Programmable Microcontroller Based Systolic and Diastolic Blood Pressure Measurable, Comparable and Displayable System

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***Abstract*— "programmable microcontroller based systolic and diastolic blood pressure measurable, comparable and displayable system" is basically a system that can be implemented in a low cost and high accuracy basis that could basically measure systolic and diastolic blood pressure for a 0.1mmHg accuracy and this system will compare the measured values with the patient's normal/reference vales and if the patients in a danger zone, this system will be able to identify and alert the situation. The available systems to fulfil all these requirements are in a high cost rage of devices and in very large scale of size and complexity .The system that are in low cost range, are not very accurate and they are not intelligent to compare values too. This paper describes the analysis, design and implementation of the "programmable microcontroller based systolic and diastolic blood pressure measurable, comparable and displayable system". Furthermore this paper includes the formal framework to model such systems, analyses the proposed model responds to those pressure readings, and explains of the implementation of sensors, software and hardware to provide capability for building systems of this nature and demonstration of working system.**

***Index Terms*—Programmable, Microcontroller, Heart rate, Blood Pressure**

I. INTRODUCTION

It is defined that the Blood pressure is the force of blood against the walls of your arteries. Blood pressure is necessary to move the blood through your body so it can get to all the body's organs.

High blood pressure is known as the "silent killer" because it often has no symptoms. It causes Stroke, Heart attack, Kidney problems, Eye problems, even Death is possible. [1] According to S. Ford, J. Stephenson and S. Ford, Hypertension is one of the single biggest risk factors for coronary heart disease (CHD), which is the largest single cause of mortality in the UK. The incidence of hypertension and CHD increases with age. Over 50% of people over 65 in the UK have hypertension. Hypertension is a major risk factor for having a stroke, as well as a heart attack. [2] Expertise recommend people at risk or people who already have high blood pressure monitor it at home. [3] Doctor may recommend to monitor blood pressure at home if the patient have been diagnosed with pre-hypertension (Maximum systolic blood pressure between 120 and 139 mm Hg OR Minimum diastolic blood pressure between 80 and 89 mm Hg) or have been diagnosed with hypertension (systolic 140 mm Hg or above OR diastolic 90 mm Hg or above) or have risk factors for high blood pressure. [4] And the home monitoring blood pressure system should be intelligent, accurate, cost effective with simply controllable considered because this system will be basically used by the patients rather than expertise.

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II. AIM & OBJECTIVES

The overall aim of this system is to develop an intelligent device that will save lives of people who are above mentioned from the premature deaths due to problems and diseases related to blood pressure of human bodies.
Main objectives of the project are:

- Accurately Measure systolic and diastolic blood pressure of the human body.
- Compare that value with the patient's normal value.
- If the patient is in the danger zone, immediately alert.

III. METHODOLOGY

A. Blood Pressure Detection System

Usually when the doctor measures the patient's blood pressure, he will pump the air into the cuff and use 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 be above the 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). And at some point, the sounds will begin to disappear. At this point, the pressure in the cuff corresponds to the diastolic pressure.

Initially the air will be pumped into the cuff to be around 200 mmHg above average systolic pressure (about 120 mmHg for an average). After that the air will be slowly released from the cuff causing the pressure in the cuff to decrease. As the cuff is slowly deflated, we will be measuring the tiny oscillation from the heart rate measuring sensor. The systolic pressure will be the pressure at which the pulsation starts to occur. We will use the MCU to detect the point at which this oscillation happens and then record the pressure in the cuff. Figure 1 describes the proposed system to measure the systolic blood pressure.

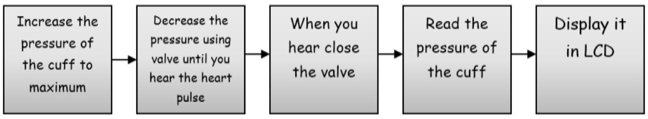

Fig.1: Block diagram of the proposed system to measure the systolic blood pressure

Then the pressure in the cuff will decrease further. The diastolic pressure will be taken at the point in which the oscillation starts to disappear. Figure 2 describes the proposed system to measure the diastolic blood pressure.

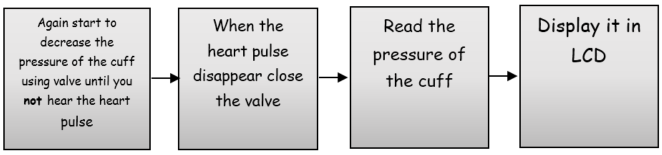

Fig.2: Block diagram of the proposed system to measure the systolic blood pressure

B. *Designs Blood Pressure Comparing and Indicating System*

The Blood Pressure and the Heart Rate Detection Systems have interfaced with PIC18F452 microcontroller and Figure 1 and 2 proposed methodologies to identify the instant blood pressure values has been programmed to the PIC microcontroller. The microcontroller will read the data it receives from the blood pressure detection system and check whether the instantly measured blood pressure measurement is specifically larger than the reference value. Reference values can be given by Reference Data Entering System such as Key pad and the data can be stored in the internal EEPROM of the PIC microcontroller .The Alerting System will indicated whether the patient is in a danger zone or not by comparing the instant blood pressure value and the stored Reference blood pressure value by using a Buzzer. Figure 2 describes the proposed system for the blood pressure detection. There are numerous number of Heart Rate Detection Systems that can be bought to implement this system. Please be noted to use a Heart Rate Detection Systems that can be read by the PIC microcontroller's TiMer_0 module or Analog_to_Digital_Converter module.

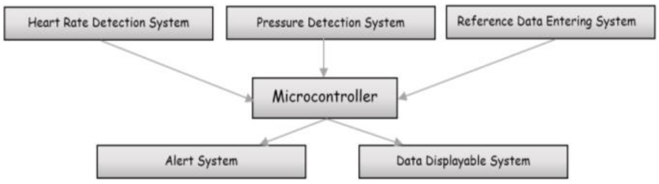

Fig.3: Block diagram of the proposed system for the systolic and diastolic blood pressure measurable, comparable and displayable system

IV. DESIGN

This chapter describes the hardware designing process of the blood pressure measuring system.

Fig.4: MPX5050BP

Figure 4 shows **MPX5050BP** pressure sensor has directly used to capture the air pressure inside the hand cuff. It is giving significant voltage that can be directly captured by the internal Analog_to_Digital_Converter module of the PIC microcontroller.

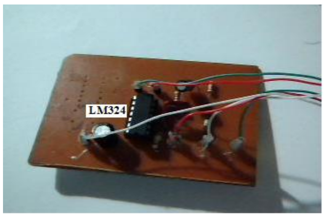

Fig.5: Blood Pressure Sensor test circuit

Figure 5 shows the test circuit that has been implemented to test the blood pressure of the human body. Pressure sensor circuit has connected to the **MPX5050BP** pressure sensor to amplify the analogue signal generated by the sensor according to the air pressure. While verifying the transfer function of the pressure sensor between air pressure and the output voltage**,** realized that the sensor is generating high and stable DC voltage that can be identified by the microcontroller. So for the final circuit **MPX5050BP** has directly connected with the microcontroller without an amplifier circuit.

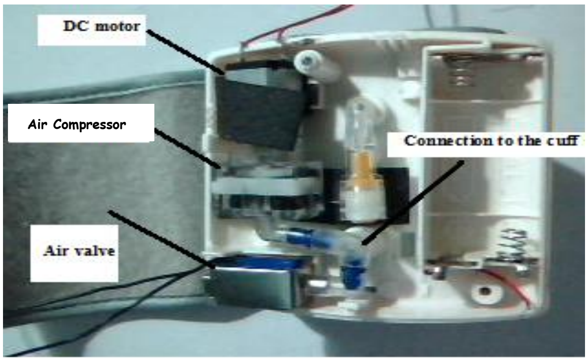

Fig.6: Pneumatic system to measure blood pressure

Figure 6 shows the actual hardware of the blood pressure detection system. This was pneumatic system that has been used to control the air pressure of the cuff by using AC motor with an air compressor and air valve while reading the heart rate of the patient.MPC5050BP pressure sensor has been used to measure the air pressure of the air lines with the assumption of the particular air pressure is equal to the air pressure inside the cuff and also the blood pressure inside of the blood vane at the hand.

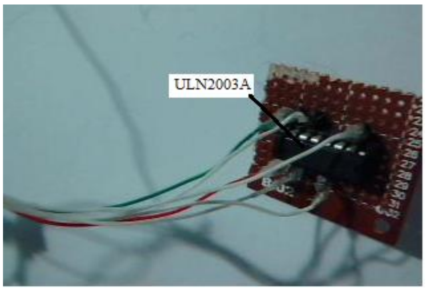

Fig.7: DC Motor driver test circuit

Figure 7 shows the motor driver circuit with **ULN2003A** to drive DC motor for the purpose of pumping air to the cuff using PIC microcontroller. **ULN2003A** will protect the microcontroller from a back EMV generated by the DC motor while its rotating. There is a small air valve also to release air in the cuff. Those motors and valves will control the air pressure in the cuff according to the heart rate measurements.

V. RESULTS

Initially checked whether the system is measuring and displaying accurate blood pressure Measurements. And the system has worked perfectly as shown below.

Table I : Blood Pressure Measurement Process Testing

Observation	**Reading**
	Systolic Blood Pressure
	Diastolic Blood Pressure

Then checked whether the system is storing patient reference data at the EEPROM and even the system ON and OFF those data still remaining at the EEPROM. And the system has worked perfectly as shown below.

Table II : Reference Information Blood Pressure Data Acquisition System Observations Testing

Reference Information to Save	**Saved information in EEPROM**
	
	

Finally checked the patient danger zone alerting process of the system. And the system has worked perfectly as shown below.

Table III : Patient Danger Zone Alerting Process Testing

Reference Blood Pressure of the Patient	**Current Blood Pressure of the patient**	**Alerting Status**
		Buzzer On
		Buzzer On

VI. COSTING

NRE (Non Recurrent Engineering) Cost Calculation for the system as follows.

Table IV : NRE (Non Recurrent Engineering Cost) for the final system

Component	**Cost Rs**
PIC18F452	550
ULN2003A	25
MPX5050DP, DC MOTOR, VALVE	2500
BUZZER	100
LCD	325
4X4 KEY PAD	214
9V BATTARY	150
HEART RATE DETECTION SYSTEM	500
	4274+OTHER
TOTAL	**Around 4500/=**

VII. CONCLUSIONS

Following objectives defined at the proposal has been successfully achieved:

- Measure systolic and diastolic blood pressure of the human body.
- Compare that value with the patient's normal/reference value.
- If the patient is in the danger zone, immediately give that message.

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This system can be further improved by adding heart rate measurement and comparison capabilities. And also by automatically sending a SMS to doctor when the patient is in a danger zone. These will make this system more smart and improve the volubility of the device too.
This type of a system can reduce number of incident deaths that happened due to less considerability of the health conditions.

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