IJASRM

International Journal of Advanced Scientific Research and Management, Vol. 2 Issue 8, August 2017.

www.ijasrm.com

ISSN 2455-6378

Automatic Temperature Regulator System for the Home Utilizing Green Technology

FA Azidin, TT Wee, MR Roslan, MNS Razali, AS Ahmad Zainuddin

Faculty of Electronics and Computer Engineering, Universiti Teknikal Malaysia Melaka, 76100 Durian Tunggal, Melaka, Malaysia.

Abstract

This paper describes an automatic temperature regulator system for home application based on green technology. To enhance comfort in the home, an automatic control mechanism regulates the indoor temperature regardless of external weather conditions. Using an Arduino microcontroller, a sprinkler is activated to cool the house when its internal temperature exceeds a set point, and a heater is activated if the temperature falls below another set point. In the Malaysian climate, the cooling mechanism is expected to operate much more frequently than the heating component. The advantage of this system lies in its low cost and low energy consumption since, unlike an air conditioner, no electrical compressor is needed. As the cooling system is water-based, this is essentially a 'green' technology. A trial operation of the automatic temperature control system was successfully conducted in a model house. Future development of the sensor system could be expanded to incorporate a fire alarm and a burglar alarm.

Keywords: *automatic temperature, green technology, sprinkler, heater, control system.*

1. Introduction

While a country like Malaysia does not experience extreme temperatures, the weather can change quite quickly from being dry and hot to rainy and cold. A house is where its residents seek refuge from such sudden changes in the weather. It is, therefore, useful if the indoor temperature of the house can be maintained at a comfortable level. During the day, radiation from the sun heats up buildings, especially roof tops, causing the indoor temperature to reach 35˚ - 40˚ C. Such temperatures can be uncomfortable for its dwellers, even with the fan running. An air-conditioner is one solution but it is a high energy consumption appliance that is expensive both to purchase and to run. Moreover, air-conditioners use coolants, some of which are hazardous to the environment [1]. At night or on a cold rainy day, the temperature may drop below 22˚C, considered cold for many Malaysians. A heater can then be used to increase the room temperature.

There are many electrical devices that can reduce or increase room temperature but they are mainly separate stand-alone devices. In this regard, a microcontroller can be used to co-ordinate the operation of these devices [2]. While there are many types of controllers available in the market, most of them tend to be expensive. For the Automatic Temperature Control System employed in the present study, the Arduino open source electronics platform was chosen because it was relatively inexpensive and its current design facilitated easy programming [3].

The Automatic Temperature Control System regulates the temperature of the house within set limits by sprinkling water on the roof surface when it is hot, and activating the heater when it is cold [4]. Water or a water-based coolant is used as the preferred heat-transfer medium because of its high heat capacity, low cost, and the fact that it is a green medium. Thus, this innovation is environment-friendly in that it cools the house interior using reduced energy as compared with air-conditioning and heater systems.

2. Methodology

The system programming process is presented in the flowchart in Figure 1. First, variables for the controller were set; these include the position of cursor on the LCD 16x2 display and the output and

IJASRM
International Journal of Advanced Scientific Research and Management, Vol. 2 Issue 8, August 2017.
www.ijasrm.com
ISSN 2455-6378

input pins in the Arduino Uno r3 microcontroller board [5]-[7]. The Texas Instruments LM35

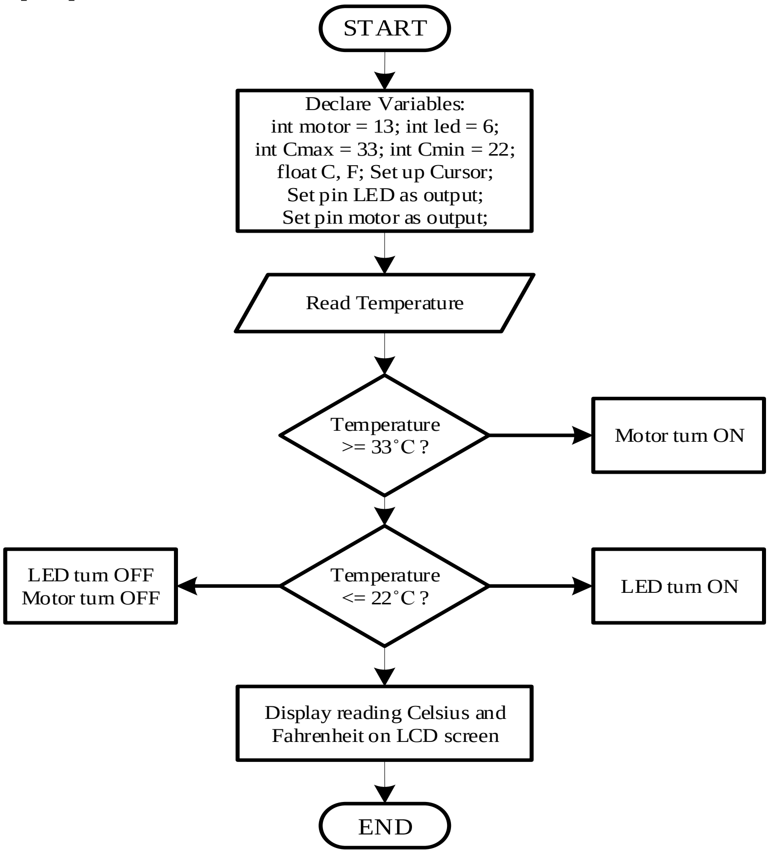

Figure 1: The flow chart of programming process

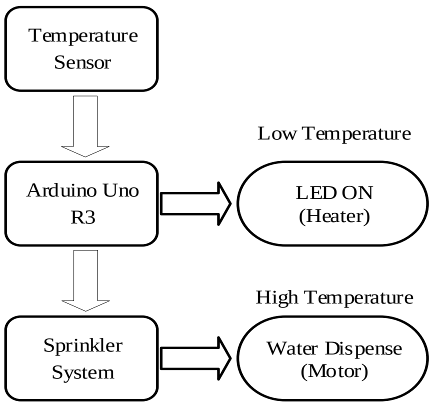

Figure 2: Block diagram of the system.

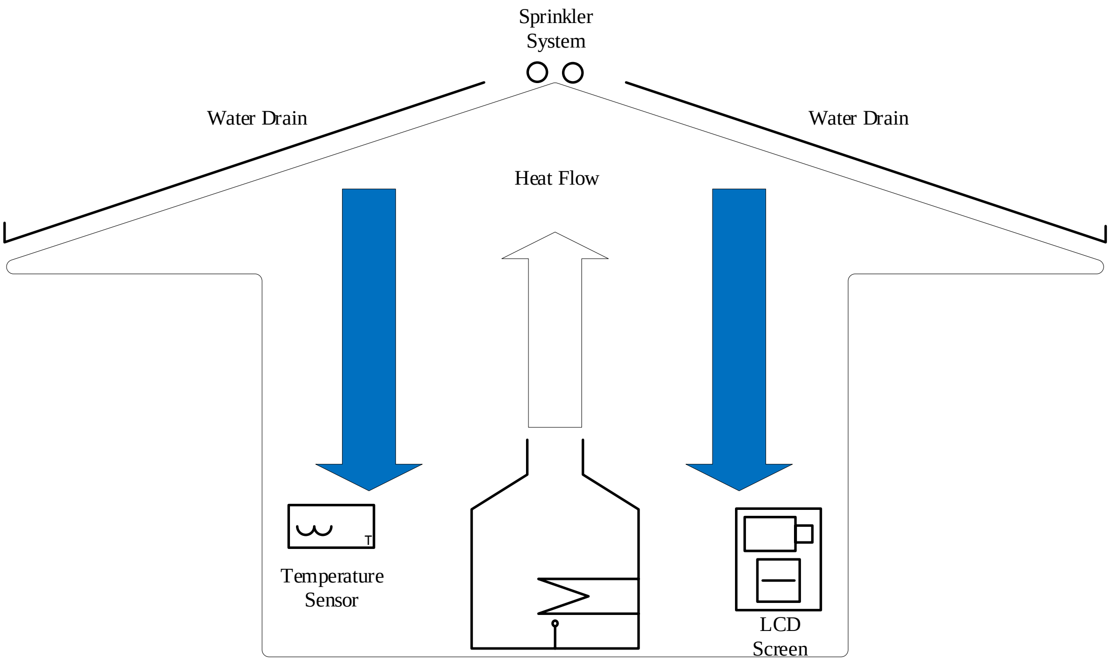

Figure 3: Design of a house prototype.

IJASRM International Journal of Advanced Scientific Research and Management, Vol. 2 Issue 8, August 2017.
www.ijasrm.com
ISSN 2455-6378

temperature sensor read the ambient temperature; this appeared on the LCD display in degrees Celsius and Fahrenheit. The analog input signal was converted into a digital output which was processed by the Arduino Uno r3 microcontroller [8]. When the temperature reached or exceeded 33˚C, the sprinkler system was activated. When the temperature reached 22˚C or lower, an LED (representing the heater which was not installed for the demonstration in this study) was lit. In actual operation, the heater would have been turned on at this juncture. When the temperature was between 22˚C and 33˚C, both the sprinkler system and the LED were turned off (Figure 2).

For the trial run of the prototype, a small house was built using plastic boards. The temperature sensor and LED (representing the heater) were placed inside the house. The sprinkler system installed on the roof top was operated by a DC motor that dispensed water through tubing leading from a water tank from which the water was re-cycled into the sprinkler system. The LCD display was installed outside the house to show the temperature, see Figure 3.

3. Results

The Automatic Temperature Control System allowed users to maintain the temperature of a room or other indoor location at a specific temperature range which, in the present demonstration, was between 22 ˚C to 33 ˚C. This temperature band was deemed ideal for living comfort.

Basically, the system consisted of one input and two outputs. The system controller, the Arduino Uno R3, received the input from the temperature sensor. One system output was linked to the LED (representing the heater in this study), and the other to the DC motor (pump) that delivered water to the sprinkler system. The LM35 temperature sensor was selected for this study as it was more sensitive as compared with other similar products. In the experiment, there were three possible controller settings, depending on whether the temperature was <= 22˚C, between 22˚C and 33˚C, or >= 33˚C (Table 1).

Table 1: Output of sprinkler system and heater when temperature <=22°

Temperature, (°C) / Condition	Output	
	Sprinkler System (DC motor)	Heater (LED)
<=22 / Condition 1	OFF	ON
22-33 / Condition 2	OFF	OFF
>=33/ Condition 3	ON	OFF

3.1 Condition 1

In the first condition, when the room temperature dropped below 22°C, the output to the LED (representing the heater) was in the ON state while the sprinkler system was turned OFF. Figure 4 shows a simulation of the condition.

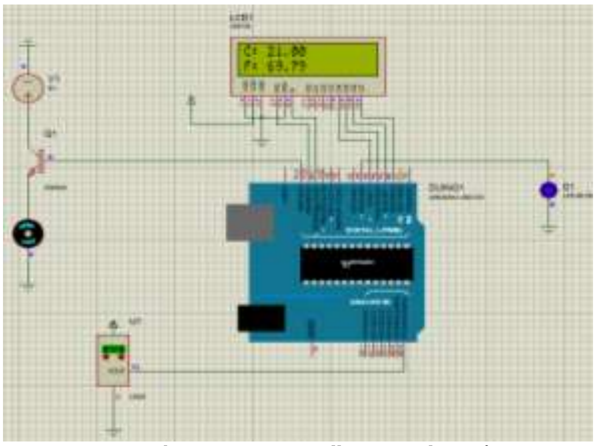

Figure 4: The temperature smaller or equal to 22˚C.

3.2 Condition 2

In the second condition, when the room temperature rose to between 22°C and 33°C (the desired temperature range), the LED (representing the heater) turned OFF. Under this condition, both the cooling system (DC motor) and the heating system (LED) were not triggered (remained in the OFF position). The simulation of this condition is presented in Figure 5.

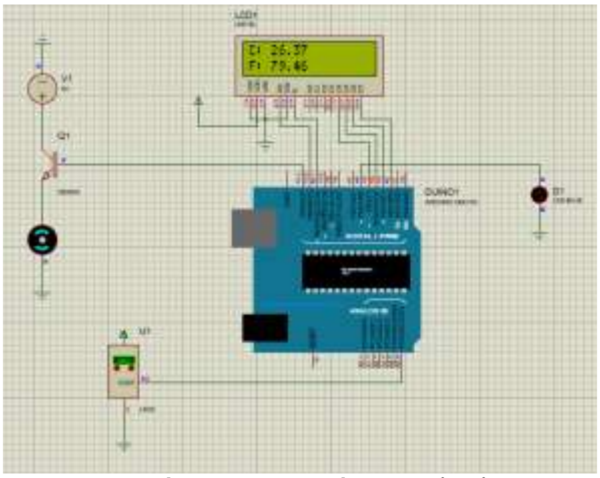

Figure 5: The temperature is in between 22˚- 33˚C.

3.3 Condition 3

In the third condition, when temperature rose to 33°C, the output voltage activated the DC motor (ON state). The motor powered the sprinkler system which was a water distribution piping system that channeled water to the roof top. The water drained over the roof of the house, lowering the indoor temperature during the evaporative process. The water from the roof was channeled along gutters and collected into a tank for recycling in the sprinkler system. The simulation of condition 3 is shown in Figure 6.

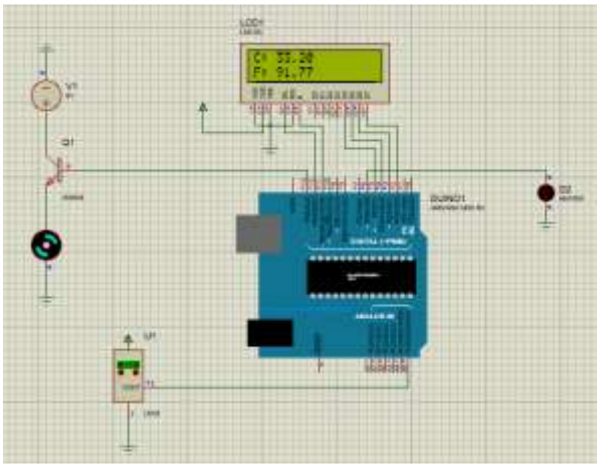

Figure 6: The temperature greater or equal to 33˚ C.

The temperature could be regulated under any of the above three conditions, but a situation where both the LED and DC motor were triggered at the same time could not occur.

4. Discussion

Environmental sustainability involves making decisions and taking actions that are conducive to the protection of the natural environment. It is essential nowadays that product design take into consideration the preservation of the eco-system [8]. The automatic smart temperature control system supports environmental sustainability by avoiding the use of the air-conditioner which consumes much higher energy. In addition, refrigerants used by many air-conditioners can contribute to depletion of the ozone layer in the atmosphere, leading to global warming.
Economic sustainability is one of strategies for utilizing existing energy resources optimally and responsibly over the longer term. From the business viewpoint, economic sustainability allows a company to continue functioning profitably over time [9]. This philosophy underpins the smart temperature control system described in this report. Temperature regulation by the system is not limited to the cooling process. In Malaysia, the weather is considered cold when the temperature falls below 20˚C, and the smart temperature control system is designed to warm up the house interior automatically. The ease and simplicity by which the microcontroller can regulate temperature would appeal to consumers.
Another important aspect of sustainable development is social sustainability that allows full access to available resources and amenities by all strata of society, leading to the realization of "inter-generational equity" [10]. In this era of global climate change, basic home comfort should be available to all, especially the elderly who are more susceptible to illnesses caused by fluctuations in indoor ambient temperature. The smart temperature control system would help to overcome this problem. Future development of the sensor system could be expanded to incorporate a fire alarm and a burglar alarm.

5. Conclusions

The temperature control system described in this report provides its user with a convenient and inexpensive way to attain a pleasant indoor environment while optimizing the usage of electricity. In the trial operations using a model house, the system's circuit functioned well in meeting all the aims and objectives of its design.

Acknowledgements

Basically this project was prepared for Faculty of Electronics and Computer Engineering, Universiti Teknikal Malaysia Melaka (UTeM), as a requirement of third year student in Integrated Design Project to complete the degree program of Electronics Engineering.

References

[1] "Coolant," *Wikipedia*. [Online]. Available: https://en.wikipedia.org/wiki/coolant. [Accessed: 27-May-2016].

[2] J. T. Lue and J.-R. Yang, A microcomputer-based programmable temperature controller, IEEE Transactions on Instrumentation and Measurement, Vol 1 (1): Page No - 87-91, (1987).

[3] Arduino - ArduinoBoardUno," Arduino - ArduinoBoardUno. [Online]. Available:

https://www.arduino.cc/en/main/arduinoboarduno. [Accessed: 27-May-2016].

[4] L. Feng, Z. Hui and T. Yan, Automatic Temperature and Humidity Control System Using Air-Conditioning in Transformer Substation, Asia-Pacific Power and Energy Engineering Conference, Page No - 1-4, (2012).

[5] W. Lumpkins and S. Giertz, The Evil Goat (Arduino Project), IEEE Consumer Electronics Magazine, Vol 4 (3): Page No - 102-103, (2015).

[6] Arduino - ArduinoBoardUno, Arduino - ArduinoBoardUno. [Online]. Available: https://www.arduino.cc/en/main/arduinoboarduno. [Accessed: 27-May-2016].

[7] Make Your Own Temperature Controller with an Arduino, MakeUseOf. [Online]. Available: http://www.makeuseof.com/tag/make-your-own-temperature-controller-with-an-arduino/. [Accessed: 27-May-2016].

[8] Tarah S.A. Wright, Definitions and frameworks for environmental sustainability in higher education, International Journal of Sustainability in Higher Education, Vol 3 (2): Page No - 203 – 220, (2002).

[9] R. M. Dangelico and D. Pujari, Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability, Journal of Business Ethics, Vol 95 (3), Page No - 471-486, (2010).

[10] A. Gruebler and Y. Fujii, Inter-generational and spatial equity issues of carbon accounts, Energy, Vol 16 (11-12), Page No - 1397- 1416, (1991).