Blood Pressure Monitor

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Abstract - Measuring your blood pressure regularly is important, especially as it helps prevent diseases such as hypertension. Home monitoring is especially important if you have elevated blood pressure or another condition that could contribute to unbalanced blood pressure. Historically, traditional mercury Sphygmomanometers were used for blood pressure measurement. The mercury sphygmomanometer method is manual and mostly understood by expert. Later, Oscillometric devices often referred to as automatic devices are introduced; automatic blood pressure devices do not require observer participation beyond placing the cuff on the arm and noting the digital blood pressure readout. Presently, the arm placement can be done by anyone but what is most important is the result communication. The objective of this paper is to develop an automatic blood pressure device and enhance its capability by adding Global System for Mobile (GSM) communication component for communicating the result immediately by Short Message Service (SMS) directly to the health personnel's mobile phone, so that a health personnel can monitor a patient's blood pressure (BP) and pulse from a remote location without being physically present. This will help to increase a patient's vital monitoring through improved communication.

Keywords - Patient, Health, Blood Pressure, Doctor, Monitor, Microcontroller

I. INTRODUCTION

The accurate measurement and control of blood pressure are key elements in the prevention of cardiovascular disease and stroke. As for adults (18 years and older), Blood pressure (BP) between 90-119 mm Hg systolic and 60-79 mm Hg diastolic are desired, BP between 120-139 mm Hg systolic and 80-89 mm Hg diastolic is considered to be pre-hypertension condition, while elevated BP above 140 mm Hg systolic and 90 mm Hg diastolic is defined as hypertensive [1]. High blood pressure usually does not have any symptoms; therefore, we need to have our blood pressure checked by specialist regularly. Aged people or physically handicapped people and the people suffering from some serious diseases experience so much difficulty when they need to go out for even small tasks. It is therefore of paramount importance to employ a system for monitoring blood pressure remotely without compromising the ordinary daily activities.

This medical device is designed to be used in hospital facilities as well as residential apartments. However, the motivation behind this paper was inspired by the need for proper (timely & effective) communication for the remote use of this device so as to get doctor's intervention when due. It describes the development of an automatic blood pressure monitoring system with additional feature of GSM communication facility so that the doctor will be informed, and hence allowing for remote blood pressure monitoring.

II. CONCEPT

A. The system includes a device user (in most case is a doctor), the device and a patient.

Fig. 1

The blood pressure module with serial output reads blood pressure and heart rate and communicates at 9600 band rate. Blood Pressure & Pulse readings are shown on the liquid crystal display (LCD) with serial out for external processing and display. The local display shows Systolic, Diastolic and Pulse Readings. The GSM module is also embedded in the entirety of the system.

B. The system diagram below shows the three main part of the entire system.

Fig. 2 System Diagram

When the patient's vitals are collected by the sensors (input data), the data recovered is then processed by the device which houses the processor and converts it to readable

information (device process) before the doctor can take the required action based on the information received (doctor's action).

C. The state machine below shows the different state the BP device will be in at any point.

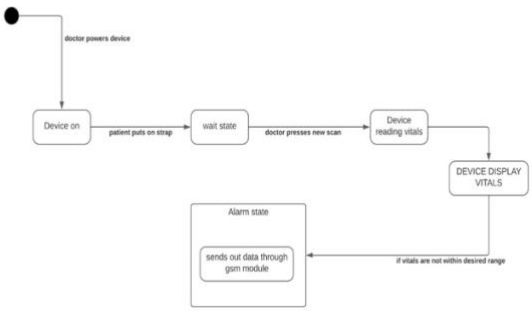

Fig 3. State Machine diagram

The system is first in a state of initializing when turned on and then a wait stage while the patient is being strapped. The system then enters a state where vitals are being read and converted and then a state of display and immediately enters the alert state which includes and alarm and data communication with the doctor involved. The alert stage is dependent on the outcome of the vitals. It only enters the alert stage if the result is not within a healthy range.

III. DESIGNING OF CONCEPT

Before doing the actual design of the blood pressure concept, we had to look into various factors that will affect the system design. These factors that were looked into are as follows:-

A. REQUIREMENTS

Functional

1) The system shall be able to process vitals efficiently collected
2) The system shall display information based on data received
3) The system shall operate in real time
4) The system shall alert the operator in the applicable scenario
5) The system shall execute commands promptly
6) The system shall drop a sound notification for the START/STOP feature
7) The system shall send out data to remote location when applicable

Non Functional

1) Reliabilty: The system should be able to function correctly at all times of usage.
2) Usability: The system should be able to be used and easy to navigate with high purpose of features
3) Performance: The system should be able to perform at high quality.
4) Design: The system should have a design that gives clear information and with easy user interface.

B. MODELS

1) Block Diagram: Figure 4 below shows a simple diagrammatic representation of the proposed system. The various hardware component involved and their relationship.

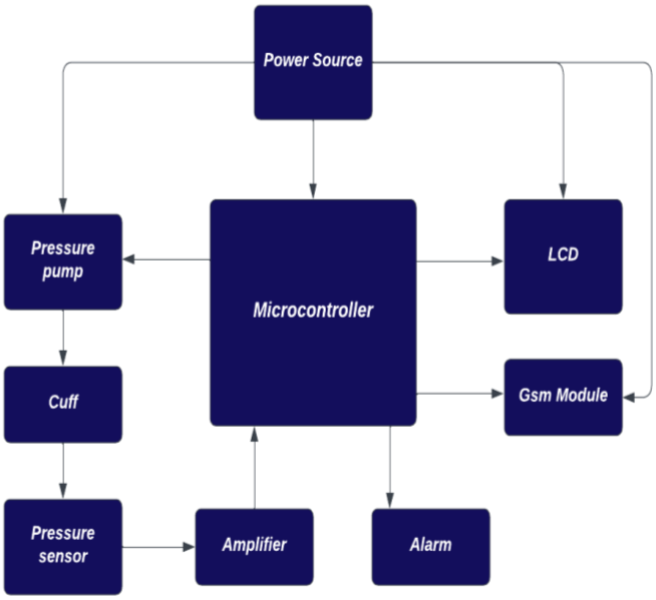

Fig. 4. Block Diagram

2) Use Case: This defines the interactions between the user (doctor) and the system.

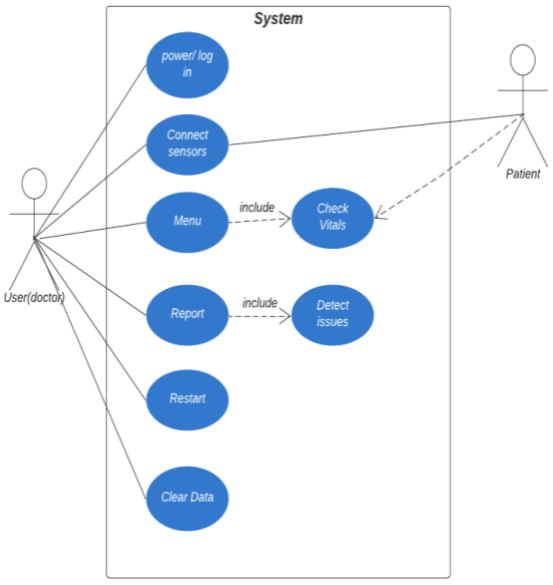

Fig. 5 Use case

3) Activity Diagram: This diagram illustrates the activity flow of the system. It further shows what happens if conditions are positive or negative.

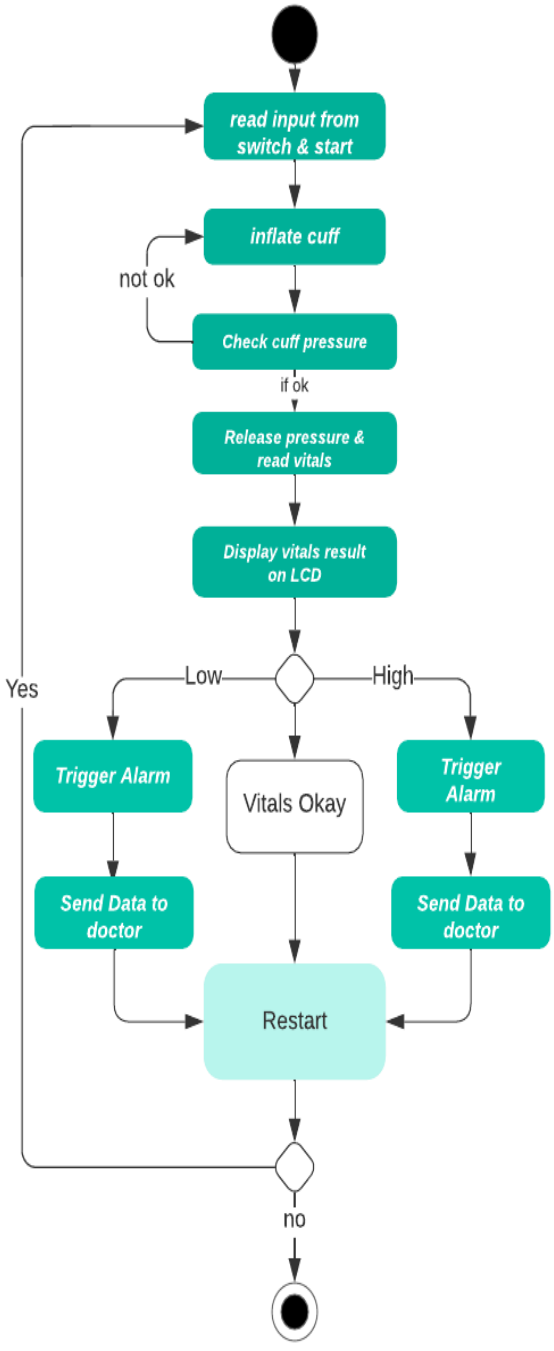

Figure 6. Activity Diagram

C. HARDWARE

The hardware used in order to achieve this design is as follows:

1) Pressure Sensors: The figure below shows a typical blood pressure sensor. It is usually installed in the cuff strap so cannot be seen in an every use of the system. It measures systolic and diastolic pressure utilizing the oscillometric method. The signal from the pressure sensor after collected in the first medium is then conditioned and amplified before data conversion by an analog-to-digital converter (ADC)

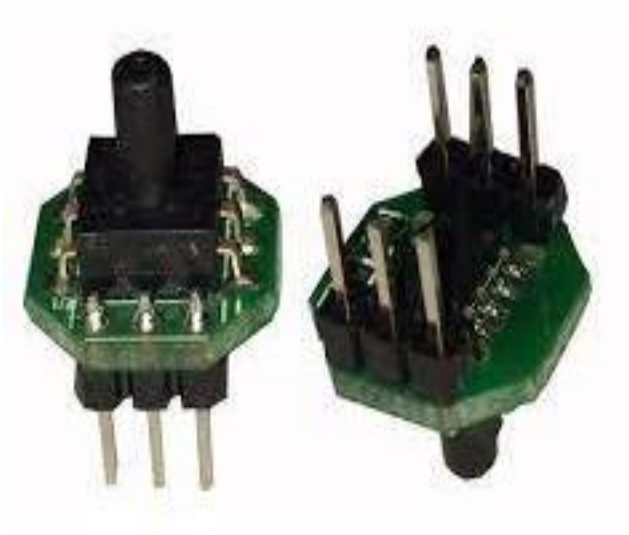

Figure 7. Pressure Sensor

2) Pulse Sensors: The pulse sensors are resposible for capturing thr heart rate. In this design structure, it is embedded in the cuff strap also.

Figure 8. Pulse Sensor

3) Microcontroller: a microcomputer on a single integrated circuit containing a processor, memory, and programmable input/output peripherals. PIC 16F877A is one of the most advanced microcontrollers. This controller is widely used for experimental and modern applications because of its low price, high quality, and ease of availability.

Figure 9. Microcontroller

4) LCD display screen/User interface – The LCD screen is responsible for display processed information from the information read from the patient. The User Interface which is attached to the LCD in most cases allows the user to operate the device with the necessary instruction to carry out.

Figure 10. LCD Screen

A 2x16 LCD is used to display the result. LCD (Liquid Crystal Display) screen is an electronic display module. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. Figure below shows how the LCD has been interfaced with the microcontroller.The 8 pins of port B of the PIC microcontroller are used for interfacing the data pins of the LCD, the R/W pin is connected to ground (0V level), the register select (RS) and Enable (EN) pins are connected to pin 28 (RD5) and pin 30 (RD7) of the microcontroller respectively

5) GSM Modem –GSM (Global system for mobile) uses a process called circuit switching to establish a path between two devices. Once the two devices are connected, a stream of digital data is conveyed between them.The GSM modem used in this device is SUNROM SIM 900D [2] shown in figure 11 below

Figure 11. GSM Modem

6) Speaker:

This basically provides notifications. One very important notification is the alarm function. This serves as an alert if the patient's reading does not fall within the acceptable range. The Pro Series Patient Monitor Speaker Assembly is utilized in this project

Figure 12. Speaker

7) Battery Source: A 5v lithium rechargeable battery will be compatible and serve as power even during a DC outage

Figure 13. Battery

8) Inflation Presuure Pump : This 5v DC pump is responsibble for inflating the cuff to a certain pressure level.

Figure 14. Pressure Pump

D. CRITICAL-BASED PART OF THE SYSTEM

- This part of the design takes care of failures and system redundancy. Taking a critical look at possible redundancy scenarios, we are most likely going to have most possible failure in the part of the microcontroller. In other to tackle such occurrence in data processing, we will implore the integration of a secondary microcontroller connected as a fail safe for the primary microcontroller.

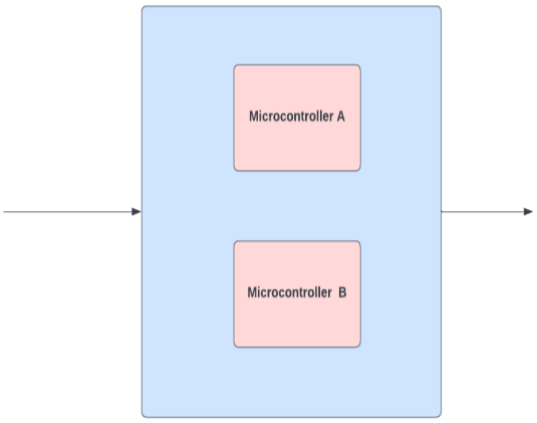

Figure 15. Microcontroller redundancy

- The system will be able to make use of a direct power source and will also have a rechargeable battery system as fail safe in case of power outage during use.

E. USER INTERFACE

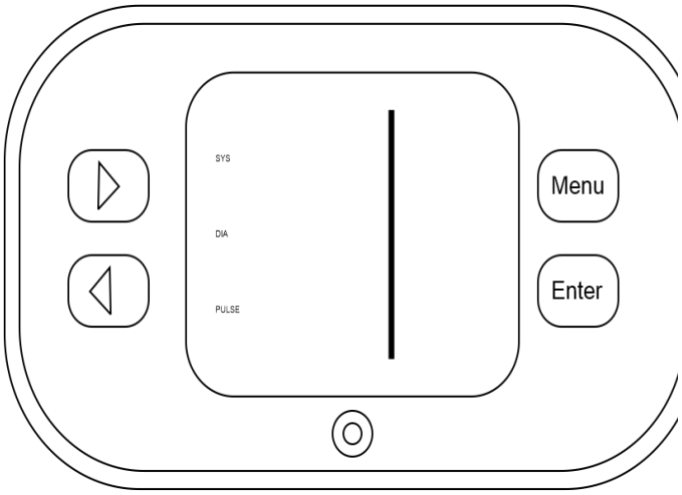

Figure 16. User Interface

The figure above shows the line sketch of the User Interface for the system It has been designed to meet functional and non-functional requirements as stated earlier in this paper. It shows the section for which the systolic (SYS), diastolic (DIA) and pulse rate (PULSE) will be displayed on the LCD. It also has buttons for navigation and interaction with the system.

Figure 17. Display Info

IV. DISCUSSION

The system works on principle of fully-automated blood pressure monitoring system to measure and display systolic and diastolic pressures and pulse rate, then send the result to the healthcare or caregiver by SMS on GSM communication protocol. When the device is started the microprocessor initializes the memory, LCD and GSM module and feed SMS format into memory. "BLOOD PRESSURE MONITOR" is displayed on the LCD to inform the user that the device is ready. When the ON button of the Blood pressure module is pressed, the cuff attached to the module automatically inflates and deflates gradually to take the measurements, and then display the result on local display attached to the module. The result is then communicated to the microcontroller via serial communication. The microcontroller display same result on the LCD (main display) and simultaneously transmits same to GSM modem which then send it by SMS to a predefined phone number (healthcare and caregiver contact numbers) for remote monitoring of the patient's blood pressure (health condition).

This solves the initial problem of prompt remote communication as the doctor or health care worker might not always be stationed with the patient to monitor his/her vitals.

Improvements, however, were made on the usability requirement as previous design of the user interface did not allow for easy interaction with device. Also, the aspect of redundancy also played a role in the improvement of the system as it handles possible failures of the system.

Another important target of this design is to minimize the cost of the developed system.

V. CONCLUSION AND FUTURE WORK

Microcontroller based fully-automatic blood pressure monitor with GSM communication is implemented in this paper. The system allows health personnel to monitor a patient's BP and heart rate from a remote location without requiring the physician to be physically present to take the measurements. Therefore, this proposed system can be practically used for remote monitoring of the patient blood pressure. The current implementation can be further improved. Future improvements to the system may include; a real time clock so that the date and time of recording can be sent along with the data and a keypad to change the recipient number when desired

ACKNOWLEDGMENT

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