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# SMART DEVICE FOR DYNAMIC BP MEASUREMENT

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***Abstract*—** In home care systems, self monitoring of Blood pressure signals can be transmitted for further analysis during emergency medical situations. In this paper, we have designed a wearable Blood pressure measurement device with intelligent emergency support using android app. We have named the Android application as "DYNAMIC BP APP". It comprises of components such as microcontroller, blood pressure sensor, DC motor, Relay valve and air chamber. High blood pressure is a serious condition that causes damage to heart and other organs and increases the risk of heart attack and stroke. The proposed system offers the advantage of providing description about health available in both English and other regional languages.

***Keywords --*** Bio medical, Dynamic Blood pressure Measurement, Android app, Instantaneous measurement

## I. INTRODUCTION

Blood Pressure (BP) is the heart beats, it pumps blood around your body to give it the energy and oxygen it needs. As the blood moves, it pushes against the sides of the blood vessels. The strength of this pushing is your blood pressure. If your blood pressure is too high, it puts extra strain on your arteries (and your heart) and this may lead to heart attack and strokes. Blood pressure is usually refers to the arterial pressure in the systemic circulation. Blood pressure is usually expressed in terms of the systolic (maximum) pressure over diastolic pressure and is measured in millimeter of mercury (mm of Hg). Blood pressure fluctuates from minute to minute and normally shows a circadian rhythm over a 24 hour period, with highest readings in the early morning and evenings and lowest readings at night. Loss of the normal fall in blood pressure at night is associated with a greater future risk of cardiovascular disease and there is evidence that night-time blood pressure is a stronger predictor of cardiovascular events than day time blood pressure. Various factors, such as age and sex, influence a person's blood pressure and variations in it. In children, the normal ranges are lower than for adults and depend on height. Reference blood pressure values have been developed for children in different countries, based on the distribution of blood pressure in children. As adults age systolic pressure tends to rise and diastolic tends to fall. Also, an individual blood pressure varies reactions, sleep, and digestion. Difference between left and right on blood pressure measurements tend to be random and average nearly to zero if enough measurements are taken. However, in a small percentage of cases there is a consistent difference greater than 10mm Hg which may need further investigation. The risk of cardiovascular disease increases progressively above 115/75 mmHg. In the past, hypertension was only diagnosed if secondary signs of high arterial pressure were present along with a prolonged high systolic pressure reading over several visits. Regarding hypotension, in practice blood pressure is considered too low only if noticeable symptoms are present. Mean arterial pressure is the average over a cardiac cycle and is determined by cardiac output (CO), Systemic vascular resistance (SVR), and central venous pressure (CVP). Systolic pressure: The blood pressure when the heart contracts, specifically the moment of maximum force during the contraction. This happens when the left ventricle of the heart contracts. Diastolic pressure: The blood pressure between heartbeats, when the heart is resting and dilating (opening up, expanding).

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## II. DIGITAL BLOOD PRESSURE MEASUREMENT

Oscillometric measurement devices use an electronic pressure sensor with a numerical readout of blood pressure. In most cases the cuff is inflated and released by an electrically operated pump and valve, which may be fitted on the wrist (elevated to heart height), although upper arm is preferred. Initially the cuff inflated to a pressure in access of the systolic arterial pressure, and then the pressure reduced to below the diastolic pressure. Once the blood flow is present, but restricted, the cuff pressure will vary periodically in synchronous with cyclic expansion and contraction of the brachial artery. The values of systolic and diastolic pressure are computed from the raw data, using an algorithm. The classification of blood pressure and Blood
Pressure chart by age shown in table 1 and table 2 respectively.

Table 1 classification of blood pressure

| **Category** | **Systolic(mm of Hg)** | **Diastolic(mm of Hg)** |
|---|---|---|
| Hypotension | < 90 | <60 |
| Desired | 90-119 | 62-79 |
| Pre hypertension | 120-139 | 82-89 |
| Stage 1 Hypertension | 140-159 | 92-99 |
| Stage 2 Hypertension | 160-179 | 100-100 |
| Hypertensive Urgency | >=180 | >=110 |
| Isolated systolic hypertension | > =160 | < 90 |

Table 2 Blood Pressure Chart by Age

| **Age** | **Min** | **Normal** | **Max** |
|---|---|---|---|
| 1 to 12 months | 75/50 | 90/60 | 110/75 |
| 1 to 5 years | 80/55 | 95/65 | 110/79 |
| 6 to 13 years | 90/60 | 105/70 | 115/80 |
| 14 to 19 years | 105/73 | 117/77 | 120/81 |
| 20 to 24 years | 108/75 | 120/79 | 132/83 |
| 25 to 29 years | 109/76 | 121/80 | 133/84 |
| 30 to 34 years | 110/77 | 122/81 | 133/84 |
| 35 to 39 years | 111/78 | 123/82 | 135/86 |
| 40 to 44 years | 112/79 | 125/83 | 137/87 |
| 45 to 49 years | 115/80 | 127/84 | 139/88 |
| 50 to 54 years | 116/81 | 129/85 | 142/89 |
| 55 to 59 years | 118/82 | 131/86 | 144/90 |
| 60 to 64 years | 121/83 | 134/87 | 147/91 |

## III. SYSTEM OVERVIEW

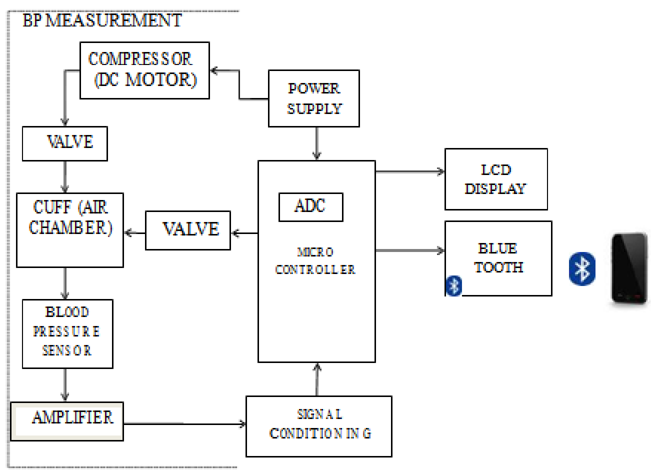


Figure 1 Overall block diagram

The functioning of this device starts from BP measurement that gives high and low BP. The overall block diagram shown in figure 1. The procedure involves the pumping of the air from the chamber into the tube that blocks blood for limited time. In case of high BP Korotkoff of sound is produced the sound is to gradually decrease that gives low BP value. Results will be displayed on LCD which can be even like a watch. Development of this App consists of five pages namely main page, help page, display page with graph, description about health and emergency page. If a patient having BP is in a serious condition, app will give missed call or message to the relations or family members. Thus, this App could be a life saving service. This proposed system was shown in Figure 2

Figure 2 Dynamic BP APP

### *(1) Systolic Pressure Measurement*

After the motor pumps the pressure up to 160 mmHg which is approximately more than the systolic pressure of normal healthy people, the cuff starts deflating and the program enters Systolic Measure state. In this state, the program will looks at the AC waveform from ADC0 pin. When the pressure in the cuff decreases to a certain value, the blood begins to flow through the arm. At this time if we look at the oscilloscope, we will see the onset of the oscillation. The systolic pressure can be obtained at this point.

The way we program this is that we set a threshold voltage of 4V for the AC waveform. At the start, there is no pulse and the voltage at the ADC0 pin is constant at approximately 2.5 V. Then when the pressure in the cuff decreases until it reaches the systolic pressure value, the oscillation starts and grows. We then count the number of pulses that has maximum values above the threshold voltage. If the program counts up to 4, the program enters the Systolic call state. At this state, the program records the DC voltage from pin ADC1. Then it converts this DC voltage value to the pressure in the cuff to determine the systolic pressure of the patient.

From the transfer characteristic of the pressure transducer and the measured gain of the DC amplifier, we can determine the systolic pressure by looking at the DC voltage of the ADC1 pin. We will explain the conversion procedure here. Let's the DC voltage that we read off of the ADC1 pin be ‘DC voltage', and the gain of the DC amplifier be ‘DC gain'. Then the differential voltage that comes out of the DC amplifier is calculated as

$$\text{Voltage} = \frac{\text{DC voltage}}{\text{DC gain}}$$

Calculate the pressure based on the voltage. The slope of the typical curve is calculated as.

$$\text{Slope} = \frac{40\text{mV}}{50\text{KPa}}$$

Thus, the pressure in the cuff in the unit of kPa can be calculated as.

$$\text{Pressure (KPa)} = \frac{\text{voltage}}{\text{slope}}$$

Then we can convert the pressure back to mmHg unit by multiplying by.

$$\frac{760\text{mmHg}}{101.325\text{kPa}}$$

Thus the pressure in the mmHg unit is expressed as.

$$\text{Pressure mmHg} = \text{Pressure KPa} \times \frac{760\text{mmH}}{101.325\text{KPa}}$$

Combining these conversions all together, we obtain the formula for converting the DC voltage to the pressure in the cuff as.

$$\text{Pressure mmHg} = \frac{\text{DC output}}{\text{DC gain}} \times 9375$$

After the program finishes this calculation, it enters the Rate measure state to determine the pulse rate of the patient.

### *(2) Pressure Sensor*

The Sensor series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, particularly those employing a microcontroller or microprocessor with A/D inputs. This transducer combines advanced micro machining techniques, thin film metallization, and bipolar processing to provide an accurate, high-level analog output signal that is proportional to the applied pressure. The Blood Pressure versus voltage range shown in figure 3.

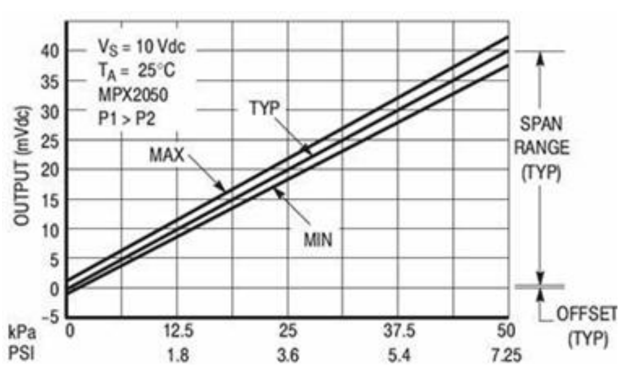


Figure 3 Pressure value versus Output

## IV. Flow Chart

### *4.1 Application (App) Processing Interface*

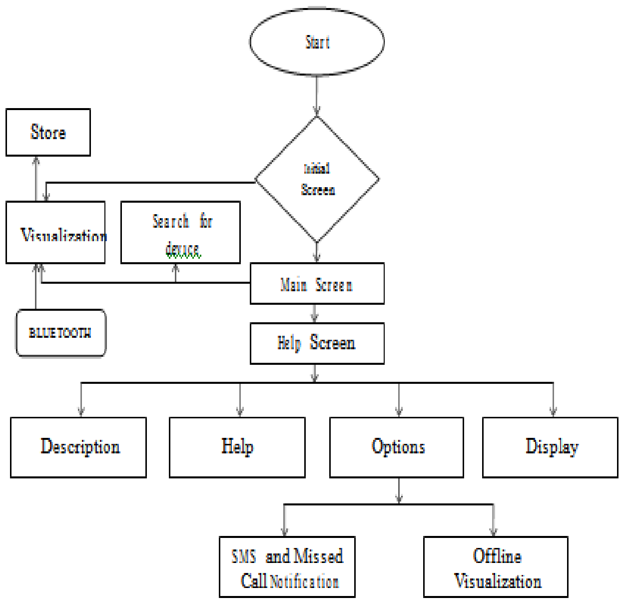


Figure 4 Mobile phone Interface

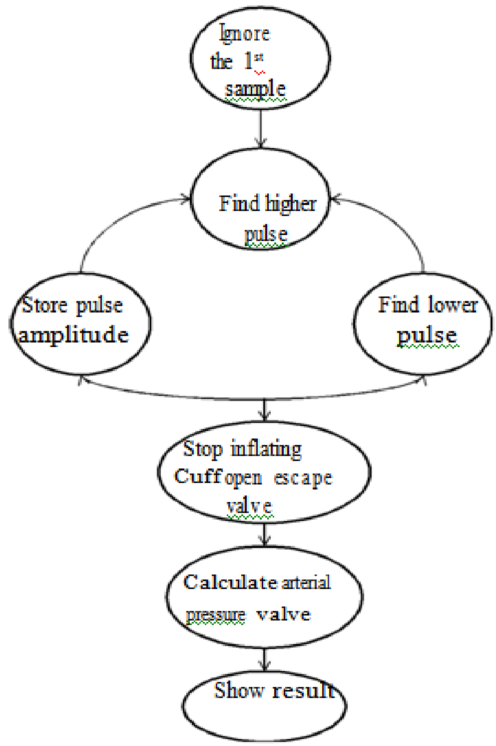


Figure 6 Hardware Interfacing Step 2

### *4.2 Hardware Interface*

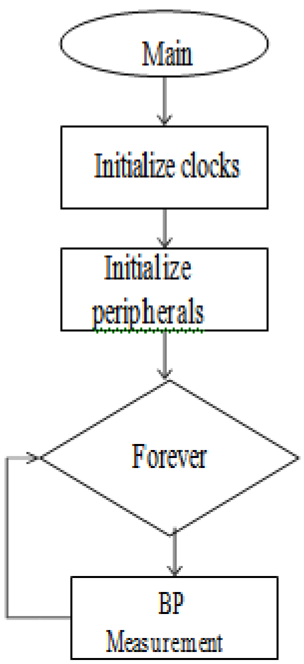


Figure 5 Hardware Interfacing Step 1

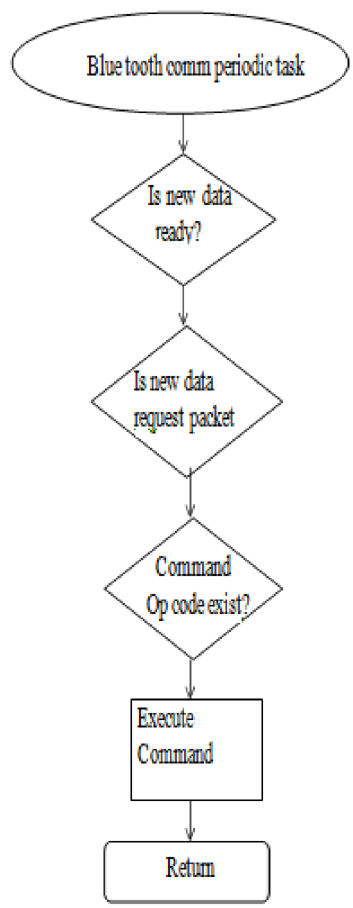


Figure 7 Hardware Interface Step 3

The above flow charts shows the process of the smart device. Flow chart in two ways Application (App) Processing Interface and Hardware interfacing shown in figures. Application (App) Processing Interface shown in figure 4. Hardware interfacing shown in figures 5,6 and 7.

## V. Circuit Diagram

The circuit diagram designed in the Dip trace software. This diagram mainly focus on the interfacing with the microcontroller. These comprise of the circuit of microcontroller interfacing with the Blood Pressure Sensor, Regulator circuit and Bluetooth module. The Circuit diagram to be shown figure 8.

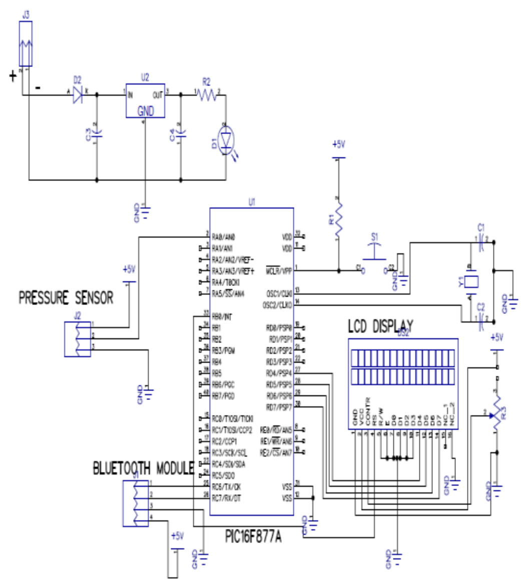


Figure 8 Circuit Diagram

## VI. Proteous Simulation

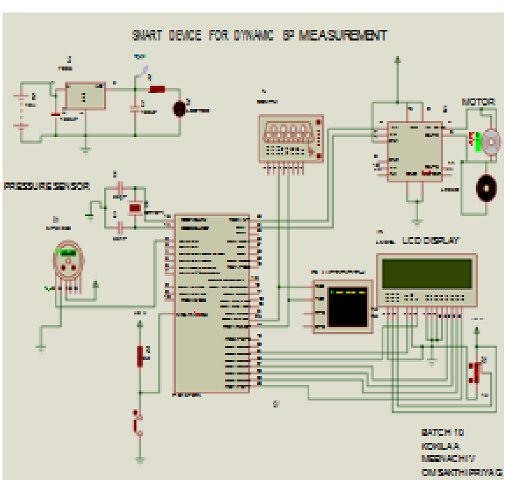


Figure 9 Proteous Simulation

The simulation diagram to be shown in figure 9. This simulation to be designed in the software Proteous. This diagram shows the interface of the microcontroller with the Bluetooth module. The simulation gives the output through program compiled by the CCS compiler.

## VII. Conclusion

We have arrived at a solution for the welfare of BP patients by a low cost, compact device with Android application by indicating and reporting of the instantaneous BP values. The concept of Self-monitoring of BP has been presented. Design and development of a low cost device with Bluetooth feature has been presented. New technology of wireless-Bluetooth monitoring is involved instead of USB Cables. It offers enormous advantages by using wireless connections. Cuff arrangement and handling problem are completely eliminated. The Blood pressure monitor works with the basic principle of oscillometric technique, with effectiveness in signal transmission is comparatively better as they are high powered signal carriers. The signal quality in the wrist to be high and very accurate.

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