Blood Pressure Measuring Device Embedded with SMS Capabilities

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Abstract – ***The current blood pressure measuring device in the market has the functions to display the blood pressure, heart beat rate and save the obtained data in the device memory. But so far, there is no development yet to this device where these obtained data can be sent to other people for records. Thus, this paper presents the development of a blood pressure measuring device that is embedded with SMS capabilities.***

Keywords – blood pressure, measuring device, sms, embedded system.

1. INTRODUCTION

Modern health care experts know that a patient's blood pressure is a good indicator of how healthy a person is. A high blood pressure reading indicates stress and possible heart problems and this is where the blood pressure measuring device is very important [1].

A high blood pressure patient can be considered as an outpatient if the illness is not critical. Thus, this device is very important for outpatients who are under an ambulatory care from doctors where only once in a while checkup is needed.

Ambulatory care is any medical care delivered on an outpatient basis [2]. High blood pressure patients do not require hospital admission unless the illness is in critical condition; otherwise, it can be managed without admission to a hospital. Medical treatments for high blood pressure patients can be performed based on the daily test results of blood pressure measurement. This is not just beneficial for the patients but also the doctors where they can monitor their patient's current condition health even though the patient is living at home and not under the doctor's direct supervision in the hospital.

1.1. Background of Study

Blood pressure measuring device is a device that can measure user's blood pressures and heart rate through an inflatable hand cuff. This device is important to monitor daily blood pressure for patients with high blood pressure illness. This device is also important to ensure patients to be aware of their current blood pressure readings.

The blood pressure measuring device consists of three main parts: the external hardware (such as cuff, motor, valve, and LCD), analog circuit, microcontroller and a GSM modem. The analog circuit converts the pressure value inside the cuff into readable and usable analog waveforms. The MCU (Microcontroller Unit) will sample the waveforms and performs the A/D conversion so that further calculation can be made. The MCU also controls the operation of the devices such as the button and the LCD display.

1.2. Problem Statement

The current blood pressure measuring device so far only has the functions to display the blood pressure and heart beat rate and also they can save the data obtained in the memory inside the device.

So far in the market, there is no development yet to this device where these obtained test data can be sent to other people for records. This is essential especially to doctors or loved ones who cares and curious for the well being of the high blood pressure patients.

1.3. Objective

The objective is to develop the blood pressure measuring device so that the daily test results obtained can be sent to other people via the Short Messaging Service (SMS). This is beneficial for doctors to keep track of the patient's daily health when they are under ambulatory care.

1.4. Scope of Study

The scopes of the project are:

- Understand the "oscillometric method", the process and how it works.
- Understand the existing pressure measurement method and how that can be developed and implemented in the project.
- Understand the GSM modem and how they work so that SMS can be sent to mobile phones by using this modem.

2. LITERATURE REVIEW

2.1. Blood Pressure Device

The current blood pressure measuring device manages to measure the blood pressure and heart beat rate. Most clinics and hospitals are using the conventional way of measuring the blood pressure which is by using the stethoscope.

Usually when doctors measure patient's blood pressure, air is pumped into the cuff and uses the stethoscope to listen to the sounds of the blood in the artery of the patient's arm. At the start, the air is pumped to the above systolic value. At this point, the doctor will hear nothing through the stethoscope. After the pressure is released gradually, at some point, the doctor will begin to hear the sound of the heart beats. At this point, the pressure in the cuff corresponds to the systolic pressure.

After the pressure decreases further, the doctor will continue hearing the sound (with different characteristics). At some point, the sound will begin to disappear. This is where the pressure in the cuff corresponds to the diastolic pressure. The systolic and diastolic pressure can be seen in figure 1.

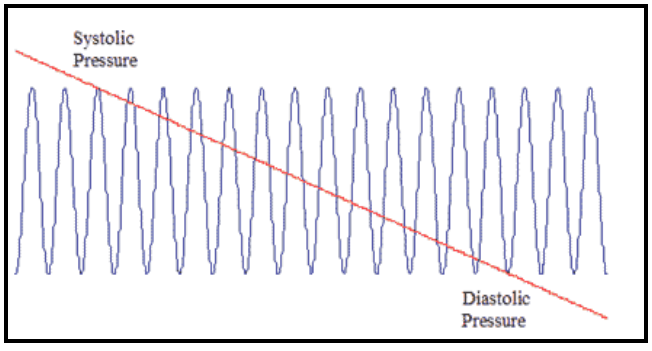

Figure 1. The systolic and diastolic pressure measurement [3]

In this project, hearing the sound would not be used since it is replaced by a pressure transducer that is built-in in the designed device and stethoscope is not used.

2.2. SMS Technology Used

2.2.1. Hypertext Processor (PHP)

PHP or Hypertext Processor will be the language for developing the system [4]. PHP is being used wisely to develop commercial software by many developers. It is chosen as it has low maintenance and development cost. It is also an open source and can be downloaded from the internet. It can support many databases including MYSQL. MYSQL will be the database for this system. The other reason of choosing PHP is that the integration with Ozeki (SMS Server) is relatively easier using PHP compared to JAVA.

2.2.2. Windows

Windows is the platform for running this system. Firefox is used due to its simplistic in its security configuration choices. Windows can also support most hardware and software. Most of the software or hardware in the market is compatible with Windows. Many source open applications (such as Mozilla Firefox browser) are also compatible with Windows) [5].

2.2.3. SMS

Short Messaging Service (SMS) will be the notification medium for this system since it is being used world wide and becomes a common technology. People prefer to text rather than emails because it is an efficient technology that can be used anytime and anywhere.

SMS can be a fast information transmission medium as it can be access whenever user wants it. But SMS has words limitation. Only simple or short information can be transmitted using this text message. In this project, that would not be a problem since data sent is not long.

2.2.4. Group System for Mobile Communication (GSM)

GSM is being selected to be used in this project as it is cheaper to be implemented and has a wider service distribution network. Cost for project development can be reduced using GSM. GSM is chosen based on these criteria:

- Widest service distribution network and choice of hand phone.
- Low cost entry hand phone.
- Lower subscriber acquisition cost.
- International roaming.
- Easy subscription process.
- Data transfer speed up to 9.6 kbit/s.

3. METHODOLOGY

3.1. Overall System Flow Chart

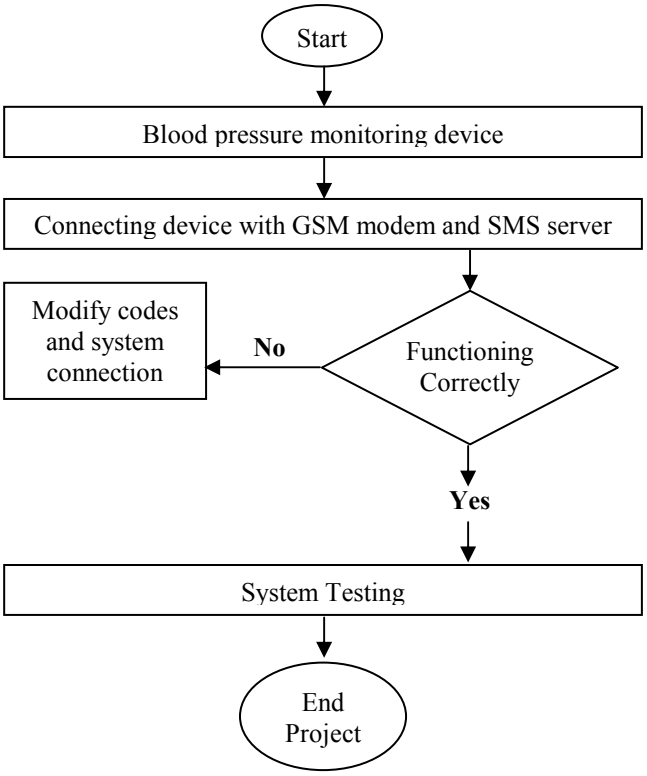

Figure 2. Overall System Flowchart

Figure 2 shows the overall system flow chart. First, the blood pressure is connected with the GSM modem and the SMS server. If the system is functioning incorrectly, the process will be repeated. If the system is functioning, then it will continue with the system testing and end up with the end user acceptance testing (test to check the end user receives the information in the SMS form).

3.2. Blood Pressure Measurement

There are two measurements that can be carried out using the device, which are the systolic and diastolic pressures.

Systolic pressure is the maximum pressure exerted by the blood against the wall of the brachial artery when the heart beats.

Diastolic pressure is the minimum pressure exerted by the blood when the heart beats. Lastly is the measurement of the heart rate. Figure 3 shows the systolic and diastolic pressure when the blood pressure measurement is done [6].

Here is how the systolic blood pressure can be obtained. The artery induced pulsations are different. When the artery compresses, no pulsation is perceived by the device, and then when the pressure decreases in the cuff, the artery starts to emit pulsations. The pressure that has been measured on the device defines the maximal blood pressure which is the systolic pressure.

Then, when the pressure decreases in the cuff, the oscillation will become increasingly significant, until maximum amplitude of these oscillations defines the average blood pressure. The oscillations can still be seen during the decrease of the pressure in the cuff until they disappear. The pressure then will read on the device that defines the minimal blood pressure (diastolic pressure) [6].

There are two methods of the measurement that can be used to measure the blood pressure, i.e., ascultatory and oscillometric method. By comparing these methods, the oscillometric method is chosen due to its accuracy.

The oscillometric method measures the mean pressure and derives the systolic and diastolic pressures. Almost all blood pressure monitoring devices nowadays are using this method due to its accuracy [7]. Fig. 3 shows the flow of measurement of the oscillometric method in detail.

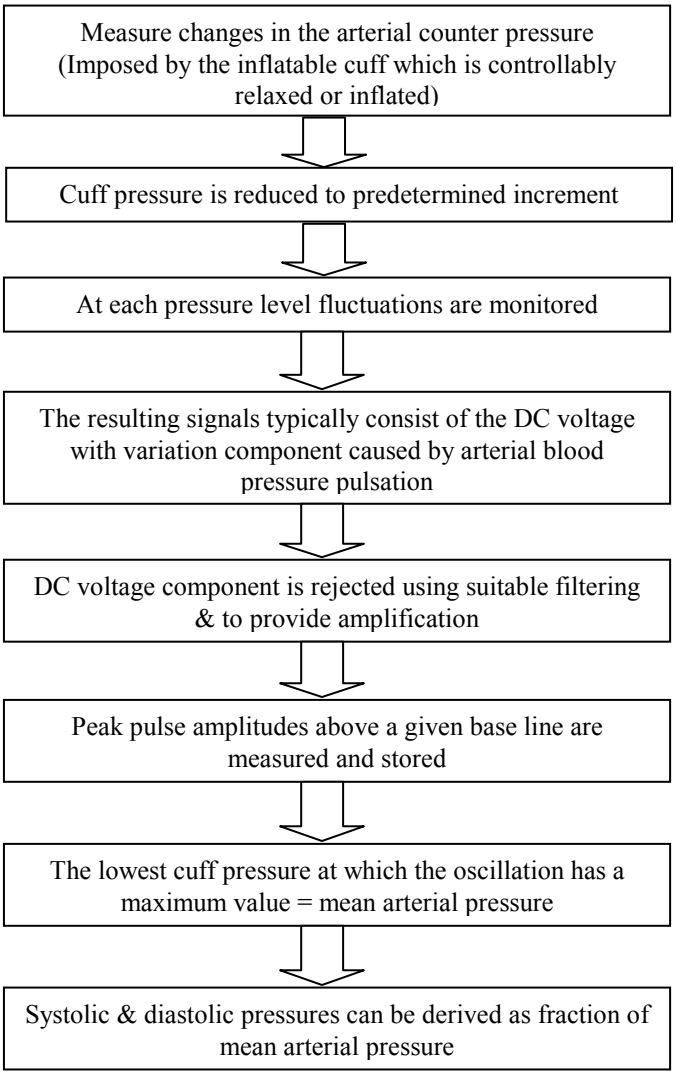

Figure 3. Oscillometric Method Flow of Measurement [8, 9]

4. RESULT AND DISCUSSION

4.1. Blood Pressure Structure

Fig. 4 shows the system configuration of the project.

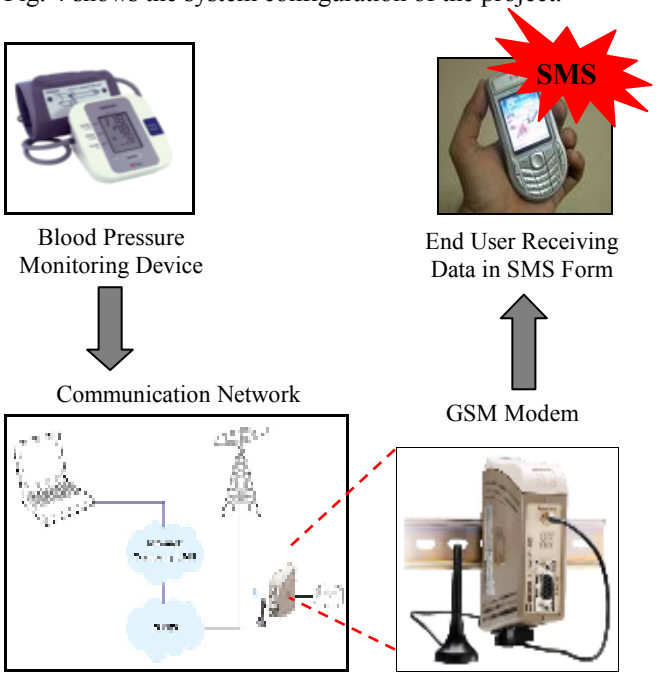

Figure 4. System Configuration [10, 11]

The system consists of three main parts: the external hardware (for instance the cuff, motor, valve, and LCD), analog circuit, microcontroller unit (MCU) and a GSM modem. Initially, the blood pressure monitoring device measures the systolic, diastolic and the heart rate. The device's operation is being controlled by the MCU.

Then test results obtained by blood pressure measuring device are then sent to others via the GSM modem on the network. This GSM modem captures message sent by the measuring device. The GSM modem used in this project is a standard GSM mobile phone with the appropriate cable and software driver and connected to the computer via serial port [12]. The modem is controlled by sending instructions called AT commands. These commands are standard commands for modern connection. Lastly, the data end receiver is the mobile phones and data received is in the form of a Short Message Service (SMS).

Figure 5 shows how the device is operated. The user will use buttons to control the operations of the whole system. The MCU (microcontroller unit) is the main component that controls all the operations such as motor and valve control, A/D conversion and calculation, until the measurement is completed. The results then are displayed at the LCD (Liquid Crystal Display) screen for the user to see.

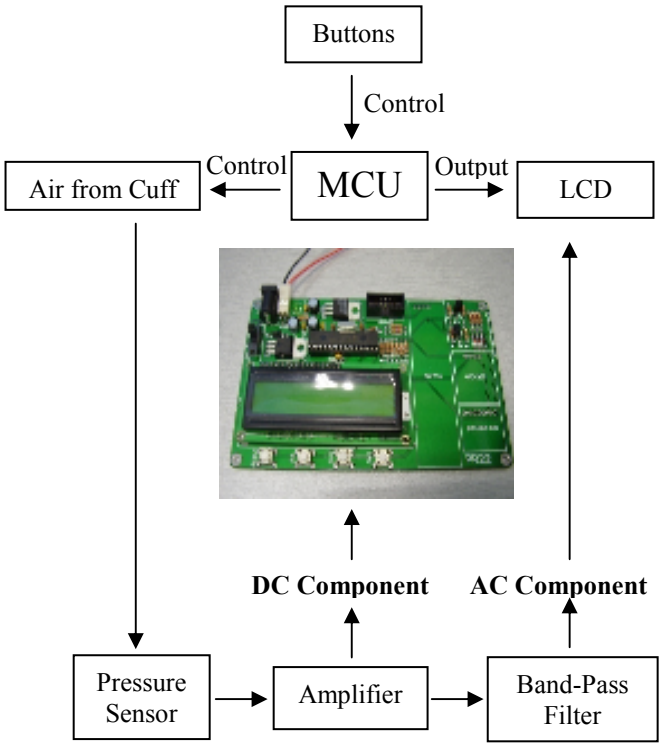

Figure 5. System Hardware Diagram

Figure 6 and 7 shows the analogue circuit which consisted of three parts which are:

- DC Amplifier
- Band-pass Filter
- AC Coupling Stage

The pressure transducer is used to sense the pressure from the arm cuff. This pressure transducer produces the output voltage proportional to the applied differential input pressure.

The DC amplifier is used to amplify both the DC and AC components of the output signal of pressure transducer so that further signal process by MCU can be done and data of user can be obtained. In this project, the arm cuff is pumped only until 160 mmHg (approximately 21.33 kPa). The values used are:

- Output Voltage : 0 to 4V
- Gain : 200

The signal then is passed on to the band-pass filter. The DC amplifier amplifies both the DC and AC component of the signal. This band-pass attenuates any signal that is out of the pass band. This AC component from the band-pass filter determines when to capture the systolic/diastolic and when to determine the heart rate of the user. The values used are:

- Gain : 1 – 4 Hz

The AC coupling stage is where this circuit is used to couple only the AC component of the signal so that it can provide the DC bias independently. The AC output from this stage is then passed on to the analog-to-digital converter in the microcontroller. The sine wave is produced during the analysis in lab.

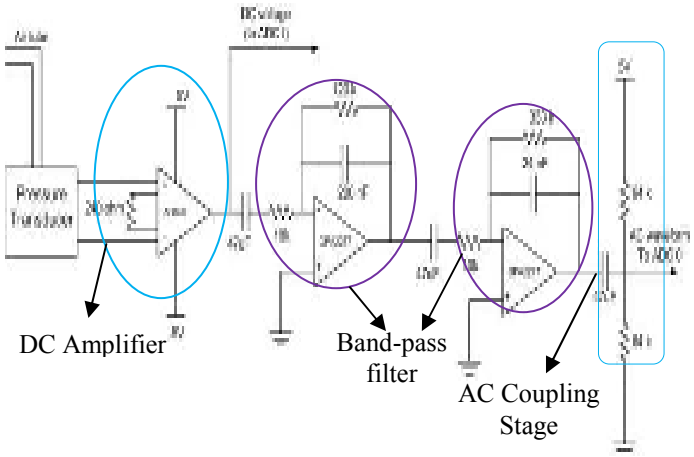

Figure 6. The Analogue Circuit Schematic

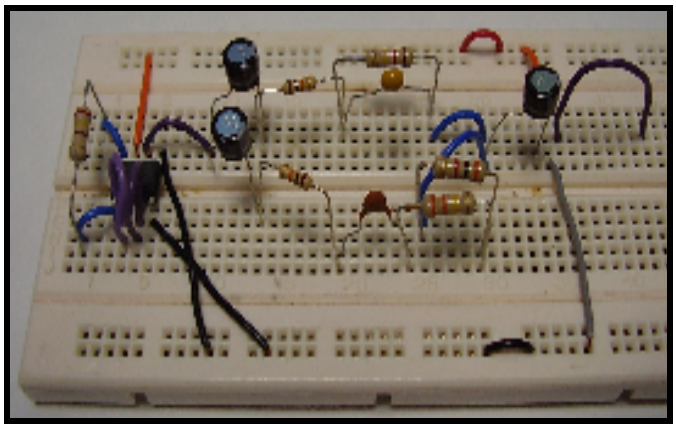

Figure 7. The Analogue Circuit

Figure 8 shows the interface for the pressure sensor interface. It uses PIC16F876A as the microcontroller unit (MCU). The function is to read the pressure transducer reading and display the reading on the LCD.

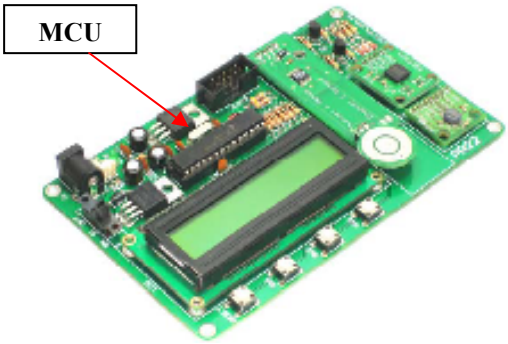

Figure 8. The Pressure Sensor Interface

4.2. SMS System Architecture

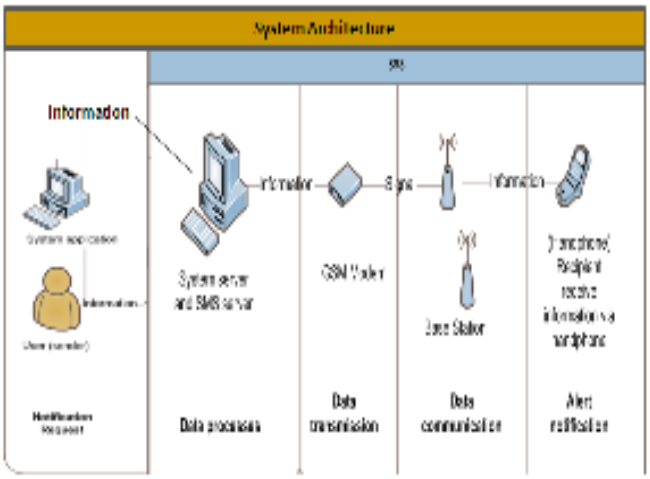

Figure 9. SMS System Architecture

Architecture is related to how the system is going to interact with other components. Figure 9 shows the system architecture for this project using SMS. User will interact with system interface as a medium for sending information to the respective receiver. From system server, information is transmitted to GSM modem. GSM modem will send data signal to base station. The base station will transmit the SMS to the receiver via hand phone.

5. CONCLUSION AND RECOMMENDATION

This paper has presented the design and development of a blood pressure measuring device that is embedded with SMS capabilities. The system could be improved further by incorporating additional on-line capabilities to record data.

6. ACKNOWLEDGEMENT

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