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Design and Construction of an Ardiuno Microcontroller Based Temperature Control System

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Abstract

Automatic temperature control can be achieved using different approaches. This manuscript describes design and construction of an automated temperature control system using Arduino microcontroller board. This system has many applications, such as, using it to control temperature in a small room, power supply enclosures, or in a smokehouse. All the phases of system development, such as, design, construction, and testing, are described in this manuscript.

Keywords: *Control system, microcontroller, system design, temperature, automation*

1. Introduction

A temperature control system is meant to keep a location at a desired temperature regardless of the fluctuating external conditions. There are many different processes which can be used to attain temperature control. One such approach, known as PID based control is described in [1]. This paper provides information regarding the use of a microprocessor-based PID controller to automate the temperature control process for a kiln. Implementation of this PID controller requires it to be tuned for the system it is installed. Another method for temperature control is demonstrated in [2] in which precise temperature control is achieved using Fuzzy Logic Controller (FIC). The four key components of the FLC include fuzzifier, the fuzzy logic rules, the inference engine and the defuzzifier. An automated temperature control system using embedded system design is described in [3]. This automated temperature control system uses a PIC microcontroller, LCD module, switching device, PWM generator, and a temperature sensing unit. Automation of a farmhouse is described in [4]. The aspects of the farmhouse that are automated include auto-irrigation cycles and automated temperature controlled enclosures for livestock and farm products.

The automated temperature control system described in this manuscript is based on Arduino microcontroller board. The other components used to build this system include temperature sensors, battery, solid-state relay, and fan.

2. System Concept

The problem to be solved was how to keep an enclosure cool during summer and warm during winter using an automated mechanism. The solution was to design and construct a control system to control alternate current (ac) devices, such as, a fan or a heat source. The ac fan works during summer by displacing warm air with cooler air while during winter a heat source such

as a lamp or bulb is controlled. This control system can be used in numerous other applications, such as, temperature control in a small room or an enclosure.

3. System Design and Construction

This control system uses a control box that is made from hard plastic which makes it water proof by using an O-ring gasket on the cover to prevent water from entering. The port that contains the cable and thermistor, has a seal around it as well. The system is based on an Arduino Uno, and houses components such as 10k potentiometer, 10k thermistor, wires, 9-volt battery, receptacle, solid-state relay, ac fan and breadboard for connections.

For usability, the system is mounted outside on the enclosure for accessibility and where it can monitor the heat. The fan or heat source does not need to operate all the time but only during extreme conditions. The control box is weather proof in order to be usable as well.

The NTC thermistor, reduces resistance when heated, paired with the right resistor can measure a wide range of temperature. A resistor or potentiometer put in series with a thermistor creates a voltage-divider. To determine the temperature, the resistance is to be measured. However, a microcontroller does not have a resistance-meter built in. Instead, it only has a voltage reader known as an analog-digital-converter. So the resistance is converted into a voltage. A potentiometer is used for this control system to fine tune the voltage signal to allow for better voltage and temperature measurement.

Another critical component of the control system is the solid-state relay. It has to be able to turn on and off using 5 VDC and control 115 VAC. This component is what allows the most flexibility for the control box. However, it is limited to a maximum of 140 VAC at 3 amps.

Figure 1 is a pictorial schematic showing the control system which is the heart of the control box and the fan.

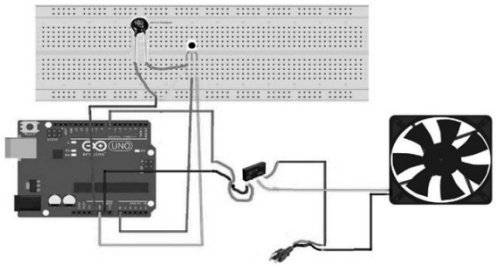

Fig. 1: Control System Schematic

As seen in Figure 1, the thermistor is in series with the 10k potentiometer and the blue wire is going back to analog input ($A0$) on the Arduino. The green wire is the 5 VDC which activates the solid-state relay and closes the switch to turn on the fan.

Figure 2 presents a view of the actual voltage-divider circuit. The programming code for this temperature control system is provided in Figure 3.

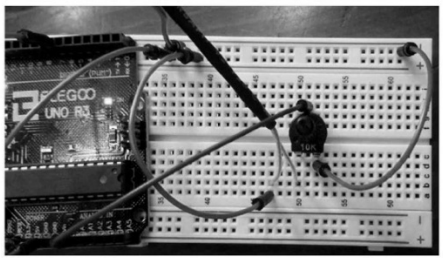

Fig. 2: Voltage Divider Circuit

```
int role-7;
int thermistor-A0;
Void setup ()
[
Serial.begin (9600);                  This starts the communicaion.
Analogreference (internal);           Arduino 1,1v reference set
Pinmode (role,output);                Relay is deined as output
]
Void loop
[
Int okunanDeger- analogread (A0);      Reads the analog input from the voltage divider
Float derece – okunanDeger/ 9.31;     Cenigrade calculator
Serial.prinin (derece);                Prints temperature on screen
Delay (1000);                         Delays print for 1 sec
If (Derece > 32)                      Set the temperature in Cenigrade
Digitwrite (role,high);               Turns the relay on above 32 Cenigrade
Else
Digitalwrite (role,low);              Turns the relay of below 32 Cenigrade
1
```

Fig. 3: The Programming Code for the Control System

4. Conclusions

An Arduino Uno microcontroller board is used to design and construct an automated temperature control system for applications, such as, small rooms and power supply enclosures. During summer, this automated temperature controller drives an ac fan to circulate outside air and remove heat. During winter, the control system controls a heat source to keep the inside of the enclosure warm.

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