EFFICACY OF THE LM35A PRECISION TEMPERATURE SENSOR FOR FIRE DETERRENCE BASED ON TICK TIME TRIAL

Ramil B. Arante,* John O. Estillore
College of Industrial Technology and Teacher Education, Caraga State University Cabadbaran City, Philippines
E-mail address: rbarante@csucc.edu.ph

ABSTRACT. *This study evaluated the efficacy of the newly developed prototype of the LM35A precision temperature sensor to deter fire based on the tick time trial. Varied temperatures were used as inputs during the simulation trial to identify the most effective program codes of the microcontroller. In testing its sensing efficacy, the researchers used the experimental method, which records and compares outputs during a simulation series to produce a more accurate temperature-sensing device to deter fire. Findings reveal that after a series of simulations, the average tick time of the device under 40 Degrees Celsius is about 2098 milliseconds, 60 Degrees Celsius is about 2580 milliseconds, 80 Degrees Celsius is about 2402 milliseconds, and 100 Degrees Celsius takes about 1378 milliseconds to send the signal to trigger the alarm. Since the LM35A temperature sensor covers only a specific detection location, placing the device in its identified precise areas of the electrical system is recommended. The device operates in programming mechanisms, delimiting users to use it. Users must be trained in programming setups and possess the basic knowledge to use them properly. The device also utilized the LM35A Integrated Circuit as a temperature sensor to trigger the alarm as the first warning stage. Fire deterrence's next phase signals to trip off the circuit breaker if nobody is around during the alarm.*

Keywords: Efficacy, Fire deterrence, LM35A, Temperature sensor, Tick time.

1. INTRODUCTION

Fire is a natural event resulting in significant property loss and human lives. Fire breakout is likely to occur anytime and anywhere; it is a sudden occurrence that demands a predictable security system to counter. Inadequate fire materials and electric short circuits caused by defective wiring are two of the most common causes. With the improvement of new technology, various innovative advanced systems have been designed and implemented through multiple platforms anchored to the 17th sustainable development goals under target 9.5 that help to enhance research and upgrade industrial technologies in various areas of developing countries [1].

Many fire alarm developers use the Arduino Uno microcontroller to build automated alarms and numerous similar systems, such as sensors and detectors. Present studies about microcontroller technology indicate various fire alarm systems developed and constructed involving detecting smoke and heat temperature and using Arduino as a microcontroller. Arduino is popular because it is a well-known open-source microcontroller-based kit for creating digital devices and interactive tools that can interact with LEDs, LCD displays, switches, buttons, motors, speakers, and a variety of other components [2].

Bahrudin et al. [3] designed and built a fire alarm system that promptly warns users of events and asks permission before reporting to the fire department. They will construct a fire alarm system with a cheaper single-board computer, the Raspberry Pi, an Arduino Uno microcontroller board, and mid-level and high-level programming languages.

Kang, Jihoon & Basnet, Shreya & Farhad, and Sardar [4] presented an innovative fire-alarm system that includes a smoke sensor and a sound sensor that can detect the smoke and noise of an analog fire alarm system and can quickly alert the user of the status. They put the intended innovative fire-alarm system into action and ran tests to determine its effectiveness. The findings reveal the system is reliable under various smoke and alarm noise circumstances.

N N Mahzan et al. [5] developed a residential fire alarm system using an Arduino-based GSM module. The project uses an Arduino Uno board intended for house safety to avoid fire accidents that may occur to residents and other property inside the house. The ATmega328 regulates the home fire alarm sent out via the temperature sensor. The heat from the fire is detected using a temperature sensor. The user will receive an alert message via the GSM module via a short message service (SMS). When the system detects a temperature of 40 degrees Celsius or higher, it will display an alarm warning on the LCD and send an SMS alert to the user simultaneously.

Dr. Osamah Ibrahim Khalaf et al. [6] presented a concept using an Arduino gadget and a temperature sensor called a Flame sensor to identify and prevent fire outbreaks. It measures the quantity of heat produced by a fire or in a specific location in our home, business, or other sites. Because fire stations often take a long time to reach a fire outbreak area, these sensors will serve as an early warning system, delivering an e-mail notification to our mobile phones and fire stations if a fire outbreak happens. Fires are a big worry in homes, offices, and enterprises, among other places. It is risky and necessitates security and supervision to prevent the loss of life and property.

Objectives of the Study

This study aimed to evaluate the efficacy of the newly developed prototype of the LM35A precision temperature sensor to deter fire based on the tick time trial. Varied temperatures were used as inputs during the trial to identify the most effective program codes of the microcontroller.

2. METHODOLOGY

2.1 Research Model

The study employed the experimental method design, which records and compares outputs during a simulation series to produce a more accurate temperature-sensing device to deter fire. This method is described as a systematic investigation into designing and developing programs, procedures, and products that must achieve a specified standard and be effective [7]. The efficacy of the LM35A precision temperature sensor can be set through program codes in the Arduino Microcontroller.

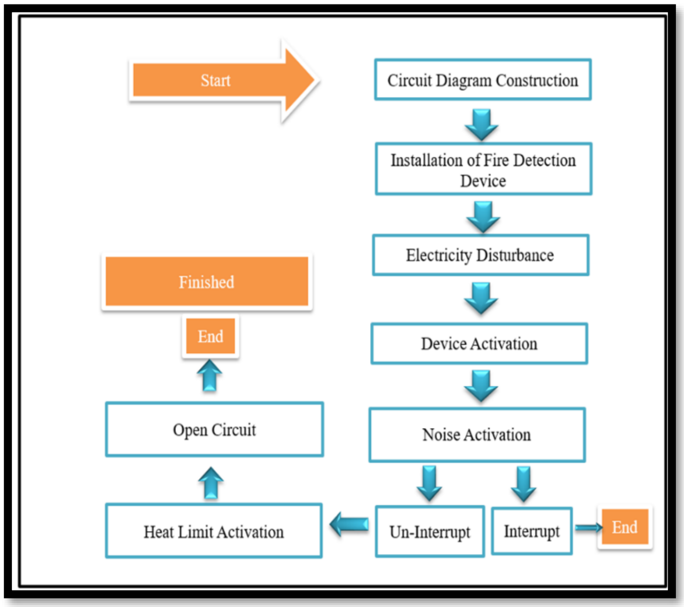

Figure 2. Block diagram of the operational flow of LM35A Precision Temperature Sensor.

Figure 2 presents the operational flow of the LM35A precision temperature sensor device explained as follows:

1. Installation of Fire Detection Device. The developed Device will have to be installed along the electrical pathways in the circuit of the identified loads.
2. Electricity Disturbance. The presence of electrical disturbance or interruptions in the circuit, such as overload of the equipment and appliances or short circuit wirings, creates excessive heat that activates the Device.
3. Device Activation. The device activation occurs when it detects electrical disturbances along the pathways where the device is installed.
4. Noise Alarm. The noise alarm occurs when the temperature reaches the set heat limit to trigger the alarm. It signals to anybody in the perimeter that something is wrong in the electrical circuit and needs immediate attention.
5. Interrupt. When the noise alarm is activated, and someone interrupts the signal flow by fixing the circuit problem's source, the device's sensing operation will end. The process will then automatically revert to normal.
6. Un-Interrupt. Suppose nobody interrupts the alarm features in unattended establishments or where the problem source is unreachable/unfixable. In that case, the device will continue sending signals until it reaches the activation of heat limits.
7. Heat Limit Activation. When the heat reaches its limit, the device will send signals to the main breaker to trip off to prevent fire.
8. Open Circuit. The Open Circuit occurs when the breaker trips off the primary source of electricity to prevent further damage.

2.2 Locale of the Study

This study was conducted at Caraga State University Cabadbaran City, Philippines. It is a government-run institution of higher learning specializing in producing technology-capacitated graduates. It is a globally engaged university excelling in science, engineering, and the arts [8].

3. RESULTS AND DISCUSSION

The researchers also did a simulation of data and programming. Because Arduino is the main board, the microcontroller on it, the ATmega328, is used as the central controller to manage the circuit. It is a well-known open-source microcontroller-based kit for creating digital devices and interactive tools that can interact with LEDs, LCD displays, switches, buttons, motors, speakers, and a variety of other components. The Arduino system provides a set of analog and digital pins that can be integrated into various other boards and circuits with various functions in a design. The Arduino board has a USB serial communication interface for loading codes from a computer. For this reason, Arduino has created its own software called the "integrated development environment" (IDE), which fully supports the C and C++ programming languages [9].

LM35A Prototype Simulation Data

Table 3 is the tick time trial of the device based on the 40 Degrees Celsius program set temperature. Results in the table show that trial 3 has the shortest tick time of about 1150 milliseconds before it has a beep. On the other hand, trial 5 has the longest tick time of about 2860 milliseconds. It is also noted that the average tick time for 40 degrees is about 2098 milliseconds to send the signal to trigger the alarm.

Table 3. Trial on Tick Time of the Device based on the 40 Degrees Celsius.

Set Temperature	No. of Trials	Time function	Remarks
40 Degrees Celsius	Trial 1	1180 milliseconds	Sound Recorded
	Trial 2	2530 milliseconds	Sound Recorded
	Trial 3	1150 milliseconds	Sound Recorded
	Trial 4	2770 milliseconds	Sound Recorded
	Trial 5	2860 milliseconds	Sound Recorded
Average time		**2098 milliseconds**	**Sound Recorded**

Table 4 is the tick time trial of the device based on the 60 Degrees Celsius program set temperature. The researchers observed that once the program change, which is 40, then set to 60, it shows that it takes a long time to beep, and there is a delay in the signal. Trial 4 is the longest tick time, and it takes 3340 milliseconds to send a signal to the buzzer.

Table 4. Trial on Tick time of the devices based on the 60 Degrees Celsius program

Set Temperature	No. of Trials	Time function	Remarks
60 Degrees Celsius	Trial 1	3180 milliseconds	Sound Recorded
	Trial 2	1320 milliseconds	Sound Recorded
	Trial 3	2410 milliseconds	Sound Recorded
	Trial 4	3340 milliseconds	Sound Recorded
	Trial 5	2650 milliseconds	Sound Recorded
Average time		**2580 milliseconds**	**Sound Recorded**

Table 5 is the trial on tick time of the device based on the 80

Degrees Celsius program set temperature. It reveals that setting it to 80 degrees obtained an average tick time of 2402 milliseconds. It is also noticeable that trial 5 has the shortest tick time of about 1330 milliseconds, which detected the heat quickly as it sent a signal immediately to trigger the alarm. The response is swift compared to other trials.

Table 5. Trial on Tick time of the devices based on the 80 Degrees Celsius program

Set Temperature	No. of Trials	Time function	Remarks
80 Degrees Celsius	Trial 1	2770 milliseconds	Sound Recorded
	Trial 2	2680 milliseconds	Sound Recorded
	Trial 3	2600 milliseconds	Sound Recorded
	Trial 4	2630 milliseconds	Sound Recorded
	Trial 5	1330 milliseconds	Sound Recorded
Average time		**2402 milliseconds**	**Sound Recorded**

Table 6 is the trial on tick time of the device based on the 100 Degrees Celsius program set to temperature. The table shows that as the researcher increased the temperature to 100 degrees, it quickly detected heat. It is the fastest response the researchers observed. Because during the test, the electrical system tested was already hot, it caught up quickly and sent the signal to the buzzer at the soonest possible time. The average tick time is also the shortest at 1378 milliseconds.

Table 6. Trial on Tick time of the devices based on the 100 Degrees Celsius program

Set Temperature	No. of Trials	Time function	Remarks
100 Degrees Celsius	Trial 1	1040 milliseconds	Sound Recorded
	Trial 2	2180 milliseconds	Sound Recorded
	Trial 3	1200 milliseconds	Sound Recorded
	Trial 4	1290 milliseconds	Sound Recorded
	Trial 5	1180 milliseconds	Sound Recorded
Average time		**1378 milliseconds**	**Sound Recorded**

Through further observation and analysis of the device, the researchers were able to identify and complete the desired programming codes, as shown in Tables 3, 4, 5, and 6. Under four device simulations, the tick time measurement was done for its sensing accuracy. Program codes that set temperature limits were adjusted to obtain the desired efficacy [10].

4. CONCLUSIONS

Based on the simulation data, it is concluded that the LM35A precision temperature sensor will be effective when:

1. It is placed at a specific location in the electrical system that bears the highest temperature;
2. The set temperature limit at the Arduino microcontroller is on average; and
3. The users are trained in programming setups and possess the basic knowledge to use them properly.

5. RECOMMENDATIONS

Based on the findings and the conclusions, the following recommendations are suggested:

1. Users of the device may first seek the advice of the experts as to where is the precise location to install the sensor.
2. A training manual may be developed to teach the prospective users the proper use of the device.
3. Further simulations are recommended to improve its efficacy when installed at an area in the electrical system that produces less heat.

6. REFERENCES

[1] Dauda, M. U. H. A. M. M. A. D. S. H. A. Z. A. L. I. (2020). Arduino-Based Fire Detection and Control System. International Journal O Engineering Applied Sciences and Technology, 4(11), 1–7. https://www.ijeast.com/papers/447-453,Tesma411,IJEAST.pdf

[2] HOME AUTOMATION USING ARDUINO. (2018). International Journal of Recent Trends in Engineering and Research, 195–199. https://doi.org/10.23883/ijrter.conf.02180328.032.9ehlj

[3] Bahrudin, S.B., Kassim, R.A., Buniyamin, N. (2013). Development of Fire alarm system using Raspberry Pi and Arduino Uno. International Conference on Electrical, Electronics and System Engineering (ICEESE), https://doi/10.1109/ICEESE.2013.6895040

[4] Kang, Jihoon & Basnet, Shreya & Farhad, Sardar. (2020). Smart Fire-Alarm System for Home. https://doi.org/10.1007/978-3-030-22354-0_42.

[5] N N Mahzan, N I M Enzai, N M Zin and K S S K M Noh. (2018). Design of an Arduino-based home fire alarm system with a GSM module. Journal of Physics. DOI:10.1088/1742-6596/1019/1/012079

[6] Khalaf, O. I., Abdulsahib, G. M., & Zghair, N. A. K. (2019). IOT fire detection system using a sensor with Arduino. AUS, 26, 74-78.

[7] Arante, R. B. (2018). Effectiveness of the improvised logic gates simulator in basic digital electronics instruction. *International Journal of Learning and Teaching*, 10(4), 367–375. https://doi.org/10.18844/ijlt.v10i4.3634

[8] Arante, R. B., Alan, F. A. O., & Beray, M. J. M. (2022). EXPLORATORY ANALYSIS OF STUDENT'S AWARENESS AND INVOLVEMENT IN CAMPUS ORGANIZATIONS: ITS INFLUENCE ON THEIR LEADERSHIP SKILLS. *Science International Lahore*, 34(2), 111-115.

[9] Obanda, Z. S. (2017). Multi-sensor fire detection system using an Arduino Uno microcontroller (Thesis). Strathmore University. Retrieved from http://su-plus.strathmore.edu/handle/11071/5686

[10] Arante, R.B. (2018) Design and Assembly of an Improvised Logic Gates Simulator. World Journal of Engineering and Technology, 6, 839-853. https://doi.org/10.4236/wjet.2018.64056