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REVIEW OF TEMPERATURE MEASUREMENT AND WIRELESS TRANSMISSION OF DATA USING IOT

Milind Shinde, Manohar Dhumal, Nikita Lole, Archana Gharge
Dept. of EE
ViMEET Khalapur Maharashtra

Sarthak Joshi
Prof at Dept. of EE
ViMEET Khalapur Maharashtra

***Abstract*— The resolution to make an advancement in the communication domain between instruments and equipment's at the industrial levels is being done with great place which may include wired/ wireless medium for transferring data by using these knowledge we are destined to make a discrete temperature monitoring system of a process. For this various methodologies are being reviewed out of which it was found that wireless medium is the most convenient method.**

Keywords— **Communication, Wired, Wireless, Instruments, Temperature Monitoring.**

I. INTRODUCTION

Many Industries are now becoming more modern. This modernization is the result of the development of the new instruments, equipment's and the communication technologies. Development in instruments bring out more close monitoring the actual value similarly the development in the equipment leads to the production of greater quality of Product while with the help of communication which is the most important domain through which Information Exchange could take place had a greater evolution having switched from wired to wireless at current scenario.
In this review paper we are going to review the technologies concerning the past and the present ad also reviewing technologies with their present competitors

II. REVIEW OF TEMPERATURE MEASURING INSTRUMENTS

It has been seen that temperature monitoring of a system is mandatory according to the manufacturing of a product was being concerned there are various processes in which measurement of temperature is of utmost importance. A small fluctuation in temperature can make the product quality from better to worse.

Recently there are large number of developed instruments in the current scenario but out of that only one instrument which is feasible, economical, efficient in monitoring the Temperature of a Process. This instruments are a deciding factor for safe and secure operation. Instruments such as RTD, Thermistors, Thermo Couple have a huge demand in the market but only one out of those three can be chosen a detailed comparison [1] of those three is shown in the table below

Table 1. Comparison Between various instruments

Sensor Type	Thermistor	RTD	Thermocouple
Temperature Range(typical)	-100 to 325°C	-200 to 650°C	200 to 1750°C
Accuracy	0,05 to 1.5° C	0.1 to 1°C	0.5 to 5°C
Long-Term Stability @100C	0.2°C /year	0.05°C	Variable
Linearity	Exponential	Fairly linear	Non linear
Power required	Constant voltage or current	Constant voltage or current	Self-powered
Response time	Fast 0.1 to 10 sec	Generally slow 1 to 50 sec	Fast 0.10 to 10 sec
Susceptibility to Electrical noise	Rarely susceptible High resistance only	Rarely susceptible	Susceptible/ Cold junction Compensation
Cost	Low to Moderate	High	Low

As seen from the table above the parameters in which RTD exceeds the other two is in terms of Accuracy, Susceptibility to electrical noise, Cost and Temperature Range.

For our project we are going to choose RTD for monitoring the Temperature. But due to some technical feasibility we are going to replicate the operation done by RTD by a Potentiometer. The operation of RTD as well as the POT is similar introducing the resistance concurrently to increase in temperature but in RTD the change in temperature will be noted according to the rotation of Knob on the RTD which will introduce resistance

III. INSTRUMETATION AMPLIFIER CIRCUIT

The controllers can only take input analog values. Since the values obtained directly from the RTD do not depict temperature values. so in order to measure the change in

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temperature the output of RTD is given to the wheatstone bridge which gives output in terms of current or voltage. This signal resulted from the wheatstone bridge is of very small amplitude so the signal has to be amplified using amplifier circuits. One such amplifier circuit eing used in industries to amplify the small signals is the instrumentation amplifier. This instrumentation amplifier [2] usually consist of the three Op-Amps out of which the two Op-Amps are of voltage follower type and one used as a differential amplifier type. The reason why voltage follower are used is for impedance matching, by matching the input impedance of the Opamps with the Ouput impedance of the circuit. The differential amplifier amplifies the difference of signals obtained from two voltage follower circuit.

IV. REVIEW OF CONTROLLERS

The value which is amplified does implies the temperature change. So in order to depict the temperature changes the current/voltage values incoming from the Instrumentation amplifier has to be converted into equivalent temperature change for that we need a processing house where the conversion can take place by using arithmetic operations.

In market at present there are currently various processing units available from small controllers to large processors. In this project used of efficient controllers is demanded and good technical feasibility. According to the industries which need highly efficient processing unit for there control action and also the production process should fit in there industry standard.

There are various boards available in the market out of which the two of the boards which are mostly used for building prototype they are Arduino/Node MCU and Raspberry PI. A detailed comparison has been shown in the following table.

Table 2. Comparison of Controllers

Raspberry pi3	Node MCU
Stronger and quicker processor, multitasking available.	Easier to connect to Analog sensors, motors and other electronic components
Built in Ethernet port, Wi-Fi Bluetooth capability	Variety of shield that can add functionality
OS can be switched easily	Long Set-up not needed, just plugged in and the code will run.
Audio output, camera port ,USB ports, HDMI output all included.	Price is Cheaper and will not need much cables
Great to start learning to code with its helpful learning programs already installed.	Great for projects that need to quickly get data from sensors and do one activity from that data.
Great for projects that need to connect online and have multiple activities going on at the same time.	Can run one code at time so can't multitask activities, slower speed.
Long set up and will need extra components when first starting .	No internet connectivity right out the box
Might need to install programs to get simple actions going	Bigger learning curve since it's C/C++ and will need to get outside sources to learn.
Can be more expensive	Can be cheap

From table as seen above the Raspberry Pi has more processing power and it is more efficient in processing information but as far as the budget has been concerned we are going to use Node MCU. It can also execute instructions but not all the time it can provide the output at exact time, It also has some delay associated with it's instructions processing.

V. REVIEW OF COMMUNICATION TECHNOLOGIES

After the voltage values from signal conditioning circuit is converted into equivalent Temperature values, the task now is to transfer the data from sender to receiver. Since Node MCU can also be used for processing the information and also transferring the information so at the sending station where the temperature of process is measured and also the receiving end station where the actual controller is present which controls the process temperature Node MCU is used.

At the receiving end station the actual controller which possess controlling action the receiving end Node MCU sends data to the controller, here the main controller could be a PLC or any other standard industrial controller. The communication will done either through RS232 or RS485 Communication Protocol.

Now the communication between the sender and receiver will be the main factor which will define the process efficiency that how efficiently the temperature is measured, also it will also define the time at which the controlling action would take place. At present communication is most important domain in which there are various mediums of transferring data has been developed. Two mediums which are utilised up till today are wired and wireless mediums. Since due to development of new wireless technologies it is having a big advantage over wired which can be seen in the comparison[3] done in the table shown below .

Table 3: Comparison of Controllers

Parameters	Wired	Wireless
Communication	Copper, fiber etc.	Air
standard	IEEE 802.3	802.11 family
Mobility and Roaming	Limited	Higher
Security	High	Lower than wired. Also easy to hack
Speed /Bandwidth	High speed upto 1 Gbps	Lower speed than wired network.
Access to network	Physical Accesss required	proximity required
Delay	Low	High
Reliability	High	Lower than wired
Flexibility to change	Less flexible to changes	More flexible configuration
Interference and Fluctuations vulnerability	Very Less	High
Installation activity	Cumbersome and manpower intensive	Less labor intensive and easy
Installation Time	Takes longer time to perfom installation	Very less deployment time
Installation Cost	High	Low
Mainatenance cost	High	Low
Related equipment	Router, switch, hub	Wireless router, Access point

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Benefits	Greater speed	No massless of cable
	Higher noise immunity	Best for mobile devices
	Highly reliable	Greater mobility
	Greater security	Easy installation and management.

From the table it can be seen that the wireless medium has the help from signal conditioning circuit which will amplify the small voltage signal to a large signal of suitable which can be sensed by the controller by adjusting the gain of the amplifier circuit. The wheatstone bridge and the amplifier circuit comes under on technical device which is called as Signal Conditioning circuit. Here the controller used can an Arduino Uno Board or a Node MCU, Node MCU will be used because it has inbuilt Wifi module. The voltage signal which is available from the Signal Conditioning device at the Analog terminals of Node MCU will be converted into temperature values equivalent to the voltage value. The NODe MCU at the sender and receiver are connected to the internet and will exchange the information. The receiving side Node MCU will send the data directly to the PLC.

VI. CONCLUSION

As far as the review of methodologies has been done it was decided that the RTD is used for measuring temperature because it is more feasible and economical, whereas the development of the instrumentation amplifier is been used with help of which the signal is amplified which will be sensed by the Node MCU(sender) while using it to transmit the data wirelessly, while Node MCU(receiver) has been used at the receiving end which will receive the data from the sender either store the data or it will send the data to the cloud finally the data will reach PLC which will closely monitor the operation.

VII. METHODOLOGY

Following block diagram shows the finalized methodology

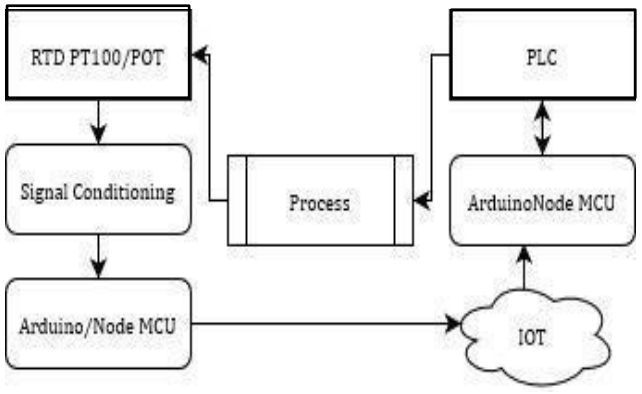

Fig. 1. Process flow diagram

RTD PT100 if available then can be used to measure the temperature in terms of resistance, If not present than the Potentiometer will operate as similar to the RTD which will include change in resistance. This change in resistance is measured in the wheatstone bridge which gives the output in terms of voltage since the voltage is so small we have to take the upper hand. Wireless medium due to its flexibility and economical feasibility has been the best option to share information from sender to receiver.

VIII. REFERENCE

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