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A Bracelet to Alert the Patient's Sudden Health Condition

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Abstracts: An elderly monitoring system makes use of mobile computing and wireless communication technologies for continuous or periodic measurement and analysis of bio-signals of elderly. The aim of this project is helping healthcare professionals to each monitoring and tracking elderly health over time. For healthcare professionals, this project provides a general health information of elderly patient such temperature and heart rate pass to monitoring systems as mobile devices.

Keyword: Patient's Sudden Health Condition, Mobile Computing, Bracelet

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Introduction

Home-bound patients face many problems regarding their critical health parameter variations and timely assistance in case of emergency. It is really difficult when they suffer from other severe diseases like heart disease, diabetes etc. A regular and reliable assistive technology is needed while taking care of home-bound patients. The situation is even worse when they are bedridden compared to other patients. Many health problems along with their regular disabilities will make the situation much more horrid. This is where they need extra care and attention from their care providers. A device that can solve all these problems together will be a boon to the homebound bedridden patients. The main aim of our project is to build a working prototype of an assistive wireless device for bedridden patients. The device will

continuously monitor the heart rate of the patient. The device communicates with a mobile in which a customizable application is developed which will enable the alert mechanism. The communication between the device and the mobile is via Bluetooth Module [1].

Literature Survey

The following related work proposed design project.

Majid H. Alsulami, Anthony S. Atkins, and Russell J Campion [2], they have used two different types of smart watches to monitor an elderly person in different locations. The elderly person was monitored from three different countries. The results show that the systems currently installed and incorporated into smart watches are only meant for visualisation; no intelligent action can be taken when abnormal events occur. Therefore, they present a complementary approach for these systems by proposing a knowledge-based system combined with a rule-based system.

Maria Araiza Alejandrino, Sean Christian Bermudez, Clarissa Jane Mesias, and Antonette D. Gabriel [3], they design a system that the proponents have developed was intended to improve the communication between the caregivers and their patients. It aimed to provide a facility where the caregivers can easily monitor their patients and attend to their needs promptly. It also aimed to provide a way by which patients can communicate their needs to their caregivers with ease which is particularly useful to patients who are speech-impaired.

Astrid Gloria Pepita, and Tutun Juhana [4], they design assisted Living app can retrieve real-time and historical user health information to Firebase Database automatically. The health information consists of user's heart rate value, fall state, and heart abnormality state. The data are displayed in a form of graph for a better user interface, so that family members can monitor the condition of the elderly. Also, this app can send automated emergency SMS to multiple numbers whenever an emergency condition occurs. This is intended so that families can immediately know whenever an emergency condition occurs to the elderly.

Hiroyuki Yamagishi and Daichi Kato and Kazunori Teshima, and and Hidekazu Suzuki and Osami Yamamoto and Akira Watanabe [5], they described the outline of various systems remotely watching the vulnerable as well as the operation of proposed system. They proposed a system by which watching persons can watch the present conditions of elderly people remotely by storing in the management server the information received by way of SmartPhone carried by them. They confirmed by using a trial system that by storing the information received from SP, the locational information and the count of steps taken can be displayed in an appropriate manner.

Objective of this project

The major parts of this project are Heart Beat Sensor, Arduino Uno, LCD, Infrared thermometer & Bluetooth Module. Inspecting patients on a regular basis is vital for their safety. Compared to the physical inspection, wireless monitoring offers continuous observation, reduced costs and increased security.

Scope and limitation of the study

This project was focused on the development of heart rate monitoring device using Arduino as microcontroller. Its scope was consisted of a heart rate monitoring device that should measure the heart rate of a patient based on how much beats per minute it occurs using its finger pulse. It can also send the data of patient such body temperature, heart rate via Bluetooth to smart device which is in our project is Android device. Some limitations on our project that was

not included due to lack reading heart rate pulses from sensor which return not so accurate value. The device could only measure the heartbeats and temperature of a patient through attached sensors to body. Authorized user should input the age of the patient in order to determine the abnormalities of the heart rate of a patient. Also, heart rate monitoring device cannot be used in low battery condition, during brown-out and if there is no abundant sunlight at the same time.

Significance of the Study

The outcome of this study may offer benefits to the following:

- **Medical providers.**

The device could assist them in diagnosing heart failure related conditions and providing them a handy tool especially when conducting checkups to remote areas.

- **Patients.**

The device may process the reading of their pulses to measure how much heartbeats they occur within a minute. It also provides transparency and accuracy on the flow of every checkup.

- **Users.**

Heart rate monitors are mainly used to determine the exercise intensity of a training session or race particularly those people engaged in sports.

Principles and Fundamentals

Over the years, the use of technology is considered to be the driving force behind improvements in healthcare which makes it more driven and effective than it has ever been. There is no doubt to agree that technology is impacting many aspects of our lives as breakthroughs in data collection, research and treatments allow medical providers to use new tools and find fresh and innovative ways to enhance our healthier way of living.

Heart Beat Sensor

Sensor is designed to provide analog output of heart beat when a finger is placed on it. When the heart beat detector is working, beat LED flashes in unison with each heart beat. This analog output can be connected to Arduino uno to measure Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse [6].

Sensor operation

The sensor consists of a super bright red LED and light detector. LED needs to be super bright as maximum light must pass spread in finger and detected by the detector. When heart pumps blood through blood vessels, finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. Signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heart beat as shown in figure (2.1) [7] [8]

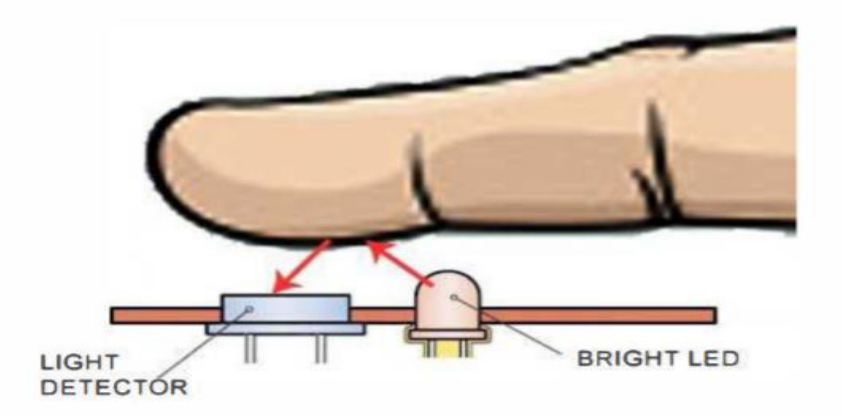

Figure (2. 1) Pulse rate sensor

Infrared Thermometer sensor

Most of the temperature measurement techniques around the world require some sort of physical contact between the temperature sensor and the object or environment whose temperature is to be measured, but as technology advanced, this changed too. The need to be able to measure the temperature of an object without physical contact arose. This need brought the measurement of temperature using infrared sensors [9]. The principle of operation of Infrared thermometers is simple, all bodies at a temperature above 0 Kelvin (absolute zero) emit an infrared energy which can be detected by the infrared thermometer sensor [10]. It's design includes a lens that focuses the infrared energy being emitted by the object in front of a detector. The detector converts the energy into an electrical signal which then can be passed to a microcontroller to interpret and display in units of temperature after compensating for the variation in ambient temperature as shown in figure (2.2) [9].

Figure (2. 2) Infrared Thermometer Sensor

LCD I2C

An I2C LCD has only 4 pins that interface it to the outside world. The connections are as follows: GND is a ground pin and should be connected to the ground of Arduino. VCC supplies power to the module and the LCD. Connect it to the 5V output of the Arduino or a separate power supply. I2C is a serial communication protocol, so data is transferred bit by bit along a single wire (the SDA line) [12]. Like SPI, I2C is synchronous, so the output of bits is synchronized to the sampling of bits by a clock signal shared between the master and the slave. The clock signal is always controlled by the master. The LCD I2C is shown in figure (2.3) [10].

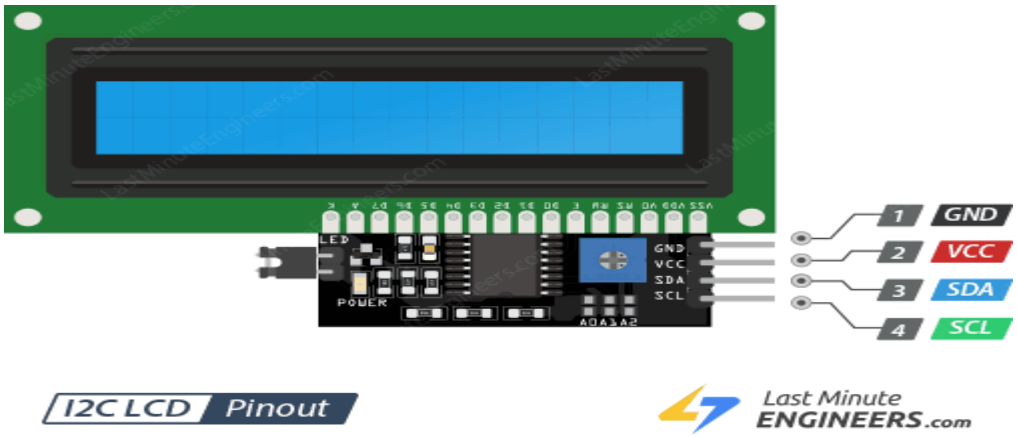

Figure (2. 3) LCD I2C

Bluetooth HC-05 Module

The HC-05 is a popular module which can add two-way (full-duplex) wireless functionality to your projects. Also can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop [14]. There are many android applications that are already available which makes this process a lot easier. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any microcontroller that supports USART. The pinout of Bluetooth is shown in figure (2.4) [11].

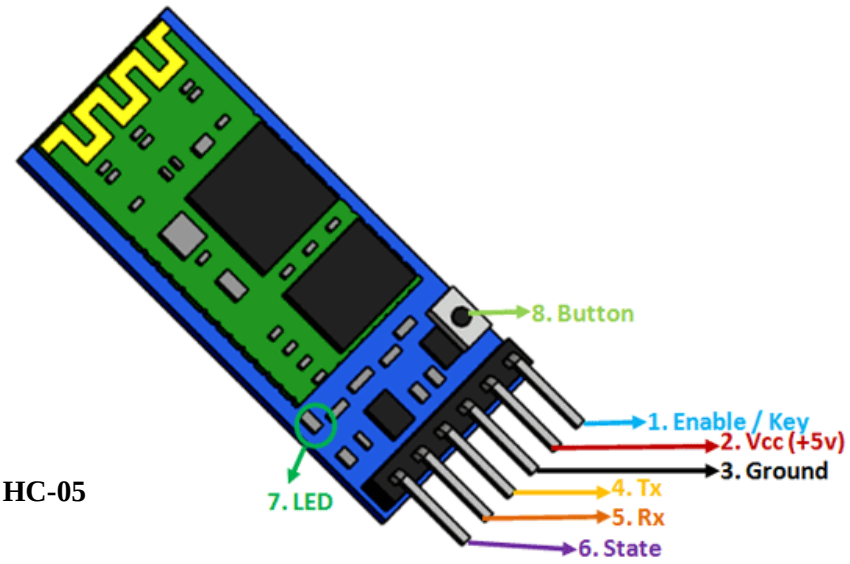

Figure (2. 4) Bluetooth HC-05

HC-05 Technical Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)

- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

Applications of LCD I2C

- Wireless communication between two microcontrollers
- Communicate with Laptop, Desktops and mobile phones
- Data Logging application
- Consumer applications
- Wireless Robots
- Home Automation

Arduino UNO

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by the USB cable [12].

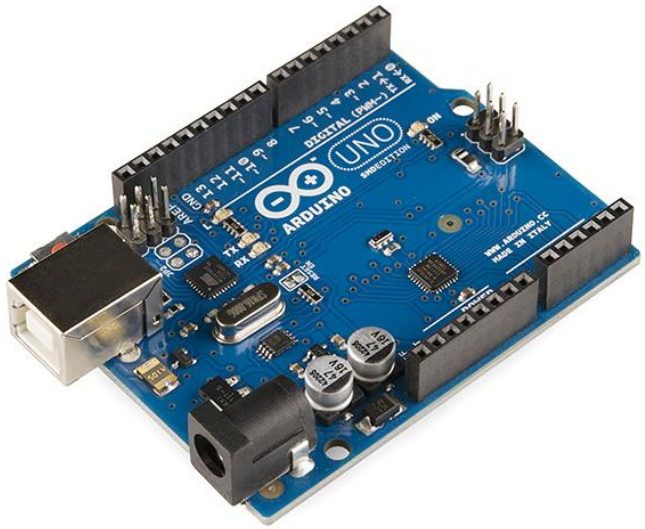

Figure (2. 5) Arduino UNO

Here are the components that make up an Arduino board and what each of their functions are.

- Reset Button – This will restart any code that is loaded to the Arduino board
- AREF – Stands for “Analog Reference” and is used to set an external reference voltage
- Ground Pin – There are a few ground pins on the Arduino and they all work the same
- Digital Input/Output – Pins 0-13 can be used for digital input or output
- PWM – The pins marked with the (~) symbol can simulate analog output
- USB Connection – Used for powering up your Arduino and uploading sketches

- TX/RX – Transmit and receive data indication LEDs
- ATmega Microcontroller – This is the brains and is where the programs are stored
- Power LED Indicator – This LED lights up anytime the board is plugged in a power source
- Voltage Regulator – This controls the amount of voltage going into the Arduino board
- DC Power Barrel Jack – This is used for powering your Arduino with a power supply
- 3.3V Pin – This pin supplies 3.3 volts of power to your projects
- 5V Pin – This pin supplies 5 volts of power to your projects
- Ground Pins – There are a few ground pins on the Arduino and they all work the same
- Analog Pins – These pins can read the signal from an analog sensor and convert it to digital [17]

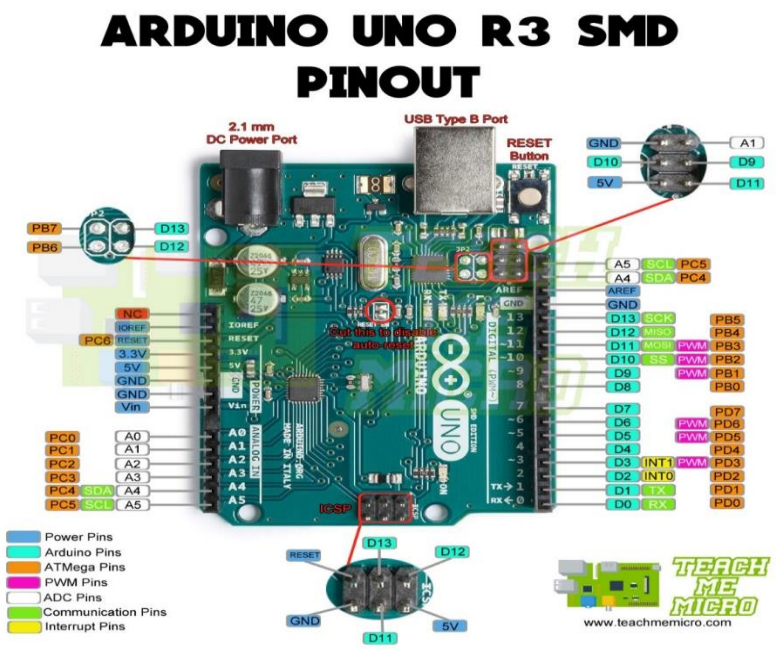

Figure (2. 6) Arduino UNO pinout

Inside structure of Arduino UNO shown as schematic diagram in figure below.

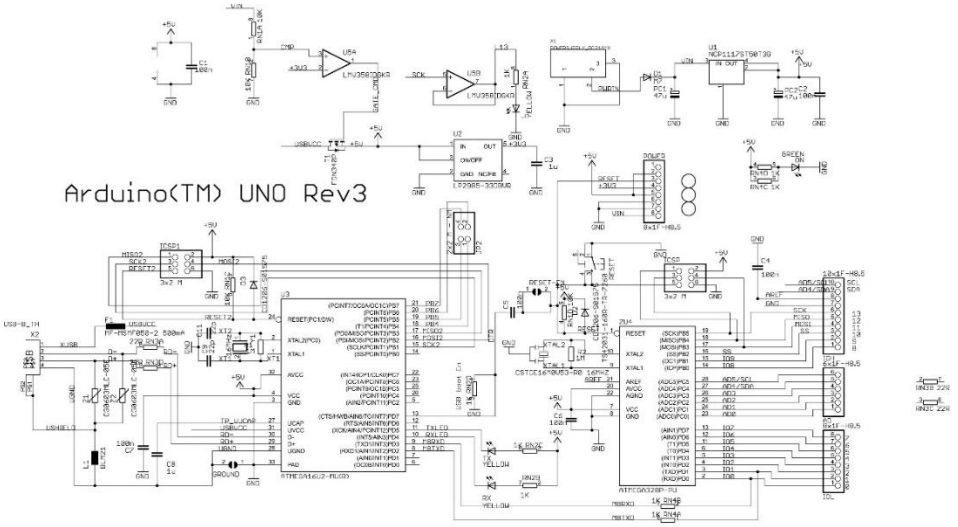

Figure (2. 7) Schemtic Diagram of Arduino UNO

MIT app Inventor

-The smartphone is an information nexus in today's digital age, with access to a nearly infinite supply of content on the web, coupled with rich sensors and personal data. However, people have difficulty harnessing the full power of these ubiquitous devices for themselves and their communities. Most smartphone users consume technology without being able to produce it, even though local problems can often be solved with mobile devices. How then might they learn to leverage smartphone capabilities to solve real-world, everyday problems? MIT App Inventor is designed to democratize this technology and is used as a tool for learning computational thinking in a variety of educational contexts, teaching people to build apps to solve problems in their communities. MIT App Inventor is an online development platform that anyone can leverage to solve real-world problems. It provides a web-based "What you see is what you get" (WYSIWYG) editor for building mobile phone applications targeting the Android and iOS operating systems. It uses a block-based programming language built on Google Blockly.

MIT App Inventor Overview

The MIT App Inventor user interface includes two main editors: the design editor and the blocks editor. The design editor, or designer (see Fig. 2.6), is a drag and drop interface to lay out the elements of the application's user interface (UI). The blocks editor (see Fig. 2.7) is an environment in which app inventors can visually lay out the logic of their apps using color-coded blocks that snap together like puzzle pieces to describe the program. To aid in development and testing, App Inventor provides a mobile app called the App Inventor Companion (or just "the Companion") that developers can use to test and adjust the behavior of their apps in real time. In this way, anyone can quickly build a mobile app and immediately begin to iterate and test.

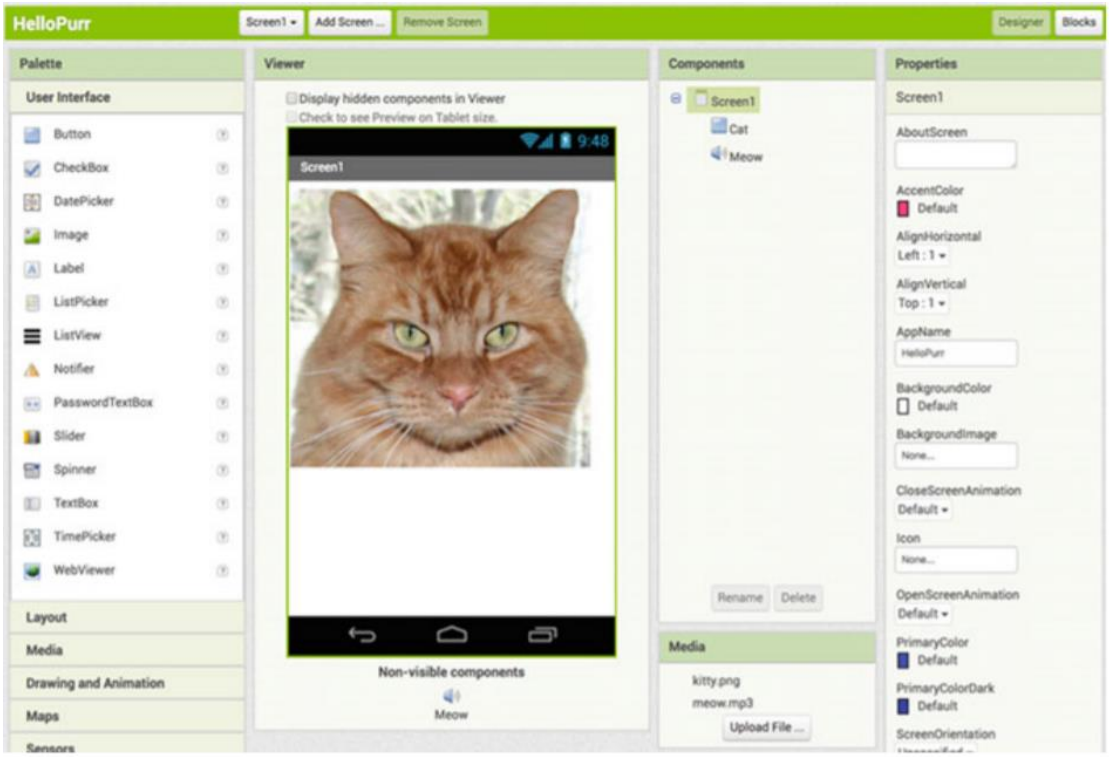

Figure (2. 8) App Inventor editor

Fig. 2.6 App Inventor's design editor. App inventors drag components out from the palette (far left) to the viewer (center left) to add them to the app. Inventors can change the properties of the components (far right). An overview of the screen's components and project media are also displayed (center right)

In the design of MIT App Inventor, introducing mobile app development in educational contexts was a central goal. Prior to its release, most development environments for mobile applications were clunky, only accessible with expertise in systems level or embedded programming, or both. Even with Google's Android operating system and the Java programming language, designing the user interface was a complex task. Further, use of the platform required familiarity with Java syntax and semantics, and the ability to debug Java compilation errors (e.g., misspelled variables or misplaced semicolons) for success. These challenges presented barriers to entry for individuals not versed in computer science, App Inventor's target demographic. We briefly highlight and discuss design goals for the App Inventor project, specifically, the use of components to abstract some of the complexity of platform behavior, and the use of blocks to eliminate complexity of the underlying programming language. These goals can be further explained as aligning the visual language to the mental models of young developers and enabling exploration through fast, iterative design.

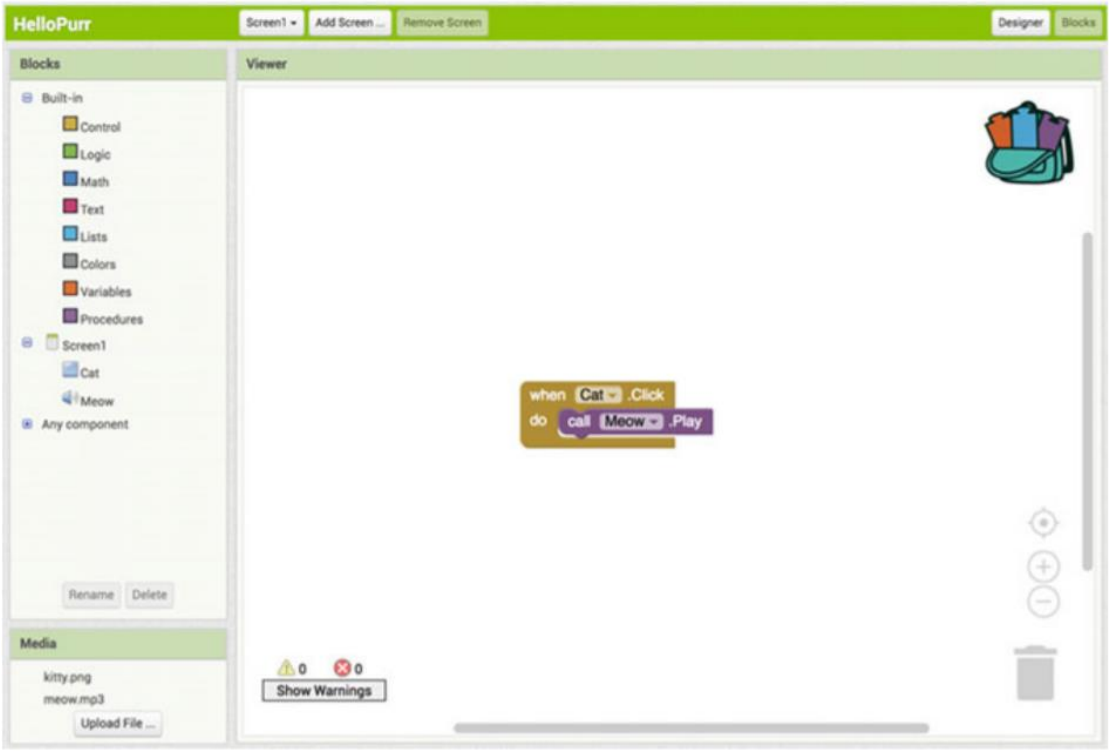

Figure (2. 9) App Inventor Blocks Editor

Fig. 2.7 App Inventor's blocks editor. Blocks code is typically read left to right, top to bottom. In this example, one would read "when Cat click, do call Meow play," that is, play the meow sound when the cat is clicked

Components are core abstractions in MIT App Inventor. Components reduce the complexity of managing interactions with platform-specific application programming interfaces (APIs) and details concerning state management of device hardware. This allows the user to think about the problem at hand rather than the minutia typically required of application developers. For example, someone planning to use MIT App Inventor to build an app to use the global positioning system (GPS) to track movement need not be concerned with application lifecycle management, GPS software and hardware locks, or network connectivity (in case location detection fallsback to network-based location). Instead, the

app developer adds a location sensor component that abstracts away this complexity and provides an API for enabling and processing location updates. More concretely, this implementation reduces 629 lines of Java code to 23 blocks, of which only two are required to accomplish location tracking. This reduction in complexity enables app inventors to focus on the problem at hand and quickly accomplish a goal. Components are made up of three major elements: properties, methods, and events. Properties control the state of the component and are readable and/or writable by the app developer. For example, the enabled property of the location sensor includes the functionality required to configure the GPS receiver and to manage its state while the app is in use. Methods operate on multiple inputs and possibly return a result. Events respond to changes in the device or app state based on external factors. For example, when the app user changes their location, the location changed event allows the app logic to respond to the change.

In MIT App Inventor, users code application behavior using a block-based programming language. There are two types of blocks in App Inventor: built-in blocks and component blocks. The built-in blocks library provides the basic atoms and operations generally available in ther programming languages, such as Booleans, strings, numbers, lists, mathematical operators, comparison operators, and control flow operators. Developers use component blocks (properties, methods, and events) to respond to system and user events, interact with device hardware, and adjust the visual and behavioral aspects of components [13].

Design and Implementation

Overview

The design of our project is based represented in illustration below.

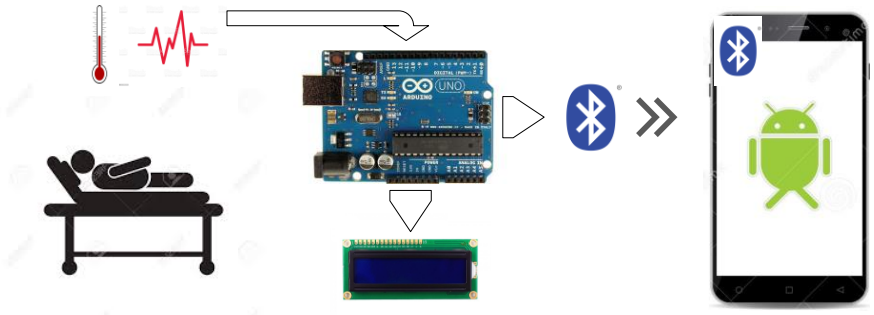

Figure (3. 1) Project proposed design concept

System Implementation

For easy understanding and explanation the complete system can be divided to three subsections.

A. Measurement Unit

B. Processing unit

C. Communication Unit

Measurement Unit

Measurement unit consist of IR temperature and Heart Beat Sensor.

The IR temperature sensor for non-contact temperature measurements. It has an I2C Interface to communicate with microcontroller. Here we use Arduino as microcontroller. This temperature sensor can measure the temperature without touch the object.

Heart rate sensor does nothing but measure heart rate of the heart, it can be found in any medical equipment that is used in measuring heart rate.

Both above sensors applied in our project as measurement unit to Arduino for further processing.

Processing Unit

The processing unit consist of the Arduino Uno kit. It runs on ATmega382. It is a high performance, low power, 3bit microcontroller. Arduino is an open source electronics prototyping platform based on flexible, easy-to-use hardware and software. Data Acquisition & Processing Output of the sensor is analog & is directly connected to the digital pin of Arduino Uno board. The output is in the form of square wave. The main logic in getting the heart rate is by measuring the time required for completion of one cycle i.e. one square wave. The pulse signal is applied to A 7 input pin of Arduino Uno board. For example, if the pulse rate is 60 BPM (beats per minute) there will be a pulse every second. The duration of one heart beat will be one seconds or 1000 x lms. Dividing 60,000 by 1000 will give the correct result of 60 which is shown on the display. If there is invalid result, (BPM>200) it will reject and wait for the next cycle. Working The Arduino software is open-source. The programming is done in C/C++ language. The Arduino Uno board is interfaced with heart beat sensor, IR temperature sensor, and Bluetooth module. The digital output of IR temperature is directly attached to I2C pins, pulse sensor attached to analog A0, and Bluetooth tx and rx attached to Arduino serial pins (D0 and D1) respectively. Arduino Uno board has dedicated pins for transmission & reception; same has been connected to transmission & reception pin of Bluetooth module. Communication has been made by using AT commands. It also provides information to LCD which displays heart rate along with the information.

Communication Unit

The communication unit consists of Bluetooth module. Programming is done using AT commands. Bluetooth module has a dedicated transmission & reception pin which are connected to Arduino Uno. It works on 3.3Vdc supply.

Methodology

The working methodology is described as below. Software design - Software uses are available in an open market i.e. open-source. Programming is done in C/C++ language. Communication from Sensor to Arduino Uno - The heart beat sensor output is analog so we can directly integrate it with any of the analog pin available in Arduino Uno kit. In addition to this, human temperature IR sensor has been attached to I2C pins of Arduino to monitoring a patient temperature in real-time.

Communication of Arduino Uno & Bluetooth module - The Arduino Uno board has the dedicated pin for transmission & reception of data for any Bluetooth communication. Same is been integrated with Bluetooth module. AT commands have been used for the transmission of data from Bluetooth module to a cell phone.

Circuit Operation

The operation of design project can be described in following.

- The both sensors (IR temperature and pulse rate) start calibrated to be ready to sensing right value.
- There a delay between these reading sensors about 1s.
- There are two types to display the sensors value
    - Local monitoring: based on use LCD display and this component attached with circuit
    - Mobile monitoring: connect the mobile device to design circuit via Bluetooth and receive the data and display the value in textbox
- The above steps keep in infinite loop till power off and when get power back the circuit will reset itself and start over.

Hardware Design and Results

4.1. The Design Implementation

In this chapter, the smart watch for elderly and monitor in mobile application have been designed by using Arduino and the sensor connection after burning the program give the good response.

The schematic diagram of circuit given as follow: At first design the device and connect the electronic components of the circuit in a computer simulator program.

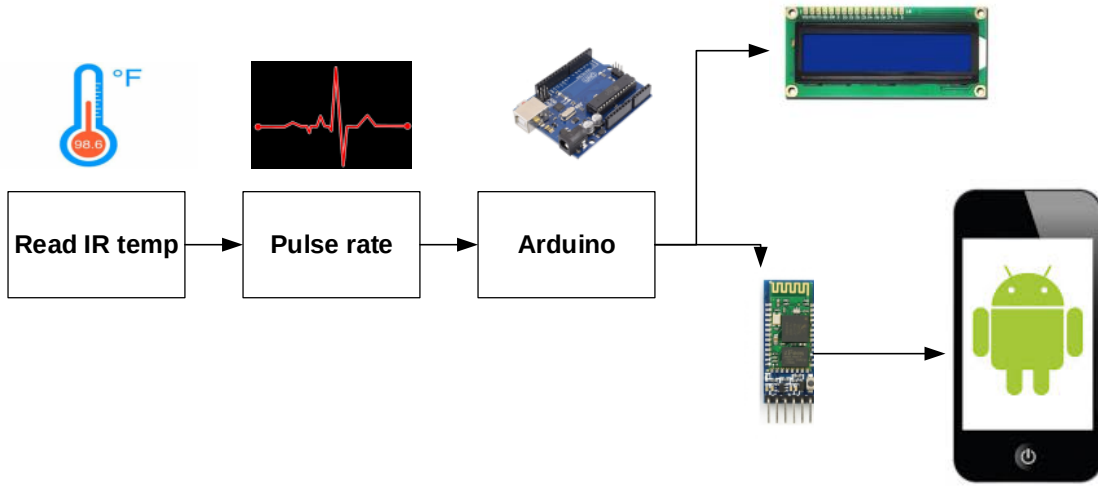

Figure (4. 1) Phases of project

Procedure of system work:

- Both of sensors (IR thermocouple and pulse rate sensors) get values from patient or elderly people
- These value processed within microcontroller (Arduino UNO).
- LCD connected to Arduino to display these value in real-time.
- In same time of displaying data in LCD, these values concatenate as one string to be passed to Android monitor (Mobile application) via Bluetooth.
- When an Android device received this string, split operation fire-up to split the string to two values (human temperature and pulse heart rate).
- After splitting the string, two values will be show in textboxes

The procedure of work can be determined in flowchart as in figure below.

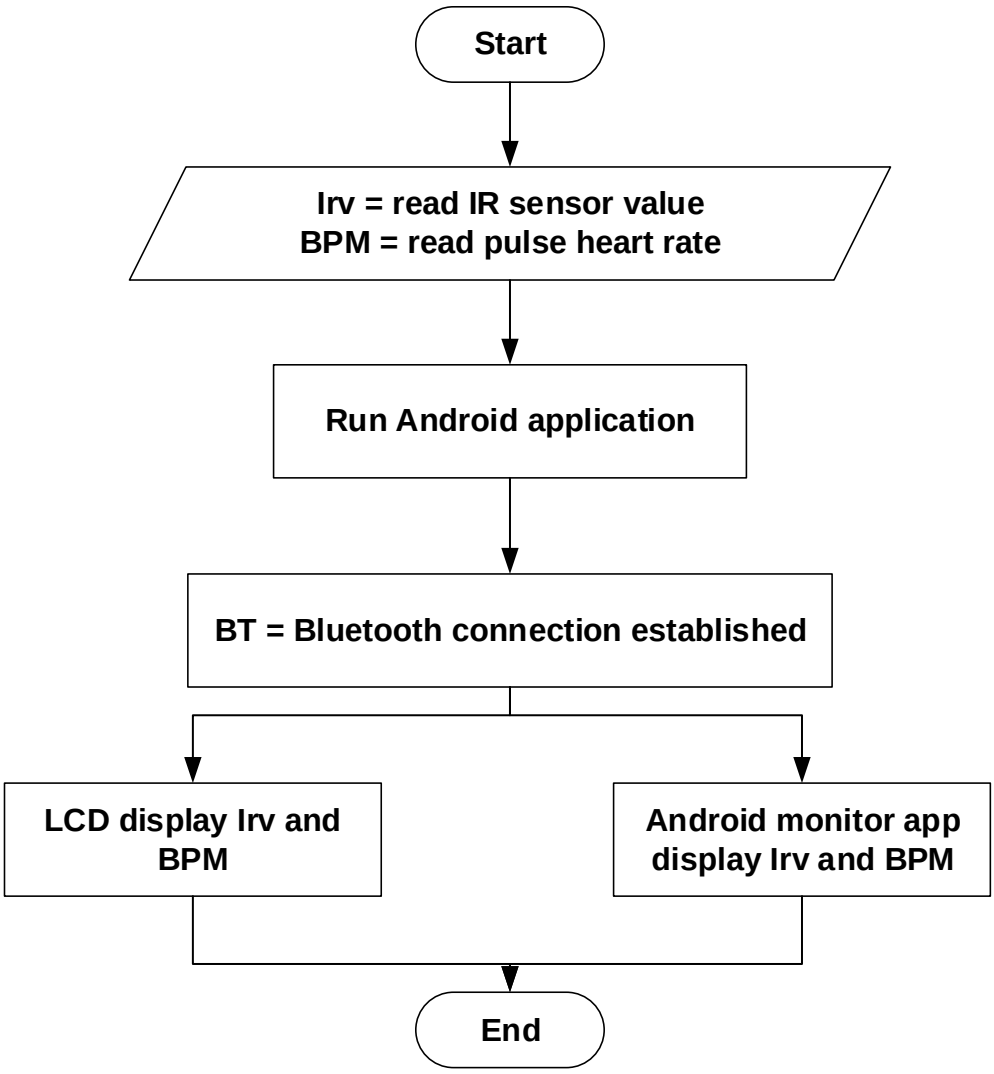

Figure (4. 2) Algorithm of procedure of the project operation

Also, the operation of electronic circuit and mobile application illustrated as in figures below:

- Electronic circuit component and design shown in figure (3.2)

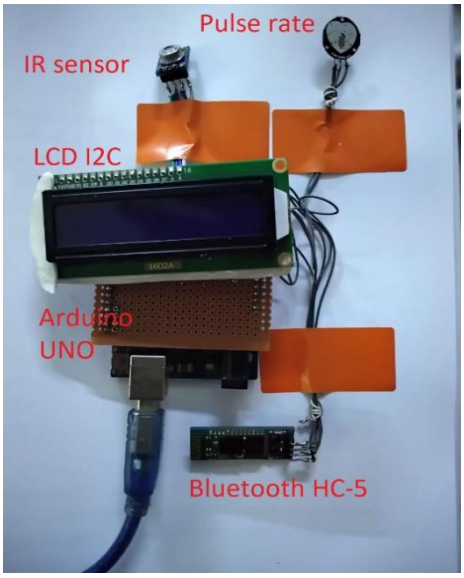

Figure (4. 3) Electronic Components used in project

- In real-time of operation of circuit, data collected by sensors (IR temperature and pulse heart rate) and LCD used to display these value as shown in figure (4.3)

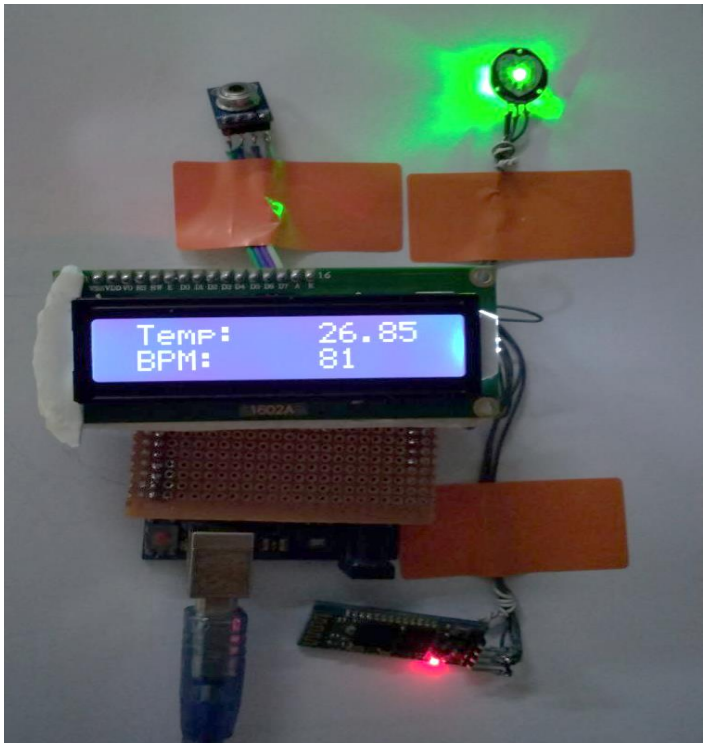

Figure (4. 4) LCD display the values of sensors

- Connection of Arduino and Android need to established to pass information, this event start by paring two devices by press on connection button from Android application design as shown in figure (4.4)

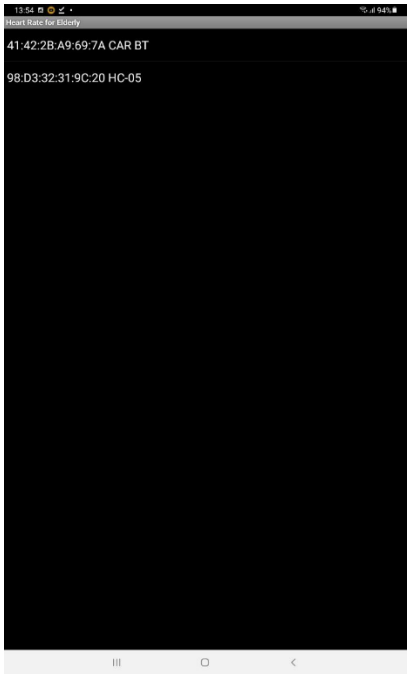

Figure (4. 5) Pairing Arduio and Android via Bluetooth

- In same time of displaying values on LCD, same values send via Bluetooth to an Android as shown in figure (4.5)

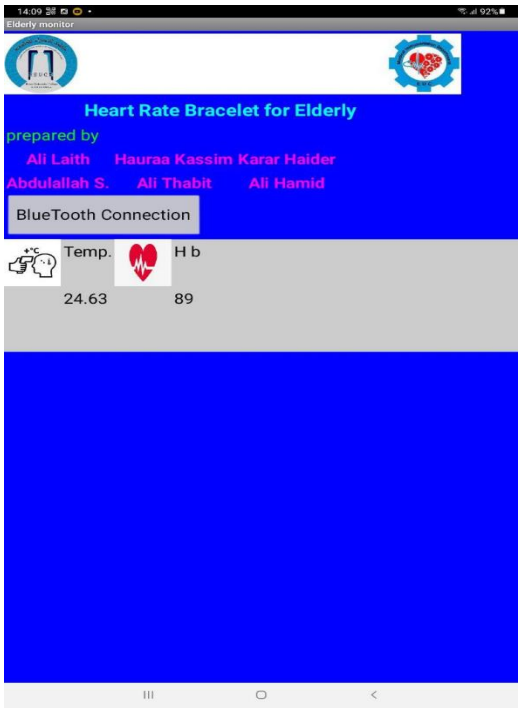

Figure (4. 6) An Android application and patient information

Conclusion

Providing quality and timely health assistance for elderly population is a growing concern of both developed and developing nations. Though there are high-tech hospitals and care centers for elderly, fact that majority of them suffer from chronic disease and they require continuous monitoring of their physical parameters make it quiet expensive. Moreover majority of the elderly prefer to be at home where they are not detached from the family and society. In such a scenario this system could be very effective. It can work independently at a home environment. Thus this device can really be a boon to elderly society by assisting them in getting quality assistance at their own houses.

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