Design a Reliable IoT based Patient Health Care and Management System using Optimal Photo Sensor

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Abstract— Among the panoply of applications enabled by the Internet of Things (IoT), smart and connected health care is a particularly important one. E-Health services can take advantage of the technological achievements in the area of the Internet of Things (IoT), and of the cost reduction and increasing user-friendliness of health monitoring devices. This paper presents the design and implementation of an IOT-based health monitoring system for emergency medical services which can demonstrate collection, integration, and interoperation of IoT data flexibly which can provide support to emergency medical services like Intensive Care Units (ICU), using optimal photosensors and IoT technique. The project is also targeting to develop a significant photosensors to the medical fields that is easy to use and monitor their health by the user everywhere. The other target is to develop a comfortable instrument, reliable, accurate result to develop of heart pulse using low cost photosensors. Home equipped with environmental sensors, physiological parameters monitoring devices, an home automation devices, could become the "hardware" of an "operating system" for application developers and service providers. The system would expose web services through a unique cloud infrastructure for users' data collection and storage, administration and billing, and healthcare service provisioning applications by possibly multiple third parties. We present an instance of a cloud-based web server which relies on a "home system" for the collection of information from an heterogeneous set of devices, providing a high level description of the proposed overall architectural model, of the induced opportunities from the market perspective, and of how it could be used by healthcare applications developers and service providers, including details on how the web server Application Programming Interfaces (API) is implemented in our instance.

Key words: Internet of Thing (IoT), Health Care, Health Monitoring, Photosensors, Web Services, Cloud Platforms

I. INTRODUCTION

The world aging population comprises an important part of the world society. Due to the worldwide improvements in society, economy and healthcare in the last decades, the average life expectancy has increased substantially while the mortality rate decreased. As a direct consequence, the number of elderly people worldwide has risen constantly. Today, the average percentage of elderly people (a person who is 65 years old or more) worldwide of 7% [1]. Moreover, in many countries the percentage of people over 65 years old exceeds the world average, such as 18% in Sweden, 18.5% in Finland and 15% average for countries in Organisation for Economic Co-operation and Development (OECD) group. Furthermore, this percentage is likely to rise in the future. It is predicted that by 2050, 24% of the Swedish population will be elderly people, among them 10% will be 80 or over [2]. This situation poses challenges to the government as well as local municipalities, whose responsibilities are to maintain the health of elderly people and enhance their quality of life.

Among the health care facilities for elderly people such as home care, hospitals, health centres, home for elderly people and service house for elderly, home care are preferred by the majority of the elderly people [3]. Furthermore, in some countries, the government makes the target of increasing the possibilities that elderly people can stay in their home and receive same care as they go to care facilities dedicated for them [4].

There are many heart pulse instruments in the market nowadays. However the heart pulse detector is expensive due to the system is complicated and it widely used in hospitals and clinics. The percentages of people who have the medical equipment at home are very less. There are many advantages of using medical instrument at home e.g. it will allow the user to monitor their health constantly without going to the clinic for a check-up, especially for the elders. The project consists of a photosensors which is used to measure the pulse by measuring the change in blood flow. The research concern is to review to the best photo-sensor such as Light Emitting Diode (LED), Infrared (IR), and Light Dependent Resistor (LDR), need to use in order to produce significant heart pulse signal detected from human finger. The wide significant between the wavelengths is the best of photosensors. Other than that, this project also used microcontroller where the microcontroller will be programmed to calculate the heart rate and control the LCD display to indicate the pulse rate. The heart pulse will be display on a LCD display. Several literature reviews were referred in completing this project.

N. I. Ramli et al [5] designed a simple and low cost microcontroller [6] based heart rate measuring device with Liquid Crystal Display (LCD) output. The pulse of heart rate will be measured from the finger using optical sensors, and displayed on the LCD. The device consists of an infrared transmitter Light Emitting Diode (LED) and an infrared sensor phototransistor. The transmitter-sensor pair is clipped on one of the fingers of the subject. LED will emit infrared light to the finger, the phototransistor then will detect this light, and then the changes of the blood volume will be measured. After that, the microcontroller will count the number of pulses over a fixed time and thus obtains the heart rate.

Research from the articles by K. Padmanabhan [7] measured either by the ECG waveform or by the blood flow in to the finger (pulse method). These heartbeats are counted by using clipping sensor technique, which a small light source on one side of the finger and the other side will observe. The microcontroller IC AT89C2051 (IC2) is used as the hardware in the project. The software will be written in assembly language and assemble using ASM51 co-assemble.

Research by Yun-Thai Li show there were many methods of monitoring heart rate and level of oxygen in the

blood system in human body such as using pulse Oximeter [8]. This device uses optical sensor and LEDs emit light at different wavelength. The LED light will emit through a finger and then the transmitted light is detected by using optical sensor. The value of oxygen saturation level can be obtained based on the principle of oxygenated haemoglobin which having a higher absorption coefficient for infrared light and then deoxygenated haemoglobin will observe more red light.

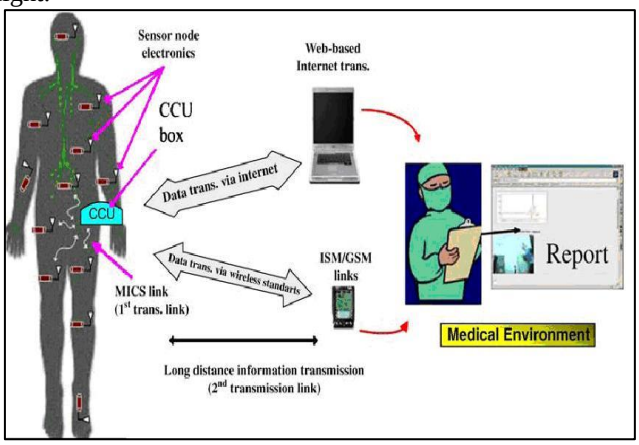


Fig. 1: IoT-based health monitoring architecture

II. COMPARISON TABLE

Existing Model	Proposed Model
Used ECG	Using photo sensor
Less efficiency	More efficiency
More cost	Less cost
No real time data uploading	Real time data uploading
Used PIC microcontroller	Arduino
Alert message facility is unavailable	Alert message facility is available

Fig. 2: Comparison table

III. PROPOSED MODEL AND RELATED WORK

The patient monitoring system is composed of two parts, which are portable remote medical monitoring unit and the monitoring center. In this project, we propose a remote medical monitoring system for heartbeat rate. Monitoring center is a station which consists of real time analysis and a warning mechanism for emergency and diagnosis.

In the first section of my project is to design a heartbeat detector using photo sensor device. In this we are using an LED and LDR in a combination such that they can capable of sensing the human heart beats. This device is attached to the patient's finger. The sensor output is given to the Arduino. Arduino is more effective than the existed PIC microcontroller. It is used for counting the heart beat pulse. An LCD is also used for displaying the heart beat count. The whole system is working on a regulated power supply.

An alert facility is also providing for the safety of the patient in emergency. If the microcontroller count goes beyond the threshold limit then an alert message is suddenly sends to the registered mobile number of the doctor. SIM 900 module is used as the GSM module in our project for sending the message when heart beat below 60 or above 120. The ESP8266 Wi-Fi Module is use as Wi-Fi module which upload the heart beat rate data on open IoT think speak wave page.

This makes our system more effective because anybody from the patient family or other can check the real time status of the patient online. The patient report or data is simply seen on the PC or mobile by visiting the mentioned webpage.

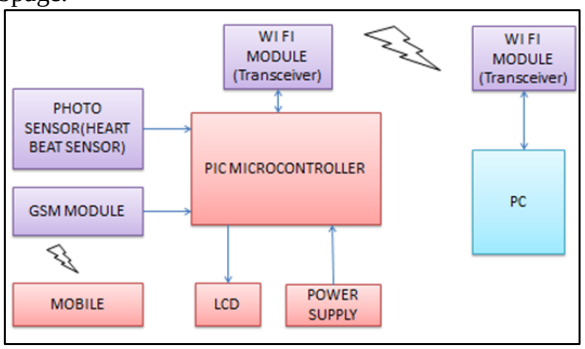


Fig. 3: Block diagram of proposed model

IV. COMPONENTS DESCRIPTION

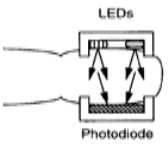
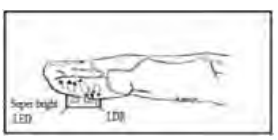
This project contains a lot of different functional components which combine together and interact with each other to provide the total performance of this project.

A. Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

B. Photo Sensor (Heart Beat Detector)

In this project I developed a photo sensor with using of LED and LDR (photo resistor) which detect the heartbeat of the patient. The working process of photo sensor is basically two types: transmission mode and reflection mode. In my project I am using transmission mode.

Criteria	Transmission mode	Reflectance mode
Figure		
Description	The sensor usually applied at finger The sensor will place on opposite The photodiode will detect transmitted	The sensor usually will put side-by side The sensor usually will put side-by side
Advantage	Light detected area is wide	Suitable for multiple location of the body.

	The amount of light transmitted through the tissues is greater than the amount of light. The signal great quality if the strong light intensity is concern to the area.	
Disadvantage	The signal only depends on the intensity of light. only able to applied in peripheral areas such as fingers, ear lobes, fingers (adults) and the foot or palm (baby)	The signal not greatly quality in a strong of light intensity through the finger.

Fig. 4: Finger probe positioning criteria

C. GSM SIM800A

SIM800 is a complete Quad-band GSM/GPRS solution in a SMT type which can be embedded in the customer applications. SIM800 support Quad-band 850/900/1800/ 1900 MHz, it can transmit Voice, SMS and data information with low power consumption. With tiny size of 24*24*3mm, it can fit into slim and compact demands of customer design. Featuring Bluetooth and Embedded AT, it allows total cost savings and fast time-to-market for customer applications.

D. Wi Fi Module

ESP8266 can be used as an external Wi-Fi module, using the standard AT Command set Firmware by connecting it to any microcontroller using the serial UART, or directly serve as a Wi-Fi-enabled micro controller, by programming a new firmware using the provided SDK.

The GPIO pins allow Analog and Digital IO, plus PWM, SPI, I2C, etc.

This board has been around for almost a year now, and has been used mostly in IoT contexts, where we want to add connectivity for example to an Arduino project. A wide adoption has been facilitated by the very modest price, ranging from 2.50 to 10 USD depending on the features offered by the manufacturers.

E. Open IOT Platform

ThingSpeak is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB code in ThingSpeak you can perform online analysis and processing of the data as it comes in. Some of the key capabilities of ThingSpeak include the ability to:

- Easily configure devices to send data to ThingSpeak using popular IoT protocols.
- Visualize your sensor data in real-time.
- Aggregate data on-demand from third-party sources.

The ESP8266 has a full TCP/UDP stack support. It can also be easily configured as a web server. The module accepts commands via a simple serial interface. It then responds back with the operation's outcome (assuming everything is running correctly). Also, once the device is connected and is set to accept connections, it will send unsolicited messages whenever a new connection or a new request is issued.

V. SYSTEM DESCRIPTION AND PROCEDURE

I explained above that my project is sum of various components: photo sensor, Arduino Uno, Wi-Fi module, GSM module and IoT platform. The individual working of each components and their integration can be technically broken down into the following subtasks:

A. Interfacing of photo sensor with Arduino Uno

We are going to interface a Photo Sensor with Arduino**.** The photo sensor we are going to use is a plug and play heart rate sensor**.** This sensor is quite easy to use and operate. Place your finger on top of the sensor and it will sense the heartbeat by measuring the change in light from the expansion of capillary blood vessels.in my project Arduino Uno interface with photo sensor, which count the detected heart beat rate by photo sensor. The counted data will also show on LCD screen which is also interface with Arduino Uno.

B. Interfacing of GSM module with Arduino Uno

There are two ways of connecting GSM module to Arduino. In any case, the communication between Arduino and GSM module is serial. So we are supposed to use serial pins of Arduino (Rx and Tx). So if you are going with this method, you may connect the Tx pin of GSM module to Rx pin of Arduino and Rx pin of GSM module to Tx pin of Arduino. GSM Tx –>Arduino Rx and GSM Rx – Arduino Tx. Now connect the ground pin of Arduino to ground pin of GSM module! So that's all! You made 3 connections and the wiring is over! Now you can load different programs to communicate with GSM module and make it work.

In my project I am using GSM module for alert message. When the counted pulse by Arduino will greater than 120 or below than 60 then an alert message send to the patient care taker.

C. Interfacing of Wi-Fi module with Arduino Uno

The ESP8266 is a low cost Serial-to-Wi-Fi module that interfaces nicely to any microcontroller. However, a word of caution -- it is highly undocumented (primary reason for writing this document), and more importantly, it is frequently updated and not backward compatible. The counted heart beat rate of Arduino Uno is uploading on the web page by using Wi-Fi module.

D. Flow chart of proposed model

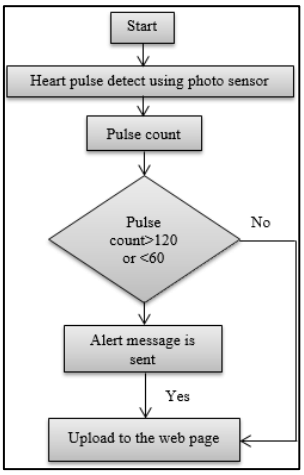


Fig. 6: Flow chart of proposed model

E. Circuit diagram of proposed model

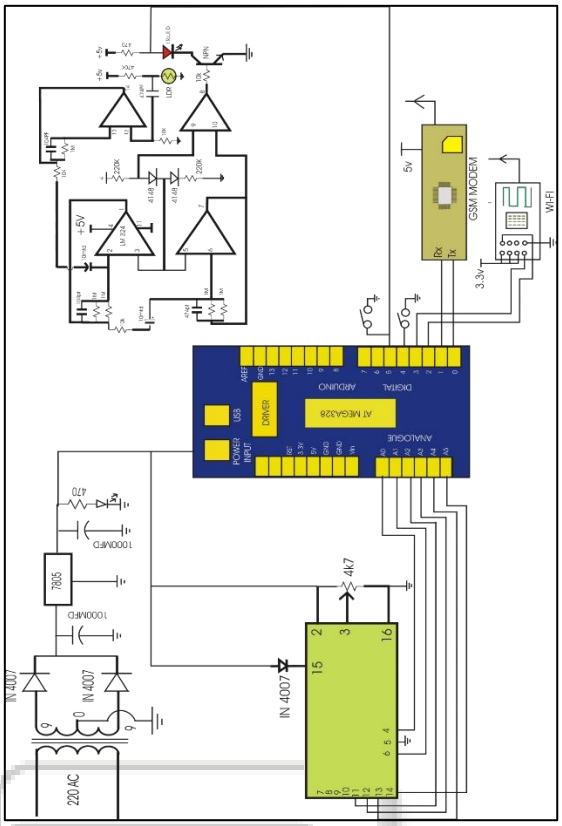


Fig. 5: Circuit diagram of proposed model

VI. Results

A. LCD Display

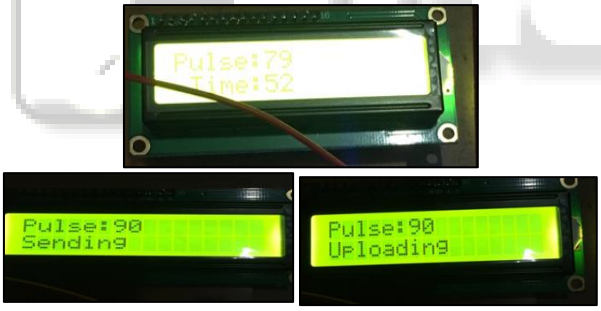


Fig. 6: LCD display

B. Think Speak Result

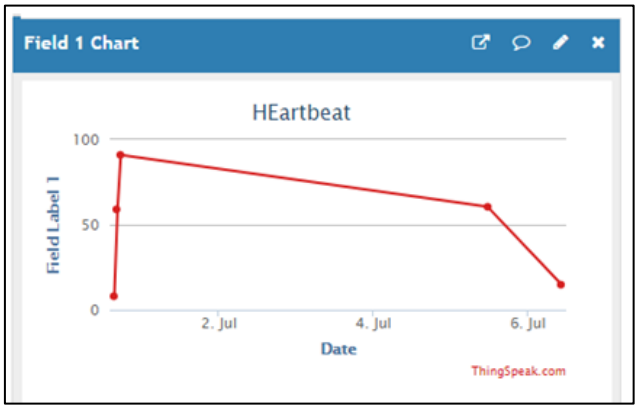


Fig. 7: Heart beat rate result

C. Complete hardware system of proposed model

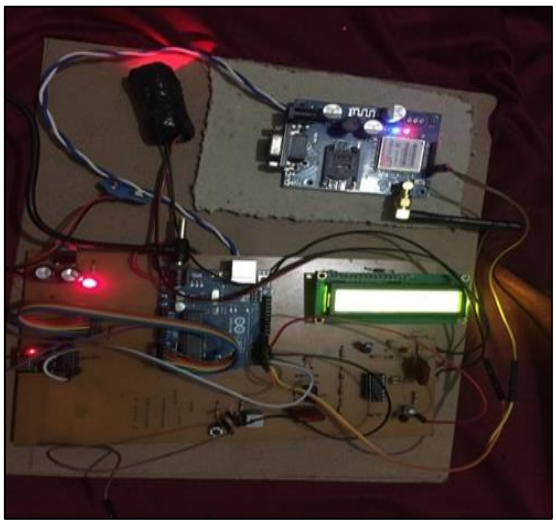


Fig. 8: complete hardware of project

VII. Conclusion

An efficient IoT based health monitoring system using photo sensor is developed to detect the heart beat rate of the patient and counted pulse uploaded on the web page. If the heart beat rate greater than 120 or less than 60 an alert message send to the doctor or care taker.

The system can be extended by adding more features to the mobile application like linking the ambulance services, leading doctor's list and their specialities, hospitals and their special facilities etc., Doctors can create awareness about diseases and their symptoms through the mobile application. From the evaluation and the result obtained from analysis the system is better for patients and the doctor to improve their patients' medical evaluation.

Acknowledgment

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