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Patient Health Monitoring System Using ECG

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ABSTRACT

This paper presents a wearable health sensor network system for Internet of Things (IoT) connected safety and health applications. Safety and health of icu patient are important in hospital workplace; therefore, an IoT network system which can monitor all health parameters and update through wireless. The proposed network system incorporates multiple wearable sensors to monitor environmental and physiological parameters. The wearable sensors on different subjects can communicate with each other and transmit the data to a gateway via IoT platform medical signal sensing network. In the proposed system having heart rate, temperature, vibration sensors all integrated to the parallel processing microprocessor. Health parameters re measured by sensors and give the RPI PICO module. This module analyzes the data and monitor in LCD, post the same in internet of things-based server. We continuously monitor, if any changes found like low heart rate, high heart rate, high temperature, patient movement iot alerts the authorized person regarding health A smart IoT gateway is implemented to provide data processing, local web server and cloud connection. After the gateway receives the data from wearable sensors, it will forward the data to an IoT cloud for further data storage, processing, and visualization.

Keywords: Health Monitoring, ECG, RPI PICO, IOT.

1. INTRODUCTION

Specialists throughout the healthcare sector are increasingly leveraging the areas of concern that these developments carry in and can allow considerable improvement in and beyond the medical administrations. Similarly, the capabilities of Electronic Health apps and Health (therapeutic organizations managed by ICT) are utilized by countless regular consumers to develop, support, and strengthen their healthcare network. The SMS is submitted to the specialist or to any family member in some fundamental situation. Health analysts slowly misuse the points of value these developments add to the social security market in the healthcare setting, thus creating a crucial change. Likewise, endless standard customers are helping and helping their health experts by using the M-Health (Mobile Health) applicants and Health. Health analysts slowly misuse the points of value these developments add to the social security market in the healthcare setting, thus creating a crucial change. Likewise, endless standard customers are helping and helping their health experts by using the M-Health (Mobile Health) programs and Health. A dependable and rapidly persistent portion of this corresponding technique. Structure like look (PMS). One of the biggest issues for society is the lack of social security. As the World Health Organization (WHO) parliaments demonstrate, the most elevated feature of the medical system is a great best thing for a person. To persuade and render people look, it is important to have a flash like the new mending machine. The system for social insurance will include stronger remedial connections for people wherever they are, in a sustainable and careful manner. Provided that such contraptions support the Internet, they boost the environment and ensure that organizations and social security become continually safe and logically drawn. The whole idea of IOT remains on sensors, portion as well as remote systems that allow customers to grant and access the application / information. No place, however, is the IOT across all zones

more apparent than it was in the areas of prosperity treatment. As a cliché states, 'Prosperity is money,' the movement towards greater results is phenomenally important. Therefore, it is necessary to connect to an IOT framework that provides secure and prosperous analysis. At present, the contraction of human institutions, the conventional way of coping with a technologically advanced personally driven oriented system, is being traded. As the age profile of many societies continues to increase, in addition to the increasing population of people affected by chronic diseases, including diabetes, cardiovascular disease, obesity, and so on, supporting health, both mentally and physically, is of increasing importance if independent living is to be maintained. Sensing, remote health monitoring, and, ultimately, recognizing activities of daily living have been a promising solution. From a technical perspective, the Internet of Things (IoT) is gaining a rapidly growing attention in many disciplines, especially in personalized healthcare. Meanwhile, body area sensor network (BASN) under the IoT framework has been widely applied for ubiquitous health monitoring, for example. ECG monitoring has been commonly adopted as vital approach for diagnosing heart disease. The main contribution of this paper includes the following: firstly, this paper presents a novel system, the WISE (Wearable IoT-cloud-Based health monitoring system), for real-time personal health monitoring. WISE adopts the BASN (body area sensor network) framework in the support of real-time health monitoring. Several wearable sensors have been embedded, including the heartbeat, body temperature, and the blood pressure sensors. Secondly, the majority of existing wearable health monitoring systems requisite a smart phone as data processing, visualization, and transmission gateway, which will indeed impact the normal daily use of the smart phone. Whilst in WISE, data gathered from the BASN are directly transmitted to the cloud, and a lightweight wearable LCD can be embedded as an alternative solution for quick view of the real-time data.

The world population is increasing tremendously. The cities accommodating more population face astounding pressure of urban living. Even though the medical resources and facilities in cities are expanded daily, still the suffice level is not attained. The massive pressure towards the management of healthcare in cities has triggered the advancement in technologies to come out with the proper solutions to the booming problems. With the increased rate of medically challenged people, remote healthcare has become a part of our life. In recent years, we observe the increased interest in wearable sensors and such devices are available in market for cheaper rate for personal healthcare and activity awareness. Researchers considered implementation of such advanced devices for the medical applications for data recording, management and to continuously monitor the patient's health. The Internet of Things offers a rising technology to attain the next level of health services [2]. It assures for the affordable, low-cost, reliable, and handy devices to be carried or embedded with the patients, so that to enable seamless networking between the patients, medical devices, and physicians. The sensors will record signals in a continuous manner, they are then correlated with the essential physiological parameters and communicated over the wireless network. The resulting data is stored, processed, and analyzed with the existing health records [1]. Using the available data records and decision support systems, the physician can do a better prognosis so that to suggest early treatment. Even when the doctor is not available, this analysis enables the today's machines to predict the health issues. Not only prediction, but machines can also be able to come out with the medicines from the systematic study of the medicinal databases. The progressive technology will have a transformative impact in every human's life and health monitoring; it will remarkably cut down the healthcare expenses and a step ahead in the accuracy of disease predictions. In this paper, we present a idea of a service model in technological and economic views for the comfort of patients and also the open challenges in implementing IoT in real world medical field.

2. LITERATURE SURVEY

We have investigated the different examinations performed utilizing existing strategies that have been applied in the field of patient wellbeing checking. This study remembers current patterns for persistent checking frameworks and related work on the far-off patient observing framework. In [2], a structure of IoT based wellbeing checking framework utilizing Raspberry Pi is proposed. In this paper, they have used Internet of Things (IoT) and distributed computing advancements. The proposed model screens the Heart Rate, Oxygen level and Blood Temperature of a patient. Distributed computing empowers tenacious capacity of information. Thus, the information assembled by the wearable sensors put on a patient's body is spared in the cloud with the goal that it very well may be gotten to from anyplace over the g projection. The specialist can login to the site to get to the patient's information and produce a wellbeing report. Patients can get to the wellbeing report by signing into the site. A visit alternative is given in the site to specialist and patient correspondence. The framework goes about as an extension among specialist and patient staying away from the separation obstruction. In country regions where satisfactory clinical offices are not accessible, it is useful and financially savvy arrangement. In [3], a wellbeing Monitoring framework utilizing RPI Pico is proposed thinking about the necessities of old individuals. In the maturing populace world, there is an expanded requirement for a specific wellbeing checking framework. In this unique situation, the proposed framework screens internal heat level, circulatory strain, and pulse and sends the information to specialists. These boundaries are commonly estimated during fundamental wellbeing exams as its qualities are significant indications of a patient's wellbeing condition. In the event of crisis, an alarm button is provisioned so the specialist will get a SMS when an alarm button is squeezed. Information is pushed to the web worker with the goal that the specialist and patient can see the qualities. The fundamental test watched was the delay of the older to utilize this innovation. They should be taught to utilize new mechanical gadgets like cell phones and PCs. In [4], Wireless Bluetooth innovation with Android is investigated for the far-off evaluation of wellbeing and fall identification. The framework screens the wellbeing boundaries like ECG, temperature, 'body pose', 'fall recognition' and present GPS area. Numerous synchronous Bluetooth associations are set up with an android telephone to move the gathered information. An android application investigations and procedures the information which is likewise sent to the worker utilizing the web. Information is sent to a crisis contact individual in the event of a crisis. Being a versatile, vitality productive, lightweight, and adaptable plan, it is generally appropriate for people that are at high hazard like officers guarding at high elevations, travelers, unskilled workers, and so forth.

In the recent years wireless technology has increasing for the need of upholding various sectors. In these recent years IoT graped the most of industrial area specially automation and control. Biomedical is one of recent trend to provide better health care. Not only in hospitals but also the personal health caring facilities are opened by the IoT technology. So having a smart system various parameters are observed that consumes power, cost and increase efficiency. In according to this smart system, this paper is reviewed. In traditional method, doctors play an important role in health checkup. For this process requires a lot of time for registration, appointment and then checkup. Also, reports are generated later. Due to this lengthy process working people tend to ignore the checkups or postpone it. This modern approach reduces time consumption in the process. In the recent years use of wireless technology is increasing for the need of upholding various sectors. In these recent years IoT groped the most of industrial area specially automation and control. Biomedical is one of recent trends to provide better health care. Not only in hospitals but also the personal health care facilities are opened by the IoT technology. So having a smart system, various parameters are observed that consume power, cost, and increase efficiency. In accordance with this smart system, this paper is reviewed.[5] Medical scientists are trying in the field of innovation and research since many decades to get better health services and happiness in human lives. Their contribution in medical area is very important to us and cannot be neglected. Today's

automotive structures have the root ideas coming from yesterday's basics. Also, Early detection of chronic diseases can be easy with this technology.[6] The body temperature, heart rate, blood pressure, respiration rate are prime parameters to diagnose the disease. This project gives temperature and heart rate values using IoT. Modern health care system introduces new technologies like wearable devices or cloud of things. It provides flexibility in terms of recording patients monitored data and send it remotely via IOT. For this connection, there is need of secure data transmission. To transmit the data with privacy is the Moto of this paper. The proposed system introduces security of health care and cloud of things. System works in two major parts viz. storage stage and data retrieving stage. In storage stage, data is stored, updated for future use. In data retrieving stage, retrieve data from cloud. The cloud server can share with authenticated user as per request. A patient with wearable devices continually updates his record every 5 or 10 min. In emergency mode, it updates for every 1min.The wearied device will send results to phone using Bluetooth connection or NFC technology. This can be able to give to cloud server using GSM and 3G. At cloud server, each patient is defined with unique address. So, data at cloud can authenticate the right patient and provide the required request. [7] Telemonitoring system via WBAN is evolving for the need for home based mobile health and personalized medicine. WBAN can be able to collect the data acquired from sensor and record the output. This output results sent to controller wirelessly to health monitoring system. In this paper, Zigbee is used to in WBAN technology due to its guaranteed delay requirement for health telemonitoring system. Zigbee used in the communication.[8] Afef Mdhaffar, Tarak Chaari, Kaouthar Larbi, Mohamed Jmaiel and Bernd Freisleben has explained low power WAN network to perform analysis of monitored data in health caring system. They have established WAN network for communication up to the range of 33m2 at around 12 m altitude. Also, they have demonstrated that power consumed by LoRaWAN network is ten times less than the GPRS/3G/4G. The IOT architecture has been given for step wise working for understanding of IOT. The main purpose of LoRaWAN is the energy consumption. The power consumption in idle mode for LoRaWAN is 2.8mA while in GPRS is 20mA.Hardware cost in LoRaWAN is 10doller while in GPRS is 50 dollar. Maximum data rate in LoRaWAN is 50kbps (uplink), 50 kbps downlink while in GPRS is 86.5 kbps (uplink ,14kbps(downlink). These results give the overall efficiency of LoRaWAN in the demonstration of IOT for health monitoring system. [9] Mohammad M. Masud, Mohamed Adel Serhani, and Alramzana Nujum Navaz had given the measurement of ECG signals at various intervals and at different situations. They have considered energy aware, limited computing resources and lose network continuity challenges. For these challenges, mathematical model has been developed to execute each task sequentially. There are three approaches designed to work out the process. One is mobile based monitoring approach, data mining and third is machine learning approach [10] Ayush Bansal, Sunil Kumar, Anurag Bajpai, Vijay N. Tiwari, Mithun Nayak, Shankar Venkatesan, Rangavittal Narayanan focuses on development of a system which can detect critical cardiac events. Using an advanced remote monitoring system to detect symptoms which lead to fatal cardiac events [11] Hamid Al-Hamadi and Ing-Ray Chen gives trust-based health IOT protocol that considers risk classification, reliability trust, and loss of health probability as design dimensions for decision making. Comparative analysis of trust-based protocol and baseline protocols to check feasibility.[12] Muthuraman Thangaraj Pichaiah Punitha Ponmalar Subramanian Anuradha." Digital hospital" term is introduced for hospital management. It enables automatic electronic medical records in standard. Also discusses with the implemented real-world scenario of smart autonomous hospital management with IOT.[13]

3. PROPOSED SYSTEM

In the proposed system of health monitoring system, we used temperature sensor, heartbeat sensor and humidity sensor for monitoring the human body health parameters and display in LCD and IOT server. If the

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heart rate fluctuations mean if we got low BP or HIGH BP, then buzzer module automatically alerts, and same thing will update in server.

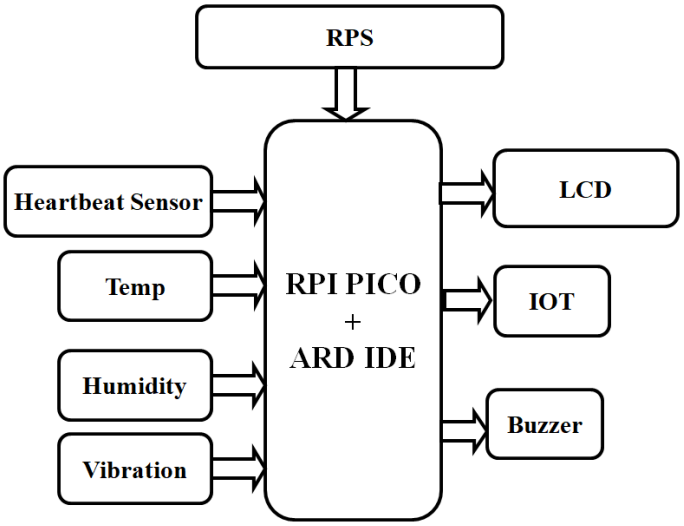

Fig. 1: Block diagram.

This methodology is intended to build a structured remote observation system for wellbeing. The goal is to track the patient's body's temperature and heart rate that the NRF innovation specialist will be faced with. The care services in medical centers are consistent with the assessment of the wellbeing of the patients. The body of the patient is continuously monitored for temperature and pulse and registered. This interface is simple, illustrating the usage of ESP8266 and RPI Pico IoT Patient Safety Monitoring Program. Temperature sensors Pulse and LM35 monitor separately BPM and Ambient Temperature. The RPI Pico designs the application and shows an LCD panel with 16 * 2. Starts sending the data to the IoT application server via WLAN ESP8266 unit partners with both the Wi-Fi. Thing speaks is the IoT server used in this. Finally, data from anywhere in the world can only be verified by identifying the channel Thing speak. Hardware modules used in this proposed system is explained in below.

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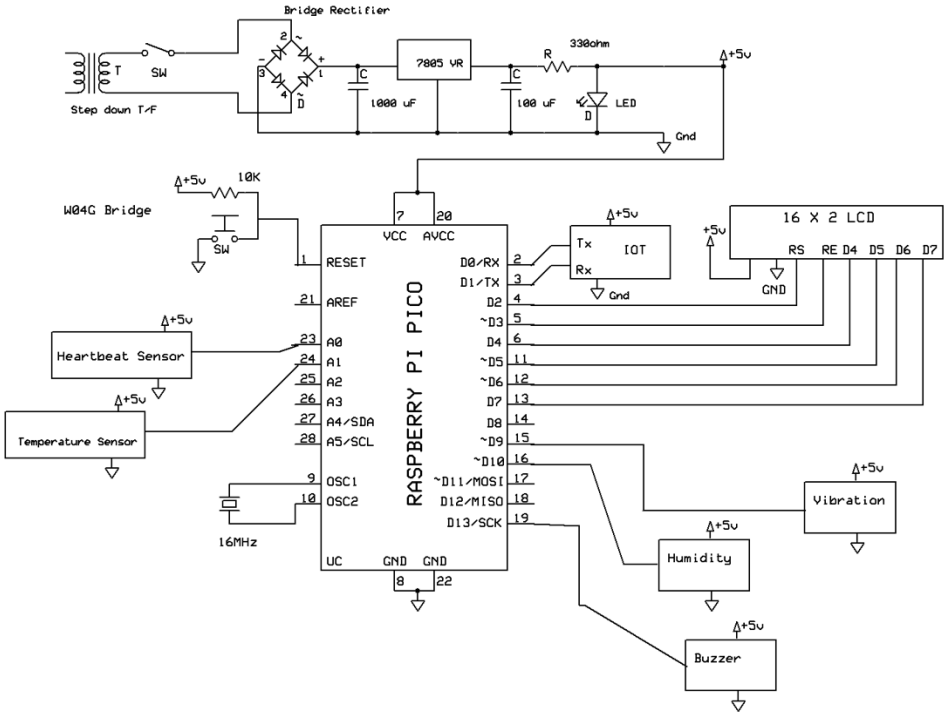

Fig. 2: Schematic diagram.

4. HARDWARE DESCRIPTION

4.1 Raspberry Pi Pico

Pico provides minimal (yet flexible) external circuitry to support the RP2040 chip: flash (Winbond W25Q16JV), crystal, power supplies and decoupling, and USB connector. The majority of the RP2040 microcontroller pins are brought to the user IO pins on the left and right edge of the board. Four RP2040 IO are used for internal functions - driving an LED, onboard Switched Mode Power Supply (SMPS) power control and sensing the system voltages. Pico has been designed to use either soldered 0.1" pin-headers (it is one 0.1" pitch wider than a standard 40-pin DIP package) or can be used as a surface mountable 'module', as the user IO pins are also castellated. There are SMT pads underneath the USB connector and BOOTSEL button, which allow these signals to be accessed if used as a reflow soldered SMT module

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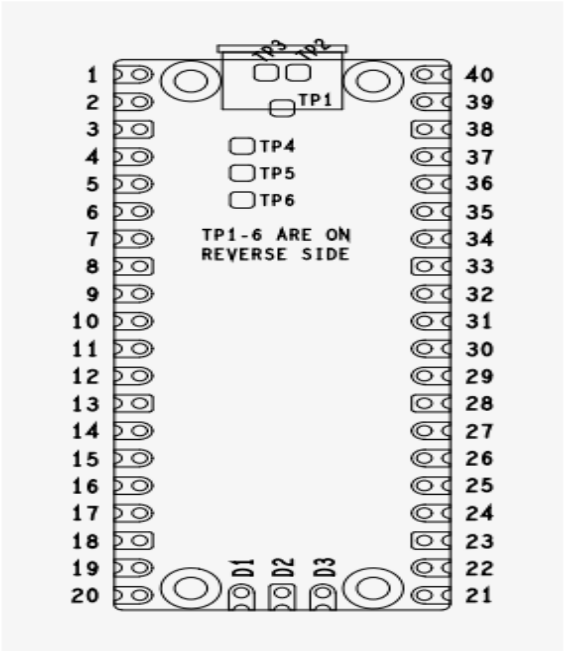
Fig. 3: RASPBERRY PI PICO Development Board.

Pin Diagram

The Pico pinout has been designed to directly bring out as much of the RP2040 GPIO and internal circuitry function as possible, while also providing a suitable number of ground pins to reduce EMI (Electro Magnetic Interference) and signal crosstalk. This is important in general but especially for RP2040 which is built on a modern 40nm silicon process and hence the digital IO edge rates are very fast.



GPIO Pin Configuration

- GPIO29 IP Used in ADC mode (ADC3) to measure VSYS/3
- GPIO25 OP Connected to user LED
- GPIO24 IP VBUS sense - high if VBUS is present, else low

- GPIO23 OP Controls the on-board SMPS Power Save pin (Section 4.4) Apart from GPIO and ground pins, there are 7 other pins on the main 40-pin interface: PIN40 VBUS
- PIN39 VSYS
- PIN37 3V3_EN
- PIN36 3V3
- PIN35 ADC_VREF
- PIN33 AGND
- PIN30 RUN VBUS is the micro-USB input voltage, connected to micro-USB port pin 1. This is nominally 5V (or 0V if the USB is not connected or not powered). VSYS is the main system input voltage, which can vary in the allowed range 1.8V to 5.5V, and is used by the on-board
- SMPS to generate the 3.3V for the RP2040 and its GPIO. 3V3_EN connects to the on-board SMPS enable pin, and is pulled high (to VSYS) via a 100K resistor. To disable the 3.3V (which also de-powers the RP2040), short this pin low. 3V3 is the main 3.3V supply to RP2040 and its I/O, generated by the on-board SMPS. This pin can be used to power external circuitry (maximum output current will depend on RP2040 load and VSYS voltage, it is recommended to keep the load on this pin less than 300mA). ADC_VREF is the ADC power supply (and reference) voltage, and is generated on Pico by filtering the 3.3V supply. This pin can be used with an external reference if better ADC performance is required. AGND is the ground reference for GPIO26-29, there is a separate analog ground plane running under these signals and terminating at this pin. If the ADC is not used or ADC performance is not critical, this pin can be connected to digital ground. RUN is the RP2040 enable pin, and has an internal (on-chip) pull-up resistor to 3.3V of about ~50K Ohms. To reset RP2040, short this pin low. Finally, there are also 6 Test Points (TP1-TP6) which can be accessed if required, for example if using as a surface mount module. These are: TP1 Ground (close coupled ground for differential USB signals) TP2 USB DM TP3 USB DP TP4 GPIO23/SMPS PS pin (do not use) TP5 GPIO25/LED (not recommended to be used) TP6 BOOTSEL TP1, TP2 and TP3 can be used to access the USB signals instead of using the micro-USB port. TP6 can be used to drive the system into mass-storage USB programming mode (by shorting it low at power-up). Note that TP4 is not intended to be used externally, and TP5 is not really recommended to be used as it will only swing from 0V to the LED forward voltage (and hence can only really be used as an output with special care).

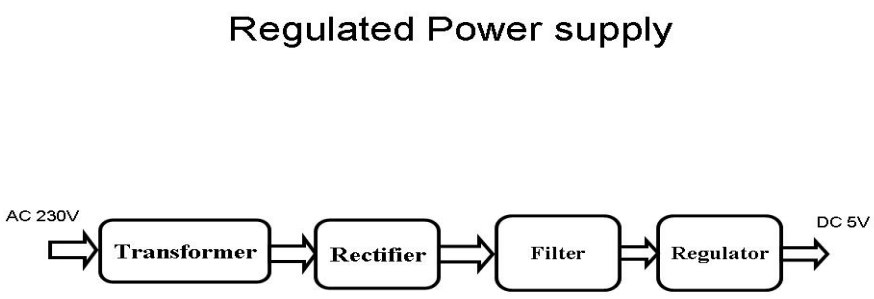


Fig. 4: Regulated Power Supply

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The basic circuit diagram of a regulated power supply (DC O/P) with led connected as load is shown in fig. 5

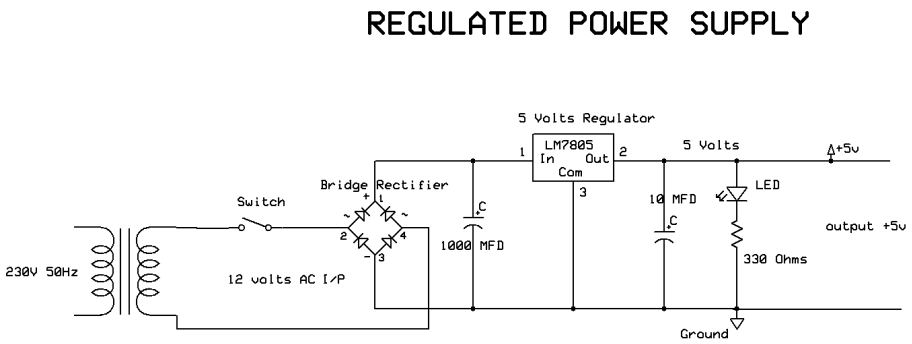

Fig. 5: Circuit diagram of Regulated Power Supply with Led connection.

The components mainly used in above figure are

- 230v Ac Mains
- Transformer
- Bridge Rectifier (Diodes)
- Capacitor
- Voltage Regulator (Ic 7805)
- Resistor
- Led (Light Emitting Diode)

4.2 Heartbeat Sensor

This heartbeat sensor is designed to give digital output of heat beat when a finger is placed inside it. When the heart detector is working, the top-most LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

Amplifier Circuit

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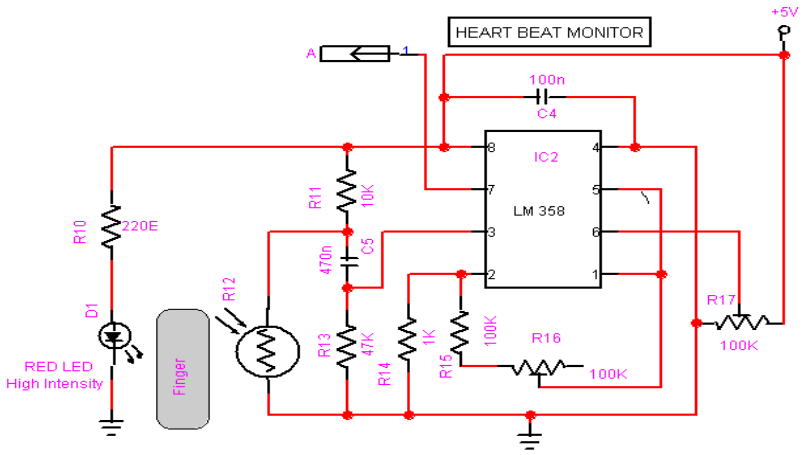

Fig. 6: Schematic diagram of Heartbeat sensor.

For amplification, we use IC LM 358. Pulse rate is sensed by using a high intensity type LED and LDR. The finger is inserted in probe and red light from high intensity LED is allowed to fall on the finger. The amount of red light absorbed by finger varies according to the pulsatile blood flow in the finger. Therefore, the amount of light transmitted varies according to the blood flow.

4.3 DHT11- Humidity and Temperature Sensor

DHT11 digital temperature and humidity sensor is a calibrated digital signal output of the temperature and humidity combined sensor. It uses dedicated digital modules capture technology and the temperature and humidity sensor technology to ensure that products with high reliability and excellent long-term stability. Sensor includes a resistive element and a sense of wet NTC temperature measurement devices, and with a high-performance 8-bit microcontroller connected.

Fig. 7: DHT11 sensor.

4.4 Mercury switch

Vibration TILT sensor

A mercury switch is an electrical switch that opens and closes a circuit when a small amount of the liquid metal mercury connects metal electrodes to close the circuit. There are several different basic designs (tilt, displacement, radial, etc.) but they all share the common design strength of non-eroding switch contacts.

Fig. 8: Mercury switch.

Description

Mercury switches have one or more sets of electrical contacts in a sealed glass envelope that contains a small quantity of mercury. The envelope may also contain air, an inert gas, or a vacuum. Gravity constantly pulls the drop of mercury to the lowest point in the envelope. When the switch is tilted in the appropriate direction, the mercury touches a set of contacts, thus completing an electrical circuit. Tilting the switch in the opposite direction moves the mercury away from that set of contacts, breaking that circuit.[1] The switch may contain multiple sets of contacts, closing different sets at different angles, allowing, for example, single-pole, double-throw (SPDT) operation.

4.5 LCD DISPLAY

LCD Background

One of the most common devices attached to a micro controller is an LCD display. Some of the most common LCDs connected to the many microcontrollers are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Basic 16x 2 Characters LCD

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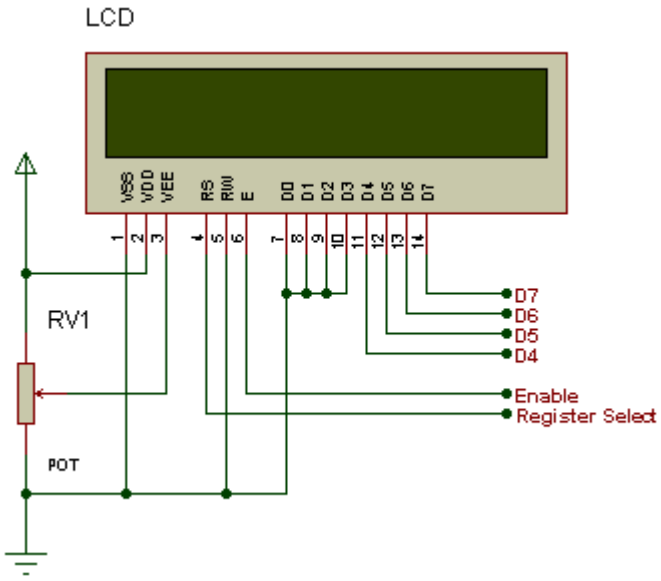

Fig. 9: LCD Pin diagram

Pin description:

Table 1: Character LCD pins with Microcontroller

Pin No.	Name	Description
Pin no. 1	VSS	Power supply (GND)
Pin no. 2	VCC	Power supply (+5V)
Pin no. 3	VEE	Contrast adjust
Pin no. 4	RS	0 = Instruction input 1 = Data input
Pin no. 5	R/W	0 = Write to LCD module 1 = Read from LCD module
Pin no. 6	EN	Enable signal
Pin no. 7	D0	Data bus line 0 (LSB)
Pin no. 8	D1	Data bus line 1
Pin no. 9	D2	Data bus line 2
Pin no. 10	D3	Data bus line 3
Pin no. 11	D4	Data bus line 4
Pin no. 12	D5	Data bus line 5
Pin no. 13	D6	Data bus line 6
Pin no. 14	D7	Data bus line 7 (MSB)

5. CONCLUSION

We designed and implemented Arduino Based E – Health System over Internet of Things with integrating of all input modules like temperature, humidity, position motions, heart rate monitoring sensors, output modules LCD, buzzer and wireless communication system called internet of things through RPI Pico processor. In this proposed system, the various health parameters such as pulse rate, temperature, angle movement of fingers and eye blink were monitored and recorded in the Thing Speak platform. The values of these parameters were analyzed and alerted in this the proposed system. In future we will add some other sensors which enhance the health monitoring system like glucometer and body fat device measurement we can add

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