International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org
Volume 5, Issue 10, October 2016 **ISSN 2319 - 4847**

An Efficient Approach to detect Anastomosis: a skin burn using Thermistor

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ABSTRACT

Checking of proper skin flap placement operation in different degree burn condition is a very difficult task for doctors Pricking of the operated skin and by observing oozing blood doctors decides the good skin flap placement. This becomes a very painful testing for patient and doctors. A solution to this problem has been developed and presented here .A thermistor is used as a temperature sensor for the measurement of the skin temperature (i.e. normal skin) is made and then the temperature of the flap (or replaced skin) is measured. If the temperature of both the normal skin and flap is same then it indicate that the flap is properly attached. If there is deviation in both the temperatures then it can be indicated that the flap is not properly placed. Hence a system is developed which is less power, less costly and provides painless options for *anastomosis* ***i.e connecting two blood vessels with skin flap operation. An algorithm is developed which calculates temperature through software and indicated on LCD display. A thermistor array is developed to measure temperature of a lager region of our skin. A PIC microcontroller based system with RS232 based communication system has been developed and tested for real life. Less error indicates the success of the developed system. A computer interface will store a data of number of person for continuous checking of flap matching.***
Also the circuit is interfaced with computer using RS232 so as to have continuous monitoring of the patients skin temperature.

Key words: Anastomosis, degree of skin burns, Thermistor, Array of thermistor, Skin flap operation

1. INTRODUCTION

Normal human body temperature depends upon the place in the body at which the measurement is made, the time of day, as well as the activity level of the person. Commonly mentioned typical values of body temperature are:
Oral (under the tongue): 36.8±0.4 °C (98.2±0.72 °F)
Internal (rectal, vaginal): 37.0 °C (98.6 °F)

The body temperature of a healthy person varies during the day by about 0.5 °C (0.9 °F) with lower temperatures in the morning and higher temperatures in the late afternoon and evening, as the body's needs and activities change. Epidermal depth varies with body surface, which can offer varying degrees of thermal protection. Older adults and young children also have thinner skin. These points becomes important for doctors when burning occurs and skin need to be repaired, Hence accurate skin temperature becomes very important factor for doctors during skin flap operation in case of burnt condition. This condition is called as Anastomosis in burnt and avulsed patient. An anastomosis is a process of checking proper connection of blood vessels between healthy and damaged skin..

During burning condition, skin surface gets damaged depending upon degrees of burning. There are 4 degrees of burn specified by the doctors as first degree, second degree, third degree, forth degree depending on the depth of burn, temperature, duration of contact, blood flow to skin, and anatomic location. Anastomosis may be may be normal or abnormal, it may be natural or artificial. During different degree of burns, there may be a need to attach the flap of healthy skin on burned skin to reduce the scar and damage. Skin flap from buttocks or thigh is removed and placed on injured area in such cases. This is called skin flap reconstruction, a type of plastic surgery and Anastomosis is the procedure of joining these two skin flaps. It becomes very important to recognize whether the placement of flap is done properly or not. The success of surgery depends on joining of vessels of under tissues and reconstruction skin flap. The doctor checks the Anastomosis by pricking or scratching the reconstructed flap by needle and judged by colour of oozing blood. But, this procedure is very painful and cumbersome. So this issue is addressed in this paper with the measurement of the temperature difference between the normal skin and the flap. Because if the temperature of abnormal and normal skin remains same then doctors say that the flap is properly attached to our body and the blood vessels of both the areas below skin are properly connected. But, if both the (normal and burnt) skin temperature differs from each other then it is concluded by the doctors that the flap is not properly done. A methodology has been

developed and presented in this paper to measure the skin temperature using thermistor temperature sensor to detect the abnormal (the area of the skin which is flapped) skin temperature and normal skin temperature. Development of the system is presented stepwise.

2.THERMISTOR AS A SKIN TEMPERATURE SENSOR

Thermistors are used to measure the skin temperature as it is a semiconductor in which the resistance changes with temperature. A greater temperature coefficient makes thermistors more sensitive than wire resistance thermometers. The NTC type thermistors have non-linear characteristics but it is linear for the range of 25^{o}C to 50^{o}C, and skin temperature is also varying from 30 to max.50^{o}C.So thermistors are used as temperature sensor. The probe is created by making the array of these thermistors to cover larger skin surface area and monitor the skin temperature more precisely and accurately. Calibration of Thermistor probe has been done by varying the temperature of the probe by placing it in the pot whose temperature is changed from 0^{o}C(ICE bath) to 100 ^{o}C(with heating of water batch).This procedure helps in deciding the calibration factor for temperature calculations. Initially for calibration the resistance readings of thermistors at various temperature were taken along with thermometer readings, and the resistance of thermistor was verified using resistance datasheet. After building the circuit a thermometer is used for verifying whether circuit gives correct temperature or not. Thermometer and thermistor probes were used simultaneously so as to calibrate the circuit.

2.1THERMISTOR PROBES

In this system two thermistor probes has been developed as shown in fig 1. Each probe consists of five thermistors. One probe is used for normal skin temperature and other for abnormal skin temperature. These probes are placed on affected skin on the body and the readings of both the probes are considered for calculations.
The purpose of array is to cover large portion area of the skin surface. Because if the flap placed is of large size then using a single thermistor will not provide good solution for accurate readings. Hence, an array is developed, so that the large area of the flap can be covered and get the accurate readings. The distance between each thermistor placed is of 1cm.

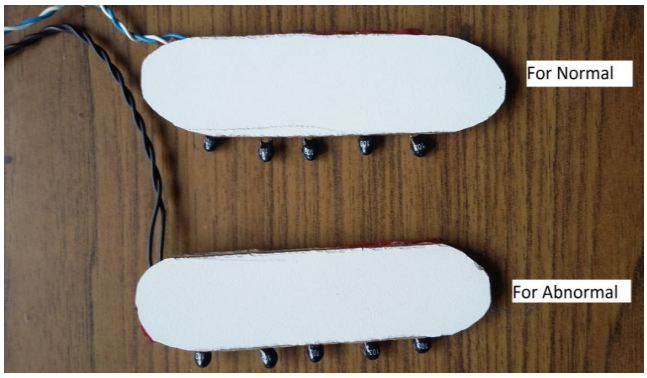

Fig 1: Temperature Measuring Probes.

3. SYSTEM HARDWARE:

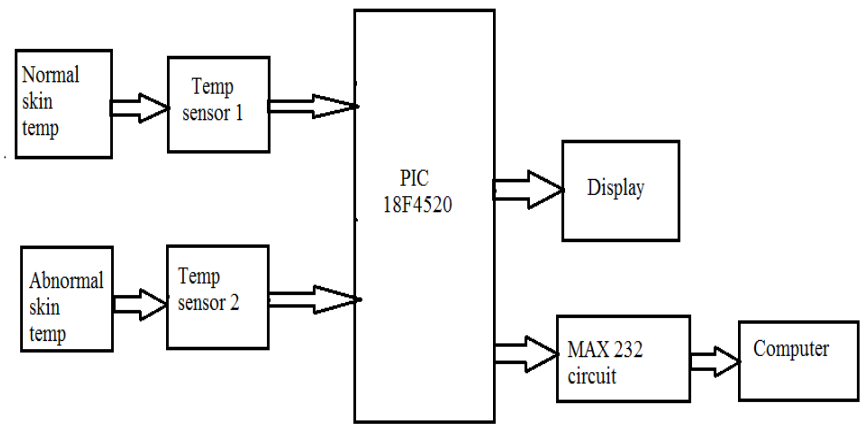

Fig 2: Block diagram of the system

Block diagram of the system is shown in fig.2. The skin temperature of both the normal skin (without burn) and abnormal skin (Flap surgery done due to burn) is measured using two arrays of thermistor to cover more area. The change is temperature gives change in resistance at the output of the thermistor. This change in resistance is then given to the microcontroller so as to scale it accordingly to get the display in terms of temperature in degree Celsius (^{o}C). The MAX 232 circuit is used to interface this circuit to the computer to get the continuous readings of the patient temperature.

4. SIMULATION

The Simulation on Proteus software as shown in figure 3 has been done to reduce the hardware cost. Figure 3 shows the total simulated which helps in deciding the total hardware required. RT1 and RT2 are the two thermistor array connected to the microcontroller to which LCD is interfaced. Software is tested for proper indication of temperature.

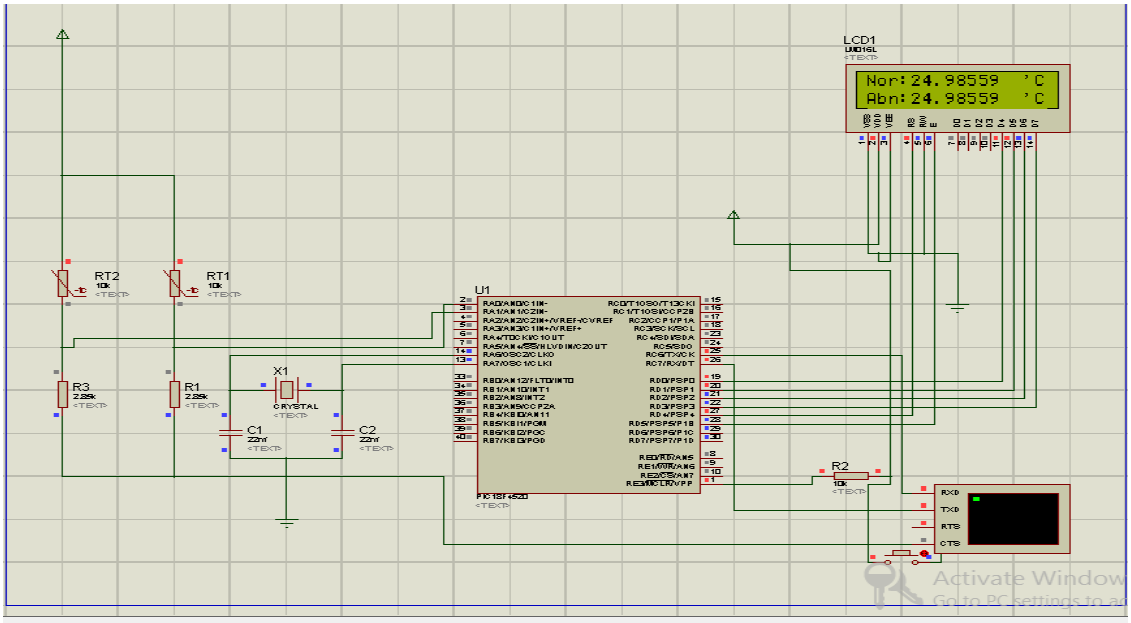

Fig 3: Circuit diagram for skin temperature measurement

5. SOFTWARE DEVELOPMENT:

PIC (Peripheral interface controller) has been used in this system as PIC microcontroller has 10 bit Analog to Digital converter which helps in accurate calculations. Programming tool used is Micro C. Thermistor probes are used to measure temperature and this probes are connected in the voltage division which are acting as the variable resistor and then the output of voltage divider is given to the microcontroller. Algorithm has been developed to carry out mathematical calculations for conversion of the voltage of voltage divider into temperature and indication on LCD. Sensitivity of thermistor is checked by calibration procedure mentioned above. The procedure for calculation of temperature from thermistor has been explained next. After getting voltage from voltage divider, microcontroller multiplies that voltage with resolution of Analog to digital converter. Then this voltage divided by sensitivity of thermistor which gives temperature reading for appropriate resistance.

For example selected thermistor gives 10K ohm resistance at 25°C.

So voltage divider gives 2.5 V to ADC of microcontroller.

This 2.5V is multiplied with resolution of ADC& divided by slope of thermistor.

V= ((2.5*(5000/1023))/*0.5)

Temp=24.42°C.This calculation gives little offset.

Finally, temperature readings are communicated to the computer using RS232 circuit and hyper terminal. Simulation circuit of RS232 (DB9) is as shown in figure4.

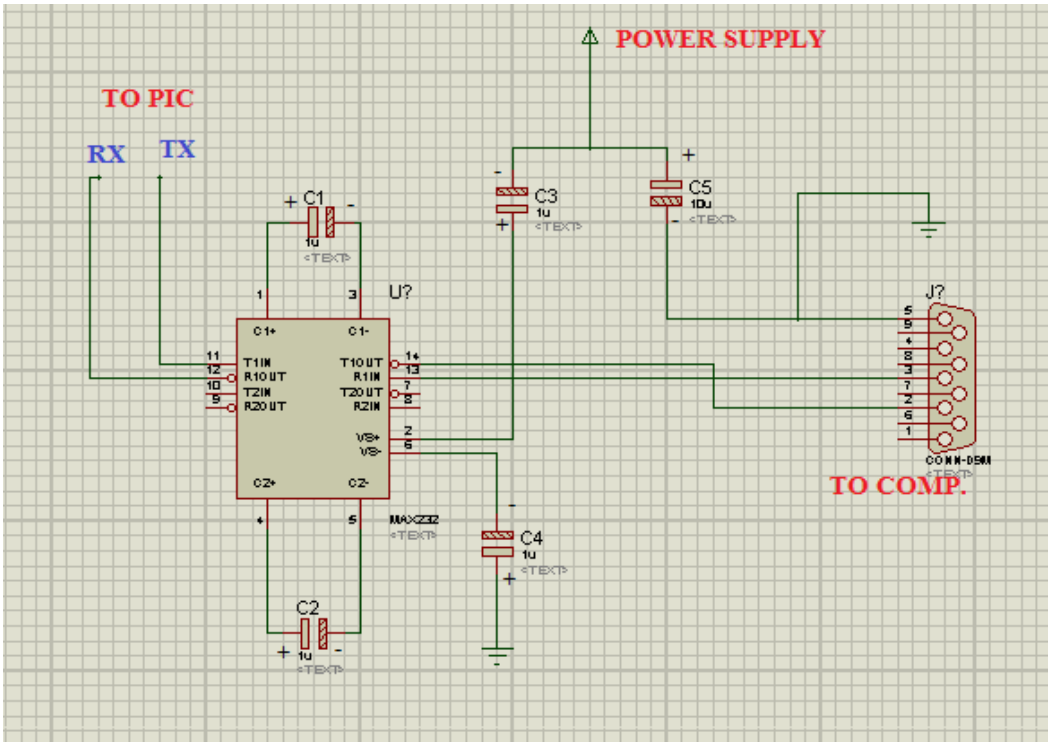

Fig 4: RS232 (DB9) communication

For Serial Communication using Hyper terminal, 9600 baud rate is selected and data transferred and stored in PC.

6. Result and discussion: Figure 5 describes the total system with temperature indication and communication port.

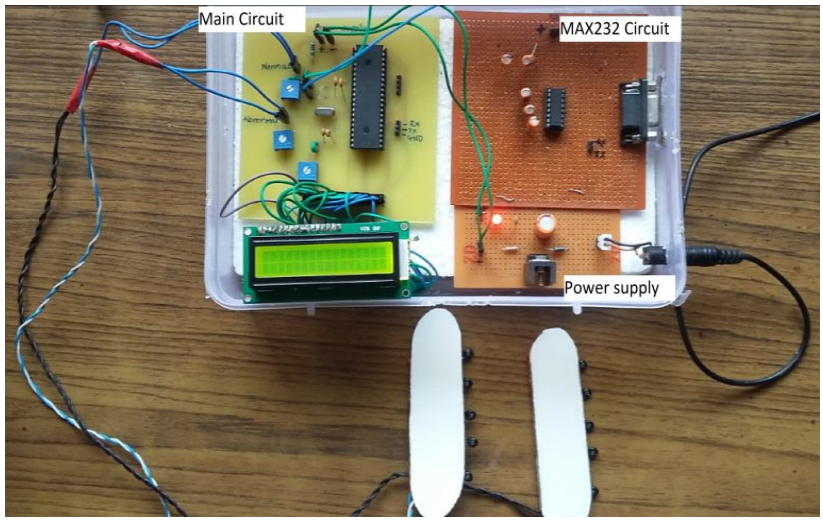

Fig 5: Temperature Measuring Module.

The thermistors are used to measure the skin temperature of normal and abnormal skin using the measuring probes and the change in resistance in given to the microcontroller. The microcontroller is connected to the LCD display that shows the difference between the two probes. The temperature may vary in certain band of allowed differences beyond this band it is said that the flap is not properly placed. Developed system is tested with participation of subjects. The observation of the temperature of ten people is shown in Table 1. The average difference of temperature of ten people is considered. If this average is tolerable then it is normal condition and if there is a difference beyond the tolerance value then it is abnormal condition. The readings in the Table 1 below indicate the value of both the normal and abnormal probes along with the details of the people under observation. The error is calculated and it can be said that if the

difference is between the tolerance limit then the flap is properly placed otherwise it is not. Thus the developed system indicate anastomosis condition properly and the error indicate the abnormal condition.

Table 1: System indicated Temperature observation

SR NO.	ABNORMAL TEMPERATURE (^{O}C)	NORMAL TEMPERATURE (^{O}C)	DIFFERENCE
1.	32.79	32.60	-0.19
2.	32.04	32.19	0.15
3.	32.56	32. 76	0.20
4.	32.37	32.37	0
5.	33.07	33.15	0.08
6.	32.10	32.31	0.21
7.	32.66	32.77	0.11
8.	32.61	32.79	0.18
9.	33.10	33.20	0.10
10.	32.79	32.89	0.10

7.CONCLUSION

The system developed using thermistor for Anastomosis condition detection is a painless testing condition for patients. An thermistor is array is developed as a temperature sensor to measure the skin temperature of a larger area i.e. more area is covered and proves good for large surface temperature indication. The system sends temperature date to PC where a log can be generated. The system developed checks and indicates proper skin flapping and gives comfort to the patient and helps doctor for proper diagnosis. Pricking or scratching the reconstructed flap by needle is replaced with faithful measurement of temperature with sensor probe. Thus using the thermistor sensor temperature can be measured and can find whether the flap is properly attached to the body or not. The developed model is very simple and easy to use in hospital.

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