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ARM Based Wearable Device for Blood Pressure,Weight and Temperature Measurement in Pregnant Woman

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Abstract:

Blood pressure monitoring has become significant in almost every aspect of life. In this paper, we developed an armband wearable system for 24-h Blood pressure measurement for pregnant women which helps to prevent a condition called preeclampsia. This paper also focuses on developing an arm band for temperature and weight monitoring for pregnant women .The aim is to monitor pregnant women during critical cases of preeclamsia which cannot be treated easily but instead prevented. Prevention can be done by constantly monitoring the weight and blood pressure of the person. The temperature sensor is being used to monitor and sense the temperature of the subject/pregnant women. It is therefore concluded from this study that the proposed wearable system has great potential to be used for 24hr blood pressure,temperature and weight monitoring . Most systems are available commercially and which are the subject of current research, are enclosed in small cases that can be attached to the body using bands or belts like wrist wearable, a private eye head mounted display and goggle glass.

INDEXTERMS:

ARM7LPC2148, BLOOD PRESSURE SENSOR (MVX10GP), TEMPERATURE SENSOR (LM35), LOAD CELL (CZL-601-AC), GSM Modem.

1.INTRODUCTION:

Scientific discoveries are being made every day that are changing the world we live in. From physics to medicine to biology, this contains some crazy innovations. Further advances in computing technology have helped with efficiency in the analytical chemistry laboratory in many ways.

The first one is automation and simplification of analytical and synthetic tasks, which includes the use of computer controlled technology and measurement system to improve the accuracy, repeatability and increased utilization of equipment. Recent enhancements in computing technology and low cost capabilities of computing trends have resulted in a new generation of automated analytical instruments. Further the huge development of microelectronics and embedded automation systems changing the way we work, and also making us to be free from tedious tasks.

• Blood pressure:

Blood pressure is the amount of force exerted by the blood against the walls of the arteries. A person's blood pressure is considered high when the readings are greater than 140 mm Hg systolic (the top number in the blood pressure reading) or 90 mm Hg diastolic (the bottom number). In general, high blood pressure, or hypertension, contributes to the development of coronary heart disease, stroke, heart failure and kidney disease.Although many pregnant women with high blood pressure have healthy babies without serious problems, high blood pressure can be dangerous for both the mother and the fetus. Women with pre-existing, or chronic, high blood pressure are more likely to have certain complications during pregnancy tha those with normal blood pressure. However, some women develop high blood pressure while they are pregnant (often called gestational hypertension).The effects of high blood pressure range from mild to severe. High blood pressure can harm the mother's kidneys and other organs, and it can cause low birth weight and early delivery. In the most serious cases, the mother develops preeclampsia - or "toxemia of pregnancy"--which can threaten the lives of both the mother and the fetus.

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Preeclampsia:

Preeclampsia is a condition that typically starts after the 20th week of pregnancy and is related to increased blood pressure and protein in the mother's urine (as a result of kidney problems). Preeclampsia affects the placenta, and it can affect the mother's kidney, liver, and brain. When preeclampsia causes seizures, the condition is known as eclampsia--the second leading cause of maternal death in the U.S. Preeclampsia is also a leading cause of fetal complications, which include low birth weight, premature birth, and stillbirth. There is no proven way to prevent preeclampsia. Most women who develop signs of preeclampsia, however, are closely monitored to lessen or avoid related problems. The only way to "cure" preeclampsia is to deliver the baby.Unfortunately, there is no single test to predict or diagnose preeclampsia. Key signs are increased blood pressure and protein in the urine (proteinuria). Other symptoms that seem to occur with preeclampsia include persistent headaches, blurred vision or sensitivity to light, and abdominal pain.

Be sure your blood pressure is under control. Lifestyle changes such as limiting your salt intake, participating in regular physical activity, and losing weight if you are overweight can be helpful.

• Body temperature:

Temperature is a measure of the degree of heat intensity. The temperature of a body is an expression of its molecular excitation. The temperature difference between two points indicates a potential for heat to move from the warmer to the colder point. The human body's core temperature varies from day to day, and from time to time, but these fluctuations are small, usually no more than 1.0°C. Humans are homoeothermic and body temperature is regulated at about 37°C ±1°C. The thermoregulatory center in the hypothalamus plays a very active role in keeping body temperature in the normal range. External and internal heat sources influence body temperature. Body temperature is maintained through a balance of the heat produced by the body and the heat lost from the body.

2. SYSTEM ARCHITECTURE

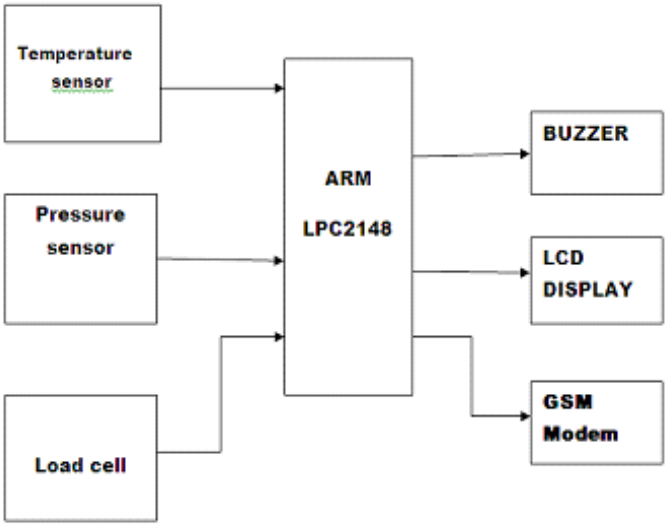

Fig 2.1 Architecture of the system

ARM (LPC 2148) :

ARM stands for Advaced RISC Machine developed by ARM Ltd which is most widely used in number of Embedded systems. Today ARM family accounts for approximately 75% of all embedded CPUs making it one of the leading architecture in the world. Previous designs used 8 bit/16 bit devices, but the designers are looking for highly integrated high performance ARM based 32-bit microcontroller. Heart of the design is ARM 32 bit RISC processor, hence brief description was given about its specifications below. The basic block diagram of the system is as shown in fig 3.1, the system shows the Fluctuation in the normal blood pressure and body temperature of the patient will be sensed by the Bp sensor and temperature sensor.

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The body temperature will be directly sent to the microcontroller by the LM 35 temperature sensor.The LPC2148 board consists of ARM7TDMI as its core and it is designed by NSK. ARM7TDMI family has good performance in situations where the energy consumption is critical design goal.

LPC2148 has ARM7TDMI as its core is called CPU core. The modules inside are connected by the CPU high performance bus called Advance High performance bus (AHB) and the peripherals are connected by VLSI peripheral bus (VPB) .

BLOOD PRESSURE SENSOR :

The blood pressure sensor used is MPVX10 and is used in place of manometer. The MPVX10 series piezoresistive transducer is a state-of-the-art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This patented, single element transducer combines advanced micromachining techniques, thin-film metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

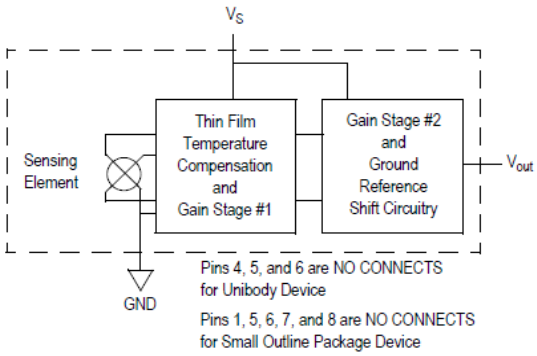

Fig 3.1 .Fully integrated pressure sensor schematic

NOMINAL TRANSFER FUNCTION:

Vout = VS (P x 0.018 + 0.04)
± (Pressure Error x Temp. Factor x 0.018 x VS)
VS = 5.0 V ± 0.25 Vdc.

Prototype :

Fig. 2 shows the experimental setup of the mobile BP measure device. The manometer is removed from a traditional sphygmomanometer and its tube connected to the pressure sensor on the PCB. The latter is encased in a free confectionary enclosure and interfaced to the arm kit lpc2148 using a standard cable. The final prototype has all the characteristics described in the methods section.

Fig3.2 prototype

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Temperature sensor :

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies.

LOAD CELL :

When the minimum weighing value (1 digit) is small compared to the rated capacity, the load cell output per digit should be above the input sensitivity of the indicator. Force applied onto the weighing pan is converted into electrical signals by the load cell and output to the indicator.
Suppose the specifications of the load cell are as follows:
Rated capacity: 6 kg
Rated output: 1 mV/V
Recommended excitation voltage: 10 V
When the rated output is 1 mV/V and the excitation voltage is 10 V, the load cell will output 10 mV to the indicator. This is the output voltage when the rated capacity of 6 kg is loaded.

(Load) 6 kg 10 mV (Output Voltage)

Load cell specifications must be checked to ensure that they satisfy the required accuracy of
measurement. The factors that influence the accuracy are nonlinearity, hysteresis error, repeatability, and temperature effects on zero balance and span. Recently, it is more common to express nonlinearity, hysteresis error, and repeatability together as the combined error.
When the required accuracy is represented as ε, one of the following formulas applies:
(1) If the combined error is specified in the catalog,

$$\varepsilon > \sqrt{\varepsilon_C^2 + \left(\frac{\varepsilon_Z \times L \times N}{W_1} \times t\right)^2 + (\varepsilon_S \times t)^2}$$

ε : Measurement accuracy of the load cell (%)

εC : Combined error (%)

εZ : Temperature effect on zero balance (%/°C)

εS : Temperature effect on span (%/°C)

L : Rated capacity of the load cell

N : Number of load cells to be used

W1 : Maximum load to be measured

t : Temperature variation range of the load cell (°C)

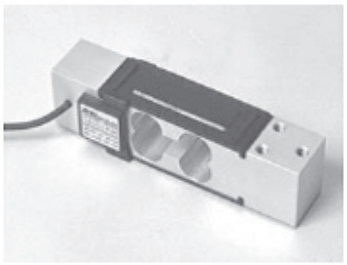

Fig 3.5 LOAD CELL

GSM Modem and Buzzer :

The GSM modem is used to send the text message to the given number in case the blood pressure becomes high and the buzzer is activated and gives a beep sound .
The GSM Modem used in the system is basically a sim900 piece and is used for sending the messages effectively.

The sim has to be placed in the slot available in the GSM Modem and interfaced to the microcontroller . An external power supply of 5V is to be given to the GSM Modem.

The buzzer is being already interfaced to the lpc2148 for buzzing sound to make the people alert in case of high blood pressure .

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3. PROPOSED MECHANISM:

The proposed project will overcome the drawbacks of the devices observed and therefore following modifications are done by replacing the devices. In the previous cases the sensors used were PPG sensor for temperature and blood pressure measurement and also electrodes were used for measuring the pulses and BP. The block diagram and the mechanism used will be improvised by some of the replaced methods from the recently implemented methods in order to make it more feasible and cost effective. The microcontroller atmega8 is replaced with ARM7 which has larger benefits from the previous implemented methods.Hence designing the signal conditioning interface based on the type of sensor such as pressure and temperature sensor. We simulate the circuits in proteus software to verify their accuracy. Therefore, the design will be useful for the patient monitoring systems which use microcontroller for interpretation before sending them to the doctor through mobile phone network assisted by GSM/GPRS modem.

SIMULATION RESULTS:

The algorithmic flow for generating the output is as follows:

- Start the program
- Let the initial values of temperature, pressure and weight be displayed on lcd.
- If temperature is interfaced then, temperature>= initial value
- If weight is applied then, weight >= initial value
- After the arm band is placed record the values of blood pressure and display it on lcd.
- If blood pressure < 110 , display as low temperature.
- If blood pressure >140 , display as high temperature.
- Next buzzer is active and beeps if pressure is recorded to be high.
- It sends the message to the given number using GSM modem.

FLOW CHART :

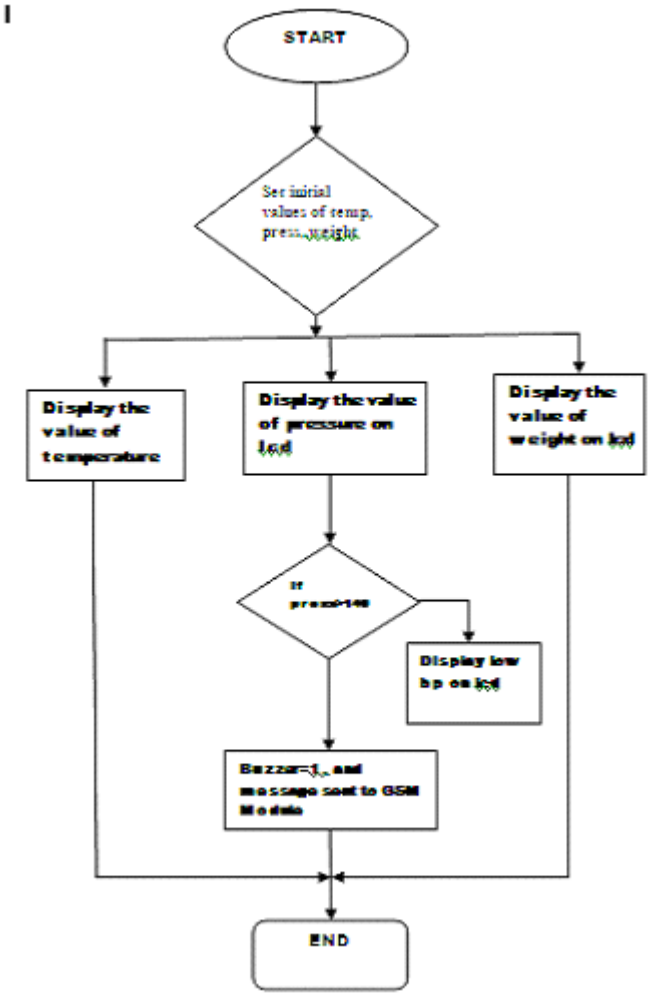

Fig 5.1 : Flowchart of the system

The process of checking the estimated values are displayed when the power supply is turned on.At first stage of the process, the values of temperature and weight are taken into consideration, later the temperature value is recorded in terms of fahrenheit as shown in fig. Then the reading are to be noted as per the lcd display.

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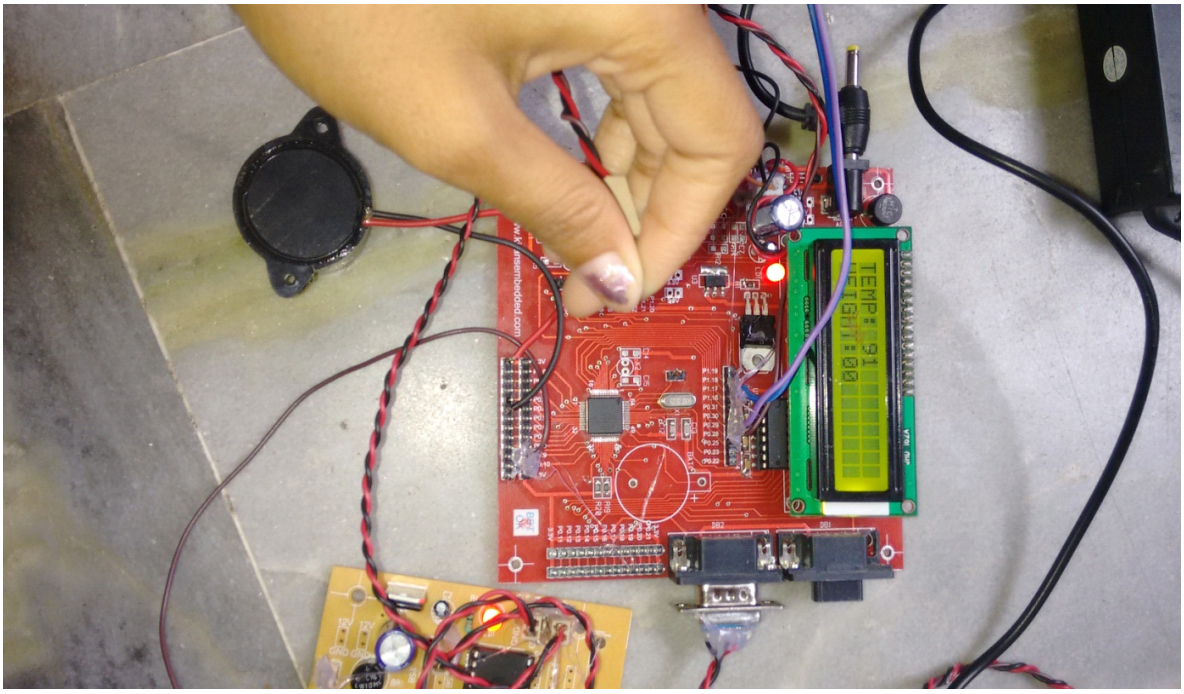

Fig5.2 : Temperature values

The temperature here obtained is usually in Farenheit and the displayed values can also be changed to Celsius values using basic formulas.The temperature sensor gives out the values in terms of Celsius which later the values have been programmed using conversion formula into Farenheit.

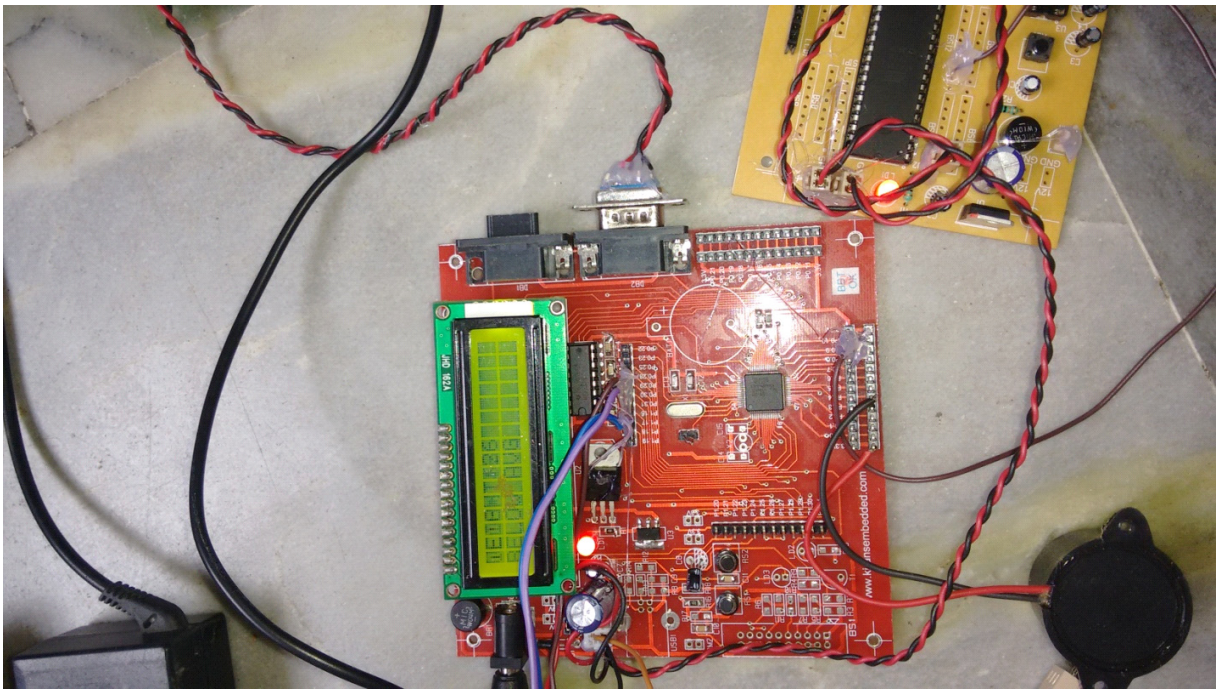

Fig 5.3 Weight is displayed on the screen

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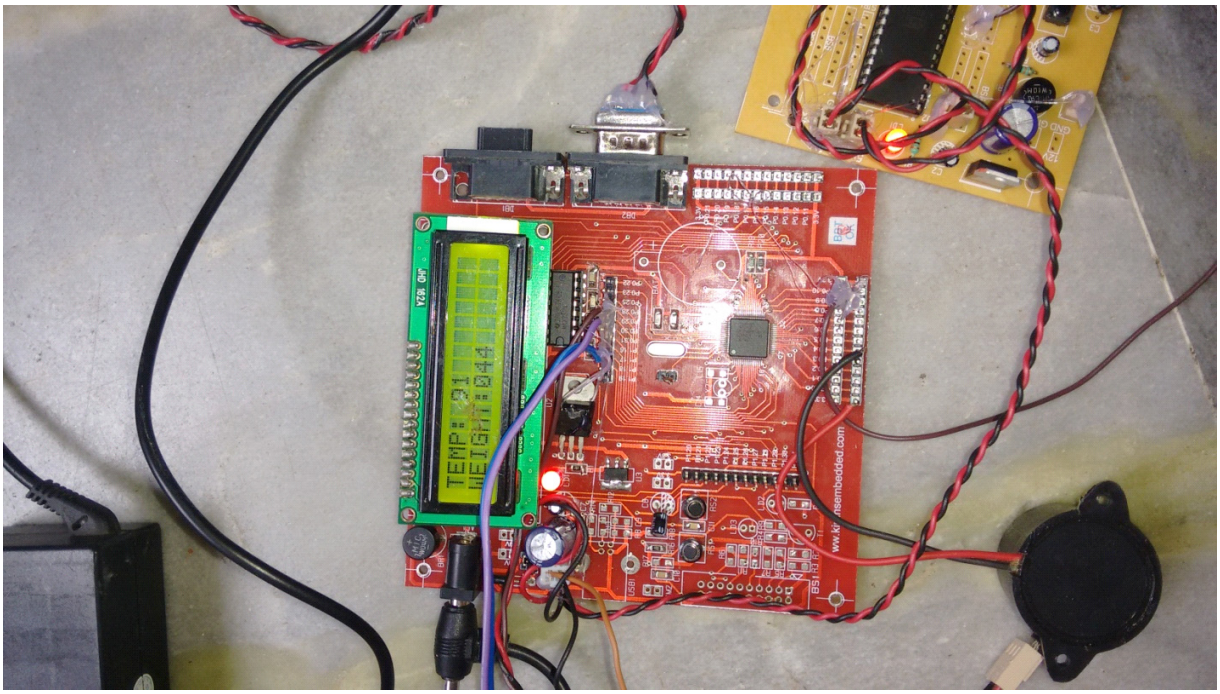

Later the weight of the human is recorded , when the weight is below 56 kgs. The weight will be displayed onto the lcd as below average.

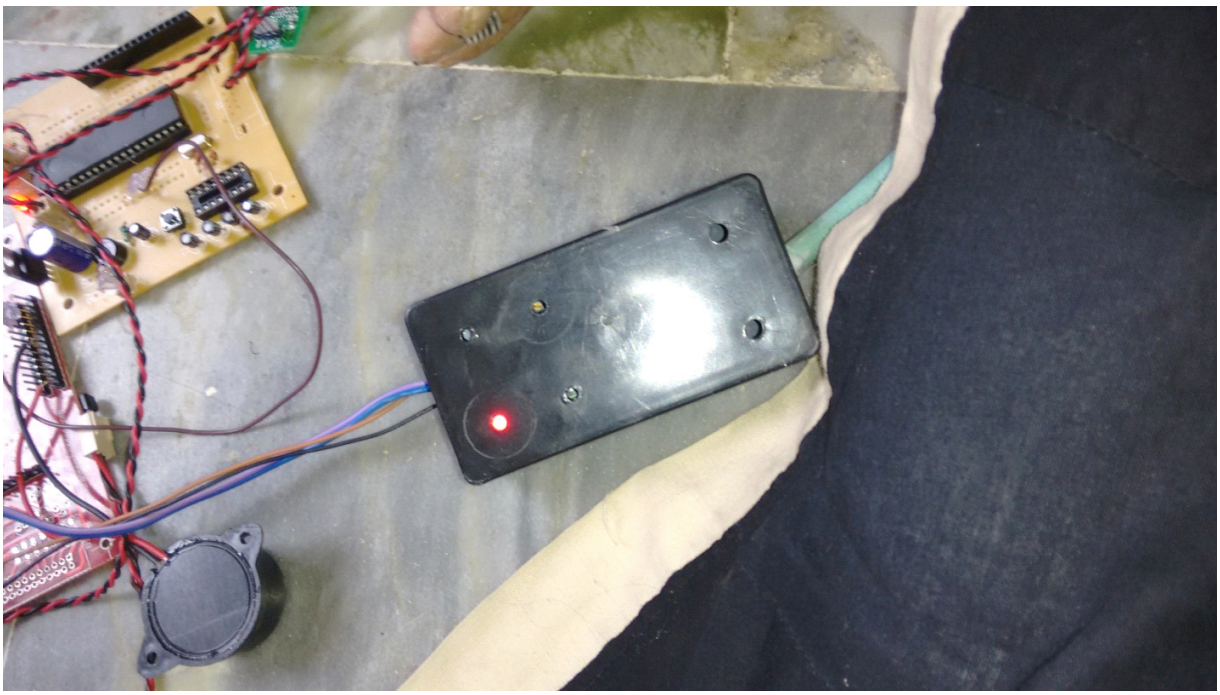

Fig5.4 BP INDICATOR

: The blood pressure will be measured when the red light is seen on the box,

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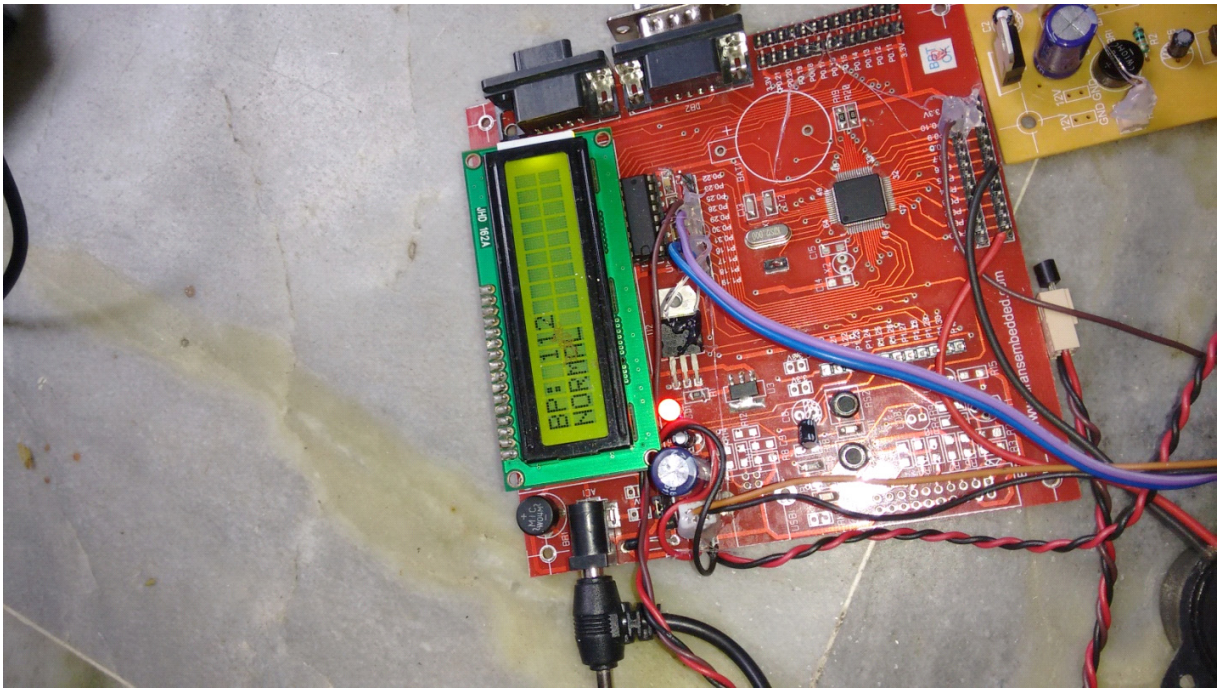

When the blood pressure goes high the message is sent to the number from gsm modem,

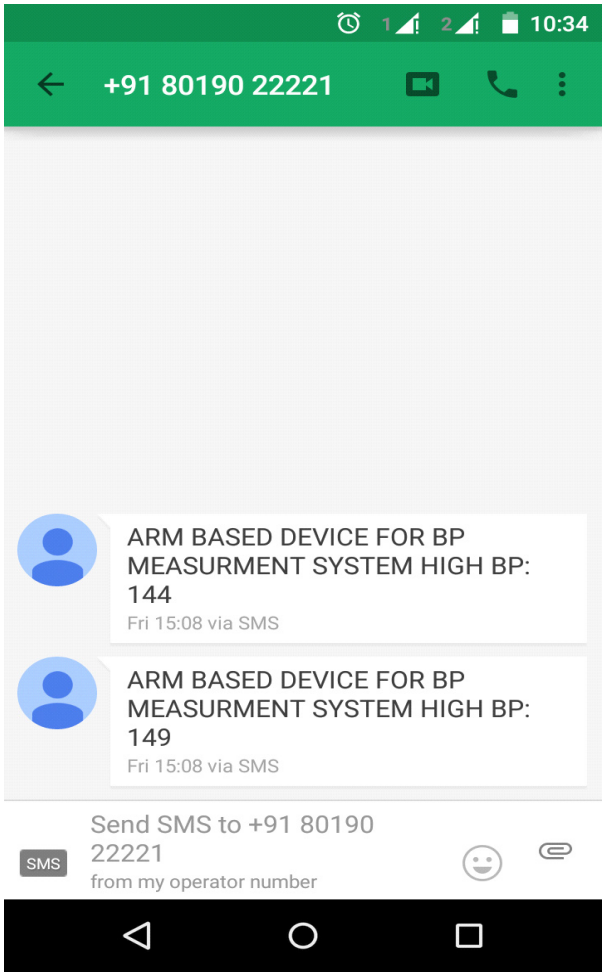

Fig . Message received on the mobile phone

The necessary precautions can be taken to reduce blood pressure when there is an issue of increased blood pressure and can be soon consulted to a doctor.

CONCLUSION AND FUTURE WORK:

The system designed hence provides accurate measurement of blood pressure, weight and temperature in case of pregnant women. This project is mainly built to constantly monitor blood pressure in pregnant women and take preventive measures against preeclampsia i.e. hypertension in pregnant women.

The strokes seizures in pregnant women can also be prevented known as eclampsia causing fetal complications and sudden death. The sensor parameters are used here to test the time to time daily basis temperature of the women at home based remedies for constant monitoring. These parameters will be sent to the doctor and patient's guardians through GSM / GPRS Modem.

There are many ongoing researches on patient monitoring system using GSM / GPRS and the main purpose behind these researches is to make this system more compact, easily available at affordable price. New technologies could also enhance the performance of the final project.

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