and some other components. The Rhythm Analyzer's functionality may be better comprehended by inspecting its circuit diagram. At each pulse, Infrared (IR) LED light traveling through a human finger and being detected by a photodiode is not the same as the quantity of hemoglobin in the finger.

The non-opposing part of the first operation, the amp, is sent to the image diode's output through a capacitor. This keeps the sign's DC components from being sent.

In the first step, the amp is used as a 1001-timesintensifier in a non-reversing enhancer configuration. The result of the first operation is amp, and this value is used in the comparator function of the second pass. The signal is sent to a microcontroller like an Arduino Nano through a transistor activated by the output of the second operation, amp. It takes readings from the user's finger and wirelessly sends them to an Android app. The sooner the issue is diagnosed, the less damage it may do if left untreated. In two situations, the patient's immediate contacts get a message or email.

An abnormally slow heart rate, or bradycardia, is defined as 60 or fewer beats per minute. Interruption of normal cardiac rhythm results from the SA node's failure to provide the electrical impulse that triggers heart contraction. While the elderly are more likely to have bradycardia, and it has also been seen in younger age groups. The most common causes of bradycardia are problems with the automatic pacemaker of the heart or a breakdown in the brain's ability to send the heart the right instructions to beat regularly. Tachycardia is characterized by an abnormally fast heart rate. Tachycardia is classified as ventricular or supraventricular, based on the site of origin of the excessively fast heart rate.

Finger signals corresponding to blood oxygen saturation are detected by the transmitter side and optical sensor in the pulse oximetry sensor. For the sake of deciphering the SpO2 data, the LED pulse durations and sample rates per sec are tweaked. The usual range for artery oxygen pressure is 75– 100 mm Hg (mm Hg). The typical oxygen saturation level in the blood content is 95–100%. Hypoxemia occurs when arterial blood oxygen saturation falls below 90%. Hypoxemia occurs when there is not enough oxygenation in the blood, which shows up most dramatically in the arteries. One of the many signs that something is wrong within your cardiovascular system or circulation is feeling out of breath. If the patient's blood oxygen level drops below 90%, an alarm is triggered, and the emergency contacts are notified via email or text.

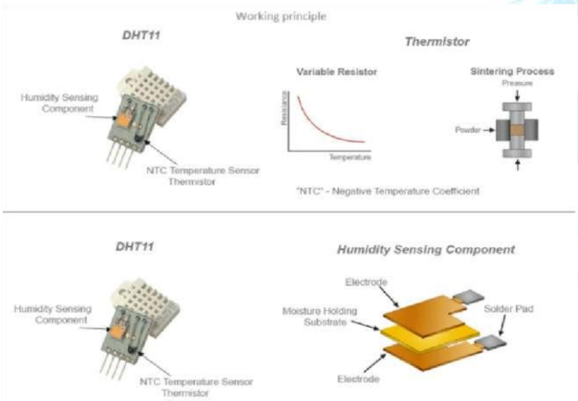

Figure 5: DHT11 Working Principle.

The DHT11 sensor consists of a humidity sensor and a temperature-measuring thermistor which is shown in the figure 5. The capacitor's dielectric is a substrate that can hold moisture, so it can function. Humidity influences the value of capacitors. The IC takes the resistance readings, processes them, and then converts them to digital form. When the temperature increases, the resistance value decreases due to the employment of a Temperature Sensor Coefficient Thermistor. Semiconductor ceramics or polymers are often used to construct this sensor because they provide a greater electrical resistance that is detectable at very low temperatures.

The DHT11 can accurately provide temperatures within a 2-degree range (from 0 to 50 degrees Celsius). The humidity range that this sensor measures, from 20% to 80%, is accurate to within 5%. The sensor in question samples at a rate of 1 Hz. That is to say, a new reading is given out once each second. The DHT11 is tiny and can function on voltages as low as 3 volts and as high as 5 volts. The maximum current draw of 2.5 mA is achieved during measurements.

When your body loses heat at a quicker pace than it can produce it, a medical emergency known as hypothermia arises. Humans typically maintain a temperature of 98.6 °F (37 ° c). Hypothermia is defined as an internal body temperature of below 35 ° c Celsius (95 ° F). Cold temperatures or water immersion are common triggers for hypothermia. Most therapies for hypothermia include raising the patient's core body temperature. As your core temperature lowers, it hinders the function of internal organs such as your heart, brain, etc. Hypothermia may cause mortality by damaging the heart and lungs if not managed. An alert is triggered, and the patient's emergency contact is informed via text message or email when the core temperature of the body dips below 95.

The non-invasive diabetes sensor, Arduino controller, Insulin infusion device, Blood Pressure (BP) sensor, and LCD are the primary hardware components used to create hypertension and insulin levels monitoring system. To import the computer code from the Arduino circuit board, we have included a little amount of programming in our gadget. Sensor and process information is gathered by it.

The laser light, which has been transforming light into energy through glucose synthesis, may be detected by the photosensor, which has a wavelength of 600 nm to 800 nm.

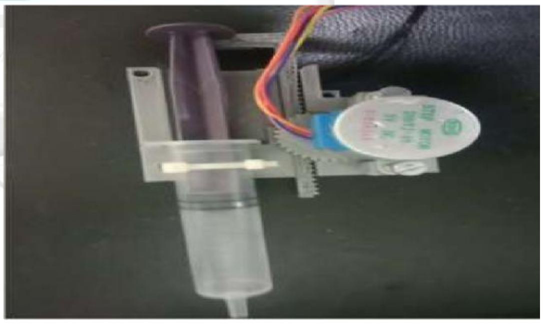

Figure 6: Insulin Infusion Device.

The Glucose Insulin Injector Servo Motor which is shown in figure 6 is included in this replica. To rotate and transport the drug to the patient's body, a servo engine is used in the equipment setup. This model receives its electricity via a charge port. Changing the voltage estimate range is a common use for DC-to-DC step converters and step-up converters.

Figure 7: Force Sensor.

Figure 7 shows a circular sensor area of 0.5" in diameter provides force detection in this resistor. This FSR has a pressure-sensitive resistance adjuster. Any force between 100g and 10kg may be detected by this FSR. It may be used as a blood pressure monitor.

IV. RESULT AND DISCUSSION

An Internet of Things technology monitors and controls human heart rate. A cardiac pulse sensor gathers data for this device. The microcontroller analyses human pulses. The IoT platform analyses and visualizes the data after evaluation. The system measured and sent the user's pulse rate, sugar levels, blood pressure, temperature, and oxygen saturation to the smartphone device, yielding precise testing results and statistics with each sensor, as seen in figures 5–7. This paper proposes a versatile, trustworthy, and discreet system for regulating and measuring heart rate employing sensor networks and IoT. Medical professionals and businesses may use the gadget to improve their performance.

V. CONCLUSION

Heart attacks are on the rise in today's society. This method uses a heartbeat to detect the rhythm of a person's heart even while they're at their house. The patient's temperature, blood pressure, sugar, heart rate, and oxygen saturation may all be calculated using this method. The individual's heart rate is tracked via a heartbeat sensor connected to the microcontroller, and the data is sent using the built-in Wi-Fi. After customizing settings, a user may begin tracking vitals and get notifications to share with medical professionals and loved ones if their heart rate goes beyond a certain limit. The major goal of this project is to quickly inform both Medical Emergency and the patient's emergency contacts of any changes in the patient's condition. We're developing a model that can monitor parameters in real-time to spot and anticipate heart attacks, as well as trigger alarms when one is imminent. If the temperature, pulse rate, or oxygen saturation of the patient goes over or below the user-defined limits, an alert will be issued to the attending physician. This is achieved by monitoring the subject's core temperature and heart rate. When life-or-death situations call for constant monitoring, it might be invaluable. Furthermore, the Heart Rate Monitor is a highly valuable piece of technology because of its portability and availability.

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