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Design and Implementation of a Non-Contact Temperature Based Attendance System

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ABSTRACT

During the COVID-19 pandemic, the necessity to monitor body temperature without touching it and swiftly led to the adoption of infrared thermometers, thermal imaging cameras, and thermal scanners as an alternative to the existing contact clinical thermometers. However, non-contact temperature monitoring equipment are not widely used, and technical–scientific literature sometimes offers contradictory reference values for healthy people' body and skin temperatures. To reduce the possibility of the virus spreading, national authorities have mandated that workers' body temperatures be taken at the entry to the workplace. In this project, we'll look at non-contact body temperature measuring difficulties from a clinical and meteorological standpoint, as well as a security-based attendance system, with the goal of (i) increasing body temperature measurement accuracy and (ii) collecting staff attendance as they arrive at work. This project's methodology takes into account both the manual technique of temperature measuring and the manual way of recording attendance. In order to appropriately pick the threshold temperature value and measurement technique to access important areas during the COVID-19 pandemic emergency, a thorough screening process for attendance taking and body temperature measurement that considers the role of uncertainty is required.

Keywords: Human Body Temperature (HBT), RFID, Temperature, Sensor, Attendance

INTRODUCTION

Recent advancements in electronics and microelectronics devices have enabled the improvement of new low-cost monitoring gadgets that people may use to keep track of their health. Sensors in medical equipment translate various types of vital signs from the human body into electrical signals. As a result, healthcare monitoring systems that incorporate non-invasive and wearable sensors as well as an integrated communications medium provide a cost-effective way to live a pleasant life. Because variations in human body temperature (HBT) can contribute to a variety of illnesses, it's critical to define the temperature range.

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Fever is one of the most important symptoms of COVID-19 Di Gennaro, F.; Pizzol, D.; Marotta, C.; Antunes, M.; Racalbuto, V.; Veronese, N.; Smith, L. (2020) but owing to the infectious nature of the virus, measuring it can be difficult. As a result, it's critical to determine a patient's temperature promptly and, ideally, without any touch. Environmental temperature, on the other hand, has been shown to impact the survival and spread of Corona virus in both epidemiological and laboratory investigations. In contrast to COVID-19, continuous temperature monitoring of both ambient and body temperature is an important task to complete Xie, J.; Zhu, Y(2020).

Problems associated with the manual method of recording attendance include significant time waste, incorrect documentation, employees forgetting to put their names down, and employees writing on behalf of other employees who are absent from work. An automated technique employing RFID technology is used to eliminate the flaws associated with the manual attendance system. An RFID reader, RFID tags, mobile devices, and a host system application are all part of the design. The design guarantees that staff attendance is captured automatically and that a brief message is sent to the organization's database for record keeping purposes.

The need for an application of a non-contact temperature monitoring system will reduce the spread of the virus due to touching of manual or mercury thermometers, and also due to the manual method of attendance system that involves contact. To eradicate the deficiencies associated with the manual method of attendance taking and temperature measurement, an automated approach is implemented using the RFID technology and MLX96014 non-contact temperature sensor.

In A, Mohamed, A, Abdel-Hamid and K, Mohamed (2009) created and built a model of a safe and handy implanted reader system to interpret biometric data from an electronic passport in order to tackle the concerns of security, privacy, and reliability in e-passports to authenticate the bearer online via the GSM network. The fundamental link between the identification center and the e-passport reader is the GSM network. The communication data between the server and the e-passport reader is encrypted using AES for security when traveling over the GSM network.
Namibia evaluated the current research application of RFID to several fields in A, Mohamed, A, Abdel-Hamid and K, Mohammed(2009) with a focus on supply chain management. A, Nambiar (2009) performed a study on the usage of RFID in an incorporated circuit (IC) packaging facility to alleviate stock transaction difficulties. According to his research, RFID leads to substantial advancement in the water collection and inventory transaction processes, resulting in lower labor costs and fewer human mistakes. Access Control that is Automated Using a Student Identification Card Based on RFID technology, the automatic access control system in C, Liu and L, Chen (2009) prevents unauthorized persons from getting access to particular organization resources and prevents unlawful entry of people into a facility. Door opens as soon as user scans the tag and system takes note of user login and logout details.
Describes how an RFID-based Test Hall Maintenance System was developed and implemented to address the issue of students being unable to locate their test rooms and seats. The card reader is near the doorway to the building; students must swipe their tag in front of the reader in any hall to have their hall and seat number shown on the LCD. Mahajan C. Geoffrey (2012) developed and

implemented RFID based library management, a use of RFID technology in libraries that saves library personnel time and energy by automating their tasks. Check-in and check-out system which is RFID based, automates the borrowing and returning of books. The limitation of the system is that it is expensive to implement.

A, Parvathy, V, Raj and M, Reddy M (2011) An automated attendance system based on fingerprint verification was proposed. The extraction of an anomalous spot on the ridge of the user's fingerprint method was used to verify the fingerprint technique. The verification validates an authorized user's identity by executing a one-on-one comparison of a recorded fingerprint template to the database's stored templates. Based on the logical conclusion of prior one-on-one verification of a person's validity, the suggested automated attendance system indicates true or false. However, no backup mechanism has been included in the different RFID attendance investigations done so far. In the event that data on the PC is lost due to a system breakdown or malfunction S, Chitresh and K, Amit (2010).

In this study, a non-contact temperature-based attendance system was designed and implemented. The device is capable of measuring the human body temperature and taking attendance of staff at arrival to work, thereafter sending these data to a central database using GSM module (SIM 900A).

RESEARCH METHOD

The power supply, GSM module SIM (900A), the MLX96014 non-contact temperature sensor, and the ultrasonic sensor are interfaced with the Arduino nano micro-controller which serves as the control unit of the system. The temperature value threshold was programmed to be 38°C. Below are some components used in the implementation of the design.

The Power Supply: A 230V from ac mains is stepped down to 12V and rectified via the use of a bridge rectifier, filtered and regulated by a capacitor and voltage regulator IC7805 respectively, to produce an output of 5V. The regulated 5V is used to provide supply to the microcontroller, LCD and ultrasonic sensor.

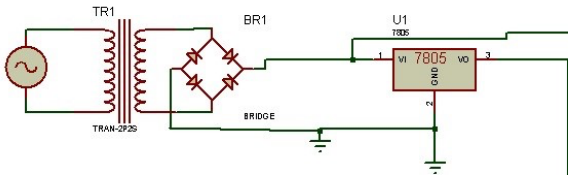

Figure 1 - Circuit Diagram of Power Supply Unit

Transformer Selection

The transformer chosen to satisfy the circuit power requirement for its operation has the following technical specifications:

Input voltage = 220V

Output voltage = 12V

Frequency = 50Hz

Current rating = 500mA

The maximum secondary voltage of the transformer is given by;

$$V_{\max} = \sqrt{2} \times V_{rms}$$

Where: V_{rms} = root mean square voltage

From the above specifications:

$$V_{\max} = \sqrt{2} \times 12 = 16.97V$$

Now I_{rms} can be determined by: $I_{\max} = \sqrt{2} \times I_{rms}$

Where I_{rms} = root mean square current

Therefore,

$$I_{max} = \sqrt{2} \times 500 \times 10^{-3} = 0.707A$$

The average d.c. current can be determined from the equation below;

$$I_{dc} = \frac{2I_{max}}{\pi}$$

Therefore,

$$I_{dc} = \frac{2 \times 0.707}{3.142} = 450\text{mA}$$

Similarly, average d.c. voltage can be obtained as follows;

$$V_{dc} = \frac{2v_{max}}{\pi}$$

Therefore,

$$V_{dc} = \frac{2 \times 16.97}{3.142} = 10.8\text{V}$$

The circuit resistance can be calculated using Ohm's law;

$$R_l = \frac{V_{dc}}{I_{dc}}$$

$$R = \frac{10.8}{450 \times 10^{-3}} = 24\Omega$$

Rectifier Selection

The output voltage of a bridge rectifier circuit is given by:

$$V_{rec} = V_{max} - 2V_f$$

Where V_f = divided forward voltage drop (about 0.7V for silicon diode)

$$V_{rec} = 16.97 – 2\ (0.7)$$

$$V_{rec} = 15.57V$$

For a full wave bridge rectifier circuit, the peak inverse voltage (PIV) is

$$P.I.V = 2V_{max}$$

$$P.I.V = 2 \times 16.97 = 33.94V$$

Based on the above calculation, 1N4001 diode is chosen for the rectification action. The diode specifications are PIV of 50V and maximum forward current of 1A. The diode having a PIV of 50V can withstand the maximum reverse repeated voltage produces of the secondary winding of transformer.

Voltage Regulator Selection

The voltage regulator is required to stabilize the A.C output from the power supply irrespective of fluctuation from the source. For this purpose, a positive voltage regulator 7805-IC was chosen to meet the circuit requirement.

This device gives a constant 5V dc output at 1A current rating. The selected voltage regulator has the following specifications.

Minimum input voltage (V_{min}) = 7.5V

Maximum input voltage (V_{max}) = 35V

Now, the average voltage of the circuit is given by the expression:

$$V_{ar} = \frac{V_{max} + V_{min}}{2}$$

$$V_{ar} = \frac{35+7.5}{2} = 21.25V$$

From equation 3.8, the differential voltage ΔV is determined using:

$$\Delta V = V_{ar} - V_{min}$$

Hence,

ΔV = 21.25 – 7.5 = 13.75V

Filter Capacitor Selection

A filter capacitor is used to ground harmonic ripples produced during rectification, thereby eliminating ripples from the rectifier output. The capacitor is shunted across the output of the rectifier and its value is given by

$$C = \frac{V_{ar}}{\Delta V f_{pR_l}}$$

where,

f_p = Peak frequency in Hz (twice supply frequency 100Hz).

Therefore,

$$C = \frac{21.25}{13.75 \times 100 \times 24} = 643.9\mu F$$

The nearest preferred standard value of $1000\mu F$, 16V electrolytic capacitor has been selected for this project.

Arduino Nano Micro-Controller Unit: Arduino Nano is a small Arduino board based on AT mega 328P or ATmega628 micro-controller. The Nano board is a microcontroller board that is tiny, consistent, and adaptable. This unit serves as the brain of the system (otherwise known as the central processing unit of the system). The microprocessor was programmed to receive, process and send commands given to it by the RFID, MLX96014 and other system components.

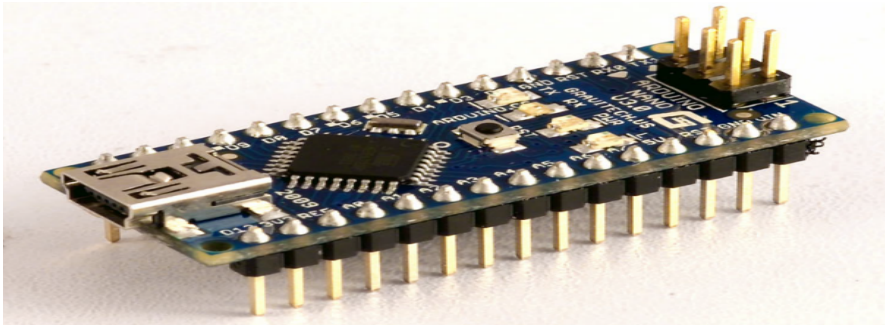

Figure 2 - Arduino Nano Micro-controller Unit

Liquid Crystal Display (LCD): liquid crystal display (LCD) is a flat-panel, electronically controlled optical device that utilizes liquid crystals with polarizers to modify light. LCDs can show random pictures (as in a general-purpose computer monitor) or fixed graphics with limited information content. Digits and seven-segment display, such as in a digital clock, are examples. They all utilize the same fundamental technology, but arbitrary pictures are created using a matrix

of tiny pixels, whereas other displays use bigger components. The HBT was shown on the LCD screen.

The LCD is wired in a 4-bit mode i.e., pins D7, D6, D5 and D4 are interfaced with pins D7, D8, D9 and D10 of the micro-controller respectively. The LCD has an Enabling pin (E) and a Reset pin (RS). E is interfaced with D11 and RS is interfaced with D12 on the micro-controller.

Pins VSS and VDD are interfaced with GND and 5V in the power supply unit while Vo is used to control the contrast of the LCD.

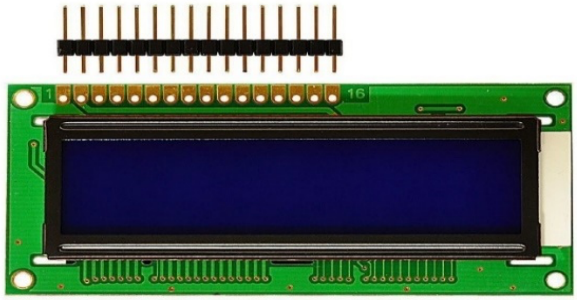

Figure 3 - Seven-Segment LCD Display

Ultrasonic Sensor: An ultrasonic sensor is an electronic device that detects the distance between an object using ultrasonic sound waves and converts the reflected sound into an electrical signal. Ultrasonic sensors include two fundamental components: an emitter (which creates sound using piezoelectric crystals) and a receiver (which encounters the sound after it has travelled to and from the target).

The time between the transmitter's sound emissions and its contact with the receiver is being monitored by the sensor in order to ascertain the distance between the sensor and the item. It has four (4) pins which are, VCC, Trig, Echo and GND. VCC is interfaced with the power supply while Trig and Echo are interfaced with the micro-controller.

Figure 4 - HC-SR04 Ultrasonic Sensor

RFID Tag

Radio-frequency identification (RFID) is a technology that sends data from an RFID tag or label to a computer through radio waves. It is connected to an object with the help of a reader in order to identify and track it. RFID is a cutting-edge technology that employs electromagnetic or electrostatic coupling in the radio frequency section of the electromagnetic spectrum to uniquely identify a person, animal, or item. The RFID tag consists of a tiny RF transmitter that sends an encoded radio signal to the tag in order to interrogate it, as well as a receiver that receives the message and answers with the tag's identifying information. The RFID system design provides a technique for distinguishing between several tags that may be within the RFID reader's range K, Mahajan, P, Pandey and B, Pandher (2010).

In order to create an attendance management system, an RFID-based system was created in this project. A GSM connection is used to link the RFID reader, which is a low-frequency reader (125 kHz) (SIM 900A). The Attendance Management System is responsible for the entire system's functions, such as displaying real-time ID tag transactions, registering IDs, and tracking attendance.

An integrated circuit for storing and processing data, modulating and demodulating a radio-frequency (RF) signal, and other dedicated functions, and an antenna for receiving and delivering the signal, make up the bulk of RFID tags.

Figure 5 - RFID Tag

MLX96014 Non-Contact Temperature Sensor: The MLX90614 is an infrared thermometer that measures temperature without making contact. The signal conditioning ASIC and the IR sensitive thermopile detector chip are both housed in the same TO-39 container. The MLX90614 thermometer includes a low noise amplifier, 17-bit ADC, and powerful DSP unit, resulting in outstanding precision and resolution. The thermometer is factory calibrated with a digital SMBus output that provides complete access to the measured temperature throughout the whole temperature range(s) with a 0.02°C resolution over the entire temperature range(s).

The user can adjust the digital output to pulse width modulation (PWM). As is customary, the 10-bit PWM is programmed to continuously transmit the observed temperature in the range of -20 to 120°C, with an output resolution of 0.14°C. It's a non-contact temperature sensor that's used to figure out how hot or cold the human body is (HBT).The MLX90614 has 4 pins which are Vin,

GND, SCL and SDA. The SDA of the micro-controller is interfaced with the SDA of the MLX90614 and the SLC of the micro-controller is interfaced with the SLC of the MLX90614.

Figure 6 - MLX96014 Non-contact Temperature Sensor

GSM Module (Sim900A)

The SIM900A modem is based on the SIMCOM SIM900A dual band GSM/GPRS modem. It uses 900/MHz frequencies to operate. These two bands may be automatically searched by SIM900A. Modifying the frequency bands is also possible using the AT command. The AT command can be used to set the band range between 1200-115200. The GSM/GPRS modem's inbuilt TCP/IP stack allows the user to connect to the internet through GPRS. The SIM900A is a compact and reliable wireless module. This is a complete GSM/GPRS module in SMT style, with a powerful single-chip CPU based on the AMR926EJ-S core, allowing for small dimensions and low-cost solutions.

Figure 7 - GSM Module SIM900A

Circuit Diagram: Below is the circuit diagram that contains the above components used for the overall design.

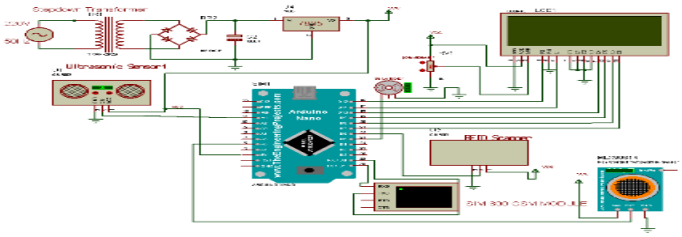

Figure 8 - Circuit Diagram

RESULT AND DISCUSSION

Test Performed

Prior to and after the complete assembly and interconnection of the system components, the following tests were conducted:

i. Component Test: Before all components were used, they were subjected to various tests to ascertain their proper functionality. The digital multimeter was used to ascertain the proper functionality of each component.

ii. Jumper/wiring Test: The wiring of the circuit was done on a breadboard while the soldering was done on a Vero board. Short circuit and open circuit tests were carried out using the digital multimeter.

Result Obtained

Table 1 below shows the results obtained after testing at temperature threshold value of 38.0 ^{0} c.

Table 1 - Result Table

S/N	NAME OF EMPLOYEE	ID NUMBER	TEMPERAURE VALUE	SERVO MOTOR
1	EMPLOYEE 1	25:B5:E1:D1	38.5℃	CLOSE
2	EMPLOYEE 2	0A:6E:19:06	36.0℃	OPEN

After the components have been simulated using Proteus Professional, the components were laid on the breadboard to form the circuit. After testing the components on the breadboard, it was transferred to the Vero board where it was finally implemented. The plates below show the interior and casing views of the project.

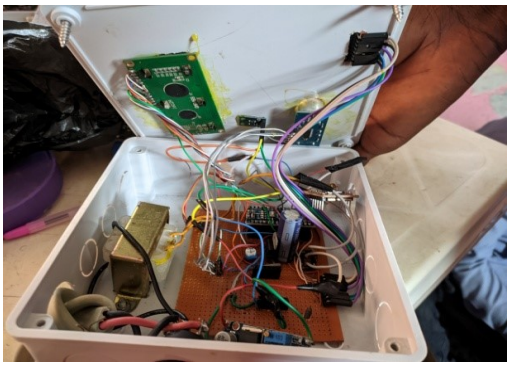

Figure 4 - Interior View

Figure 5 - Exterior View

CONCLUSION

Low-cost RFID and sensor system applications may provide organizations with a dependable and accurate diagnostic monitoring system, as well as an accurate attendance tracking system. This research presents a real-time monitoring of body temperature and attendance at work utilizing an embedded platform. This platform is wirelessly linked, allowing it to monitor and display real-time data from installed temperature sensors, as well as communicate temperature and attendance information to the relevant individuals inside the company.

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