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# ELECTROTERMOSTAT DESIGN FOR ROOM THERMAL COMFORT CONTROL

**Oktay HACIHAFIZOĞLU**
*The University of Trakya*

**Ömer Faruk SEL**
*The University of Trakya*

**Özcan ÇETİNKAYA**
*The University of Trakya*

**Erdem YAZGAN**
*The University of İstanbul*

**Abstract**

*In this study, a microcontroller which is based on electro-thermostat is designed for indoor spaces, which is heated by a natural gas-fired heating system. Thermal comfort is controlled by opening and closing a valve and the valve connects to the radiator by measuring the room temperature and humidity in order to reach the specific or desired room value and in order to fix the room temperature to that value. In addition, when the windows are open for more than 1 minute with the limit switches, which are attached to the room windows. In this case, the system cuts also the water out to the radiator and so, it saves energy. Furthermore, there is a DHT11 temperature and humidity sensor to measure the room temperature and humidity in the system with the help of a potentiometer in order to set the room temperature to the desired setting value and also, the screen, which is depended on the display, has the measured humidity and temperature information and the set temperature value of the room and finally, the development board with the Atmel-based ATmega328P microcontroller has been used. Experimental findings have discussed and recommendations for the development of thermal comfort systems have been presented.*

**Keywords:** Room thermostat, efficient energy, thermal comfort.

## INTRODUCTION

Nowadays, due to the decrease in fossil energy sources, energy unit prices have increased, therefore, researchers has been working on new energy sources and on the other hand, they have been looking for ways to make or use existing energy sources efficiently. Nowadays, indoor comfort temperature is controlled by smart systems between 20-25 $^0$C depending on the work and season (Coskun et al, 2009). However, when the existing building stocks are considered, because the indoor comfort temperature is not controlled by smart systems, the energy loss is very high. This means that the more public energy expenditure and the greater share of the country's budget for energy expenditure. This situation leads to an increase in the current account deficit and increases the foreign dependency (Doğan and Yılankıran, 2015). In addition, the excess energy used often negatively affects heat comfort. It is possible to make the heat comfort stable and to use the energy more efficiently with small modifications to the existing systems where the use of electronics is easier.

In this study, it is aimed to keep the indoor comfort temperature at the desired target temperature and to use the energy source efficiently with a room thermostat designed for the hot water flow of a radiator used in a closed environment heated by natural gas. In order to reach the desired set value and to fix the indoor comfort temperature with the system created in this study; By measuring the indoor room temperature, outdoor temperature and humidity, the indoor thermal comfort control is performed by opening and closing a valve connected to the radiator.

In addition, with the limit switches installed in the room windows, when the windows remain open for more than 1 minute, the system cuts the water out to the radiator and so, it saves some more energy.

System includes DHT11 temperature and humidity sensor for measuring indoor room temperature and humidity, DS18B20 temperature sensor for measuring outdoor temperature, magnetic door switch to determine when the window is open, a valve for controlling the flow of water through the radiator, and a valve with measured internal room and outdoor temperatures ArduinoUno development board, where all data from system elements are processed and controlled by 2x16 LCD text display showing warning and target temperature and control software prepared.

## SYSTEM COMPONENTS

The DHT11 has a high reliability and stable 8-bit microprocessor for long-term operation. The fast-responding calibrated digital temperature and humidity sensor measures 0 to 50 $^{0}$C ± 2 $^{0}$C error, 20 to 90% ± 5% error and relative humidity. is an advanced sensor unit that outputs the signal. (Int-1, 2019)

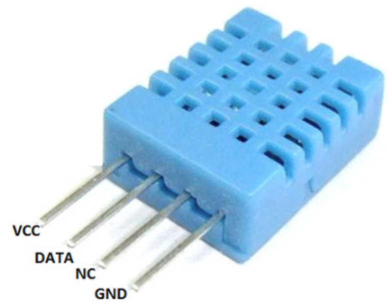


***Fig. 1.*** DTH11 Temperature and Humidity Sensor

The DS18B20 temperature sensor (1-Wire) is a temperature sensor that converts temperatures from -10 $^{0}$C to + 85 $^{0}$C to a digital output with a resolution of 9-12 bits using the single-line communication protocol with an accuracy of ± 0.5 $^{0}$C (Int.-2, 2019).

***Fig. 2.*** DS18B20 Temperature Sensor

The magnetic door switch relay with tongue contact has a normally open contact, and when the magnet is at least 20mm closer to the relay, the tongue contacts close to inform the microcontroller that the window is closed. Of course, when the magnet moves more than 20mm away from the tongue contacts, it is a switch with a tongue contact relay and a set of natural magnets that sends information that the window is open because the contacts are open. (Int-3, 2019)

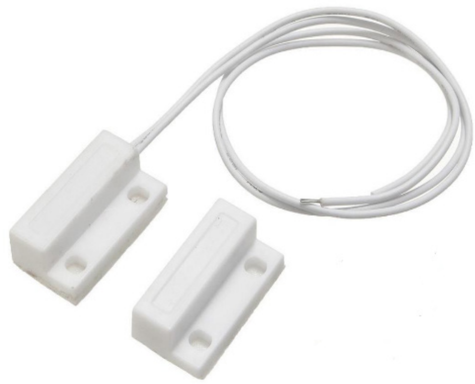

***Fig. 3.*** Magnetic Door Switch.

The TC1602 is an LCD display that shows the indoor room temperature and humidity measured by the sensors in the system, the outdoor temperature and whether the window and valve are open in 2 rows and 16 columns. (Int.-4, 2019)

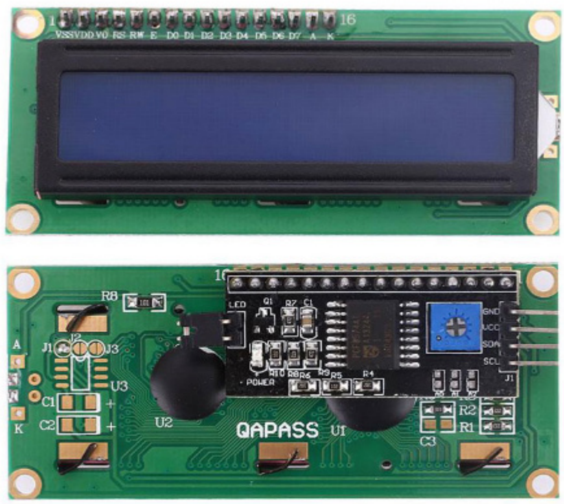


***Fig. 4.*** 2x16 TC1602 LCD Display

AQT15SP is a solenoid valve that can operate with a minimum pressure of 0.02 MPa of 3/4 "inlet and outlet pipe diameters working with 12V to control the water flow through the radiator in the system (Int.-5, 2019).

***Fig. 5.*** AQT15SP Solenoid Valve

Ardunio Uno is a development board with 6 analog inputs, 14 digital inputs and outputs and ATMEL - based ATmega328 microcontroller (Int.-6, 2019).

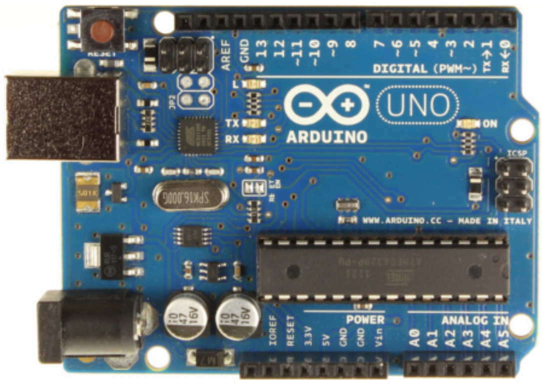


***Fig. 6.*** Arduino Uno

## SYSTEM OPERATING CYCLE

Algorithm flow chart of the control software prepared for the system is shown in Figure 7, when the system is closed, the temperature and humidity values are measured and compared with the set temperature. In case the temperature exceeds the set temperature, it closes the valve and prevents hot water from entering the radiator. When the window is open, it gives a waiting time of one minute, and in case of exceeding the waiting time, it sends a signal to the valve to save energy and closes the hot water inlet.

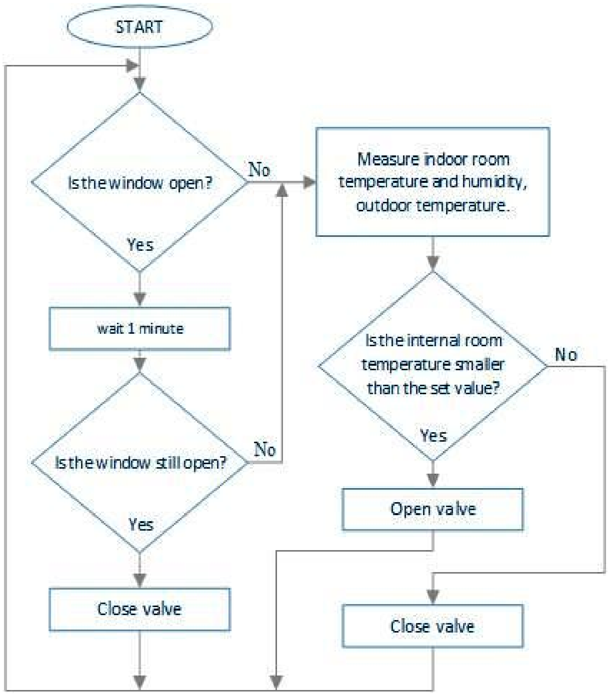


***Fig. 7.*** Algorithm Flow Chart


***Fig. 8.*** The Differences of Desired and Indoor Heat Values

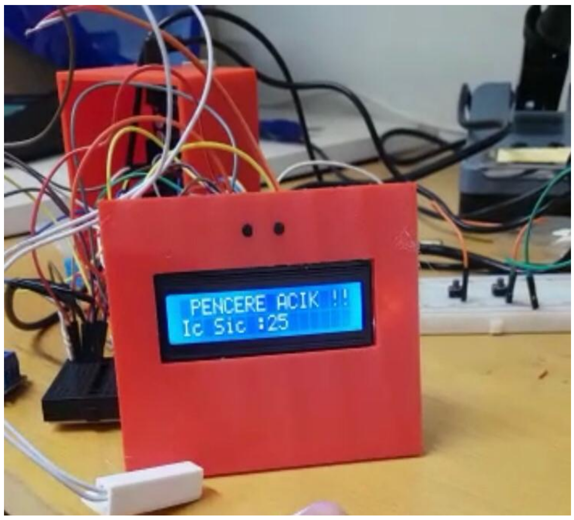


***Fig. 9.*** Room Thermostat Operations

## CONCLUSIONS AND RECOMMENDATIONS

In this study, it was realized that the indoor comfort temperature was kept at the desired target temperature by a room thermostat designed for hot water flow of the radiator used in a closed environment heated by natural gas. Depending on the indoor comfort temperature being kept at the desired target temperature and the windows being open, the room was not heated unnecessarily, thus saving energy and contributing to energy efficiency. In addition, temperature and humidity of the indoor environment, outdoor temperature and system warnings are shown on the thermostat display. Intelligent systems currently cover a limited portion of the housing stock still available. By making the system more useful with the studies to be done, it can contribute to energy efficiency and thermal comfort by using it in the existing building stocks.

## REFERENCE


[1]Coşkun C., Oktay Z., Ertürk M., 2009, The evaluation of the indoor temperature parameter selected in the heating season of the houses in terms of energy-cost-environment and an application example, IX. National Installation Engineering Congress, 529-538.

[2]Dogan H. Yılankırkan N., 2015, Turkey's Energy Efficiency Potential and Projection, Journal of Gazi University Science Part C, Design & Technology Gu Jun Scan Part C 3 (1), 375-383.

[3]Int-1, 2019, DTH11 Technical Data Sheet, https://www.mouser.com/ds/2/758/DHT11-Technical-Data-Sheet-Translated-Version-1143054.pdf.

[4]Int-2, 2019, DS18B20 Technical Data Sheet, https://datasheets.maximintegrated.com/en/ds/DS18B20.pdf.

[5]Int-3, 2019, Magnetic Door Switch Data Sheet, http://www.braude.ac.il/files/departments/electrical_electronic_engineering/labs/data_pages/p3.pdf.

[6]Int-4, 2019, GDM1602K Technical Data Sheet, https://www.sparkfun.com/datasheets/LCD/GDM1602K-Extended.pdf.

[7]Int-5, 2019, AQT15SP Technical Data Sheet, https://www.sparkfun.com/datasheets/Robotics/Aqua%20Tech%20Solenoid%20Valves.pdf

[8]Int-6, 2019, Ardunio Uno Technical Data Sheet, https://store.arduino.cc/usa/arduino-uno-rev3.