OPEN ACCESS
Global Journal of Research in Engineering & Computer Sciences
ISSN: 2583-2727 (Online)
Volume 04| Issue 05 | Sept.-Oct. | 2024
Journal homepage: https://gjrpublication.com/gjrecs/
Review Article

The Benefits of a Temperature Monitoring System in the Fourth Industrial Revolution

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DOI: 10.5281/zenodo.13849834 **Submission Date:** 15 Aug. 2024 | **Published Date:** 27 Sept. 2024

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Abstract

High fever illness claims numerous lives annually, prompting this essay's exploring of innovative solutions. The fourth Industrial Revolution (4IR) offers technological advancements, including digital inventions, to address this challenge. Non-contact temperature detection systems utilise infrared radiation to measure object temperatures and ambient surroundings. Recent microelectronics and electronic advancements enable the development of reliable, affordable monitoring systems for businesses, organisations, institutions, schools, and individuals to identify high-temperature patients and prevent disease spread. This study examines the benefits of temperature monitoring systems, highlighting their potential to save lives and enhance public health.

Keywords: *Fourth Industrial Revolution (4IR), Benefits, Temperature (MLX90614) Sensor, Arduino, IR Sensor, Patients.*

I. INTRODUCTION

In the medical settings, temperature is the most commonly measured parameter. The physical, chemical, and biological worlds are all impacted in various ways by its full force. People have long known intuitively what temperature means: snow is cold and a fire is hot. As man tried to work with metals during the bronze and iron ages, more knowledge was acquired. Some technical processes call for some degree of temperature control, but in order to manage something's temperature, you must first be able to measure it. The measurement of temperature was fairly simple about 260 years ago. The first known thermometer was created in 1592 by a scientist by the name of Galileo. It was an air thermometer, made of a protracted tube to which a glass bulb was fastened. This bulb was heated while this tube was submerged in a cold liquid to expand the air inside. Some of this air escaped as it continued to expand. The amount of air that was still present in the tube decreased as the heat was removed, which caused the liquid to rise and reveal a change in temperature. This type of thermometer is very receptive, but it is affected by the changes in atmospheric pressure. In the year 1714, another scientist named Daniel Gabriel Fahrenheit invented both alcohol and the mercury thermometer. Fahrenheit's mercury thermometer comprises a capillary tube, which after being filled with mercury, is heated to increase the mercury and eject the air from the tube. This tube is then sealed, leaving the mercury free to contract and magnify with the temperature changes. Though this mercury thermometer is not as subtle as the air thermometer, by being sealed it is not pretentious by the atmospheric pressure. Mercury normally freezes at a temperature of -39°C, so it cannot be used to measure a temperature below this point. Alcohol, on the other hand, freezes at -113 °C (Celsius), allowing much lower temperatures to be measured. Late in the 18th century, a scientist named Anders Celsius realised that it would be profitable to use more common adjustment allusions and to rift the scale into 100 additions instead of 96. Anders chose to use zero degrees as the boiling point and 100 degrees as the freezing point of water. The previous years of the 1800s were very effective in this area of temperature measurement and perception. William Thomson (later Lord Kelvin) presumes the presence of an absolute zero. When sunlight was spread into a color swath using a prism, he noticed an increase in temperature when moving a blackened thermometer across the spectrum of colors. William Hershel found that the heating effect increased toward and beyond the red, in the region we now call "infrared. He measured radiation effects from candles, fires, and stoves and derived the similarity of light and radiant heat. In the year 1821, T.J. Seebeck discovered that a current can be produced by unequally heating two junctions of two dissimilar metals, the thermocouple

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effect. T.J. Seebeck assigned constants to each type of metal and used these constants to compute the total amount of the current flowing. Likewise, in the year 1821, Humphrey Davy discovered that all metals have a positive temperature coefficient of resistance and that platinum could be used as an excellent temperature detector (RTD). These two discoveries marked the beginning of serious electrical sensors. The 19th century saw the introduction of the bimetallic temperature sensor. These types of thermometers contain no liquid but operate on the principle of unequal expansion between two metals. Since various metals expand at different rates, one metal that is bonded to another will bend in one direction when heated and will bend in the opposite direction when cooled. This bending motion is transmitted, by a suitable mechanical linkage, to a pointer that moves across a calibrated scale. Although not as accurate as liquid in glass thermometers, BiMets are hardier, easy to read, and have a wider span, making them ideal for many industrial applications. The 20th century has seen the discovery of semiconductor devices, such as the integrated circuit sensor, the thermistor, and a range of non-contact sensors. Likewise, Kelvin was finally rewarded for his early work in temperature measurement. The increments of the Kelvin scale were changed from degrees to Kelvins. We no longer say "one hundred degrees Kelvin," but rather "one hundred [1] Kelvins." The "Centigrade" scale was changed to the "Celsius" scale, in honor of Anders Celsius. The 20th century also saw the refinement of the temperature scale. Temperatures can now be measured to within about 0.001°Cover a wide range, although it is not a simple task. The most recent change occurred with the updating of the International Temperature Scale in 1990 to the International Temperature Scale of 1990 (ITS-90) [1]. In the digital era of the Fourth Industrial Revolution (4IR), health monitoring poses a global challenge throughout people's lifetimes, largely due to excessive smartphone and digital facility usage. The comfort of life lies in a healthy condition which is affected by environmental and surgical facts. The measurement of human body temperature is very important in order to acknowledge the health status of that person. Installing or mounting a temperature detection system that will measure the body temperature of an individual or object is very important nowadays because of the rising rate of deaths in the world today as a result of various kinds of sickness that are related to high body temperature. The system will measure the temperature of an object or individual. If it is above the expected temperature range of a normal human being that is not ill or feeling well, it will sound an alarm and display the information on liquid crystal display that you should see a medical doctor. The table below shows the expected body temperature.

II. LITERATURE REVIEW

Each temperature sensor's range is allocated, and simulation is carried out in LabVIEW. Different colors are used to illustrate and plot the combined results. The temperature ranges for the thermistor, resistance temperature detector, and LM-35 are, respectively, 50 °C to 100 °C, 101 °C to 650 °C, and 651 °C to 850 °C. By changing the assortment of each detector in the simulation studies, it was clear that across a wide range of temperatures, the simulated setup presented reasonable results and the individual sensors were spontaneously nominated to perform in their dispense ranges. As a result, this device can normally monitor temperatures between -50 °C and around 1000 °C using the indicated approach [2]. This research presents a tangible time-based observation of the body temperature using an embedded platform. The microcontroller controls the gathering of tangible time information. The transmitting of intuited information from the instigated LM-35 and MLX-90614 temperature sensors to the online portal is accomplished through the ESP-Wi-Fi buffer. The podium is wirelessly linked to a monitor and displays the actual time information of positioned S1 and S2 sensors, respectively, in both the outdoor and indoor environment. This positioning elucidates the properties of advancement in the temperature readings, which differ due to other environmental features such as a barometer, blood pressure, humidity, and heart rate that are not considered in this research. According to the findings of the study, the average temperature change from S2 is approximately 150 °C. However, the day-to-day checking of the body temperature can preclude people from developing threatening hypothermia, fever, and hyperthermia illnesses [3]. Resistance temperature detector linearisation has been executed in LabVIEW, using feedback and divider voltage compensation methods. A two-parameter model for resistance temperature detectors was studied and implemented to simulate and implement linearization procedures within a predictable temperature assortment from 0 °C to 500 °C. The linearisation error was estimated to be less than 0.5°C. An evaluation with a resistance RTD without linearization signifies an enhancement of around twenty-five percent, which is very imperative for industrial applications like thermal compensation and room temperature measurement [4]. His research aims to design and locally produce a Smart Body Temperature Detector that is capable of activating an alarm for temperatures that exceed 38°C, while the set aims are too decisive for the cost of local production without compromising efficiency, produce, calibrate, and validate [5]. A tentative design of a resistance temperature detector based on low-temperature sensors was designed with an electroplating technique on the variant of the concentration of the solution and the electrode distance. The greater the concentration of the solution, the layer formed by the electroplating process, the thicker it gets. The electroplating can increase the resistivity of the thin layer of the sample [6]. Furthermore, a study on thermal camera usage for contactless monitoring of the laboratory animals' temperature. Experiments were implemented in the laboratory conditions by using a commercially available thermographic camera, the Testo 885 thermal imager. For video processing, he proposed the method of detecting animal position in the thermal video record (ROI), choosing the precise points in the ROI, and reckoning temperature for them. This suggested system was tested on the experimental thermal information of rats [7]. The contactless infrared irradiation method was applied by carrying out thermal imaging and point measurement techniques with the use of pyrometers to determine the spatial and temporal temperature distribution in wire-based

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electron beam AM. The emissivity was calibrated by thermocouple readings and geometric boundary conditions. Thermal cycles and temperature profiles were recorded during deposition; the temperature gradients are described and the associated temperature transients are derived. In the temperature range of the + field, the cooling rates fall within the range of 180 to 350 °C/s, and the microstructural characterization indicates an associated expected transformation of '+ with corresponding cooling rates. As a result of the temperature gradient and the formation of the', local disorientation was observed within as a result of the temperature gradient and the formation of the' [8]. The purpose of this research is to achieve a protocol for temperature determination with a high spatial resolution of the order of the micromanometer dimension by manipulating Raman spectroscopy on anisate powder. As multiple signals are present in the Raman spectrum of titanium dioxide, the choice of the actual Raman mode to be used has been made based on its sensitivity to temperature.

The ratio between Stokes and anti-Stokes signals of the same Raman mode has been investigated as a function of temperature (T), excitation wavelength, and input power. The control of the temperature is obtained by using a temperature controller, which is assumed to also serve as a reference for the determination of the absolute temperature. The performance of the temperature sensor is examined in the wavelength range 488.0–647.1 nm, to identify the best excitation wavelength in terms of reaching the highest sensitivity, and in the temperature range 283–323 K, which is essential for biological applications. The work will demonstrate that a different calibration constant is necessary for different wavelengths and Raman modes. The calibration constants, determined in this work, have been tested on a titanium dioxide-based test sample, obtaining results with high sensitivity and low uncertainty and opening the way to the use, in the future, of titanium dioxide-based new biosensors [9]. The thermometer designed in this research uses the microcontroller as the control core of the research, and it accomplishes accurate contactless temperature measurement and identity mask recognition for the measured person by using the identity recognition component and temperature detection module. The system uses the MLX90614 module and laser distance measurement component to complete the contactless temperature measurement for the human body through the process of distance reimbursement. By using a deep learning system, the K210 module is used to deep learn and extract facial features from the member pictures, and finally, determine the identity of the subject and carry out epidemic prevention detection [10, 11].

III. TEMPERATURE MONITORING SYSTEMS: THE BENEFITS

1. Getting Real-Time Data
   Industries using freezers, refrigerators, and warmers must adhere to a number of rules and specifications. These are non-negotiable regulations that are essential to the operation of the firm. Failure to maintain this could result in financial loss, as well as patient or consumer mortality or poor health. Temperature monitoring devices make it easier to spot problems as soon as they arise. On the market, there are sensors that offer precise, minute data. As soon as errors are identified, you can take immediate corrective action. For example, by examining trends in the data, you can even remedy infractions when staff members are keeping an eye on the data. The fact that some sensors send out notifications even before a violation occurs makes this trend analysis feasible.
2. Process Validation Activities
   Every year, the majority of healthcare professions—if not all of them—have to validate their standard operating protocols. It's a laborious process that can lead to incorrect conclusions. The task is mechanised with a temperature monitoring system. This automation saves time validating the job procedures. Automation benefits this industry in addition to making accurate data widely accessible online.
3. Compliance Monitoring
   You want a temperature monitoring system that can function at its best in this day and age of technology. When compliance teams audit the industry, they check to determine if the business is compliant even in the absence of human involvement. With temperature monitoring systems, you can look over compliance issues immediately around the clock. Customers and investors alike will feel more secure knowing that their products are secure around-the-clock.
4. Statistical Process Control
   Statistical process control, or STC, has been utilized for many years in the industrial sector to enhance results and optimize procedures. STC adaptation in the healthcare sector is a relatively recent development. With this adaption, there is a requirement for routine monitoring of all actions. Because the healthcare sector is delicate, regular supervision is necessary. Data access is provided so that you can use and analyze it as you see fit. To make the process of implementing statistical process controls much simpler, you can even employ third-party software for forecasting and trend analysis.
5. Assist With Auditing
   Every industry undergoes audits at different times to make sure that rules set forth by the government and the industry are followed. Systems for measuring temperature provide you an advantage during audits. Creating reports with the information gathered from your temperature monitoring system for auditing purposes is one benefit. This compilation can be completed in a flash, and the data is nearly always precise to the degree.
6. Money Saver

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Systems for monitoring temperature can really save you money. Product recalls or ruined goods cause financial losses. Additionally, financial loss may result from litigation arising from patient illnesses or even more serious incidents like patient deaths. One of the system's advantages is its efficiency; in the event that there are any errors, you are promptly notified.

7. Efficiency and Convenience
   Temperature monitoring, like any other electronic software or system, is useful because it reduces the amount of physical labor required. Reports, trends, and analyses are automatically compiled by the system on your behalf. When you purchase this tool, your sole task is to download the desired information.
8. Ease of Access
   The necessity for this system is multifaceted. The most important feature is how simple it is to obtain. You can receive your real-time reports directly to your inbox, no matter where you are. Even better, you can receive alerts via SMS or an app on your phone.
9. Easy to Use
   In the past, purchasing new technology, such as the temperature monitoring system, was frowned upon. Both installation and maintenance were costly and time-consuming. But because to this recent development, there are now simple-to-install wireless solutions available. The temperature monitoring system requires little human intervention once it is installed and operates continuously.
10. Affordability
    A temperature monitoring system is not very expensive, even with all of its advantages. You need to check temperatures regularly once you are in an industry where this is vital. You will be forced to make an investment in technology that will benefit you more than hurt you because of this monitoring activity. The system is dependable and well worth the money spent on it [13].

CONCLUSION

We are now in a contemporary era of the Fourth Industrial Revolution (4IR). The purpose of the study was to raise awareness about the steps and things people can do on a daily basis to combat the rising mortality toll in the world [12]. In addition to reviewing some relevant studies, the study addressed the implications of employing temperature sensing systems and emphasised the difficulties associated with their installation in our homes, businesses, organizations, marketplaces, institutions, and offices [11].

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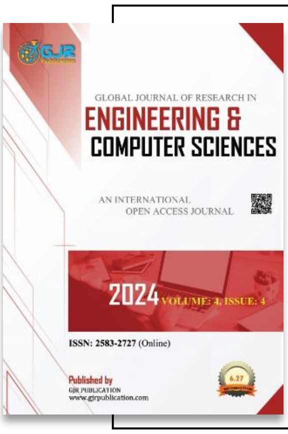
CITATION

Isa A.I., & Muhammad A. B. (2024). The Benefits of a Temperature Monitoring System in the Fourth Industrial Revolution. In Global Journal of Research in Engineering & Computer Sciences (Vol. 4, Number 5, pp. 109–112). https://doi.org/10.5281/zenodo.13849834



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