

# Improvised Temperature Sensing In Efficient Dynamic Devices

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**Abstract**—The document here describes the method of accurate and efficient temperature sensing using multiple thermistors and then it suggests the method to mathematically analyze these incoming data and getting the final accurate result. This method of temperature sensing would prove to be very useful at instances where the temperature probes cannot remain intact with the subject at all times, moreover it also addresses issues of probe detachment and error handling.

**Index Terms**—Probe detachment, thermistors, temperature.

## I. INTRODUCTION

Accuracy of thermal measurements directly affects the thermal management and the efficiency of the whole system. Temperature estimations higher or lower than the actual may change or trigger the behavior of the dependent functions and the sub-systems attached to it. There may also be cases where the sensor probe cannot remain intact at a particular position over a prolonged period. This method of temperature sensing addresses such issues and it targets the fundamental systems for accurate and non-variant temperature data. The solutions provided here aims at increasing the number of sensors for a better and accurate value. Moreover adding the extra cost while adapting this method is prohibitive and further improvisations can be made to further reduce its complexities. The data so obtained by these sensors are fed into a common block and then analyzed so as to give a singular accurate value. Taking the example of a healthcare device where issues such as probe detachment hold prime importance, this method could be adapted for a better and convenient solution. The temperature data value is responsible for triggering other sub functions and hence its value needs to be very precise at all moments though varying quickly over a period of time. Dynamic systems need real time data analysis as these values are connected over various dependencies. Addressing their dynamic and accurate behavior will provide a faster and a more efficient solution to be incorporated over these systems.

## II. THERMISTORS AND INITIAL ANALYSIS

A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. The word is a portmanteau of thermal and resistor. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting overcurrent protectors, and self-regulating heating elements. Unlike most other resistive devices, the resistance of a thermistor decreases with increasing temperature. That's due to the properties of the semiconductor material that the thermistor is made from.

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If you have a resistance value - and that is what you will measure electrically - you then need to solve for the temperature. The Steinhart-Hart equation below can be used for temperature values:

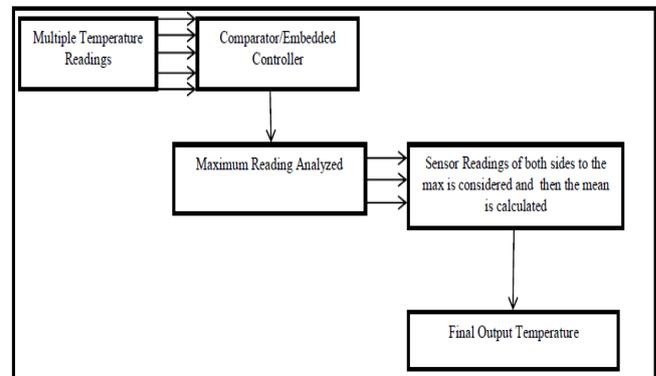
$$T = 1/[A + B*\ln(R) + C*(\ln(R))^3] R \text{ in } \Omega, T \text{ in } ^\circ\text{K}$$

The constants A, B and C can be determined by plotting an experimental graph of resistance vs. temperature. Then through the direct substitution approach the equation can be solved.

Initial analysis shows that if a temperature probe mentioned as above is placed over a subject's body then there may be many issues due to the probe contact wires and its attachment abilities and arrangement. If multiple values of such temperature readings are taken and then analyzed for a singular accurate value then these readings could be fairly improved with higher accuracy and the issue of dynamic temperature readings can also be addressed using this method.

## III. UNDERSTANDING OF THE SYSTEM

Taking an initial approach of taking the orthodox method of taking the temperature reading from a singular probe at the subject's body, many issues were identified and especially when they are used in the healthcare sector their accuracy holds prime importance. The system here proposed takes multiple temperature readings and then these values are further analyzed as mentioned in the paper to get the desired results. Considering that the temperature readings at an enclosed surface under the subject will be higher rather than the readings on the top the difference for each subject remains a constant and this calculation can be further fed into a feedback loop to get the temperature readings same as those if a probe is placed over the upper part of a subject. The block diagram shown below explains the full functioning of this methodology of temperature measurement in detail.



Initially all the values from the temperature sensors are taken and all these values are fed into an analyzer. This analyzer is primarily an embedded controller programmed so as to act as a comparator and take the maximum output values as compared with all the sensor readings. Then the logic will also decide the values to the left and right of the sensor. Since all these thermistors are aligned as an array the mean of all the three readings will give us the final output value required.

For the ease of understanding the following has been shown mathematically with an example.

#### IV. MATHEMATICAL UNDERSTANDING

Let us consider 6 temperature readings from 6 different sensors namely as a,b,x,y,z,c and now let us assume that the reading y has the maximum value. Hence forth the mean of x,y and z as

$$(x+y+z)/3 = \text{Final Output}$$

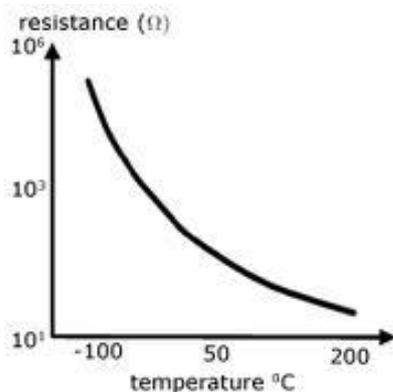
Gives us the final output reading.

#### V. COMPARISON BETWEEN THE METHODS

If a single probe is considered then the traditional way of getting the readings is as follows. First the graph of temperature vs. resistance is plotted and then a polynomial equation is calculated from this curve which is specific to each sensor.

Then from this mathematical equation the corresponding temperature values are calculated and used as final display Readings.

The method proposed here uses a similar approach but since the values and the readings are multiple these turn out to be much accurate than the traditional method. A graph of varying resistance with temperature is shown below:



As shown the output graph is never linear and moreover since only a few numbers of points are actually/practically measured there may be many errors arising due to the curve irregularities itself.

#### VI.HARDWARE DEPENDENCIES

The primary hardware required for implementation of such a system is the sensor array of thermistors which are required to send multiple temperature readings to the comparator. The comparator takes in input from all these sensors and compares them individually amongst each other. These values are not compared with a standard reference temperature but amongst each other so that the maximum out of them is filtered out.

Once this value is know the controller will automatically takes the readings of the sensors to the left and the right side of that particular thermistor. All this is done with the help of pre- coded logic and this selection is not dynamic. Once these 3 values are taken and stored in respective variables, a simple arithmetic mean will be calculated and the final result obtained is used as the final output display temperature.

#### VII.CONCLUSION

The system uses an efficient and accurate way of responding to the dynamically changing temperature readings. The use of multiple inputs and mathematical analysis and comparison over them carefully ensures that the readings are non-fluctuating and there is minimal noise interference due to other subsystems of electronic dependencies that may have been incorporated. To my best knowledge the system in a one of a kind solution for accurate temperature reading systems. The implementation of the same may lead to variations from the initial prototype. The logic of multiple reading inputs is looped and common grounding would help in further system integration.

#### VIII.ACKNOWLEDGEMENT

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