Design and Development of Controller Board for Automation of Home Cooler using Microcontroller

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Abstract — *Home automation has always been a key region of interest for the researchers. Many home appliances have already been automated. In this paper, the authors propose a model for controller board to automate the home air cooler for implementing the control algorithm using the microcontroller. The surrounding temperature is the input to the algorithm while the speed of the motor and state of the pump is the output. The developed control board has been implemented in a home air cooler to test the working of the developed system and control algorithm. The outputs have been compared with the expected results and it has been found that the developed system works quit well.*

Keywords — *Speed Control, Automation, Home Dessert Cooler Control, 8051.*

I. INTRODUCTION

With increase in demand of energy in every practical sustainable environment, energy saving has become an important parameter while choosing a device for either commercial or domestic application. The energy saved at the operation of one device can be used for other device. Another important parameter for the selection of a device is the cost and level of automation applicable. Cost effectiveness has proved to be important parameter even for automation of a device, since the benefits of automation needs to be reached to every user. Automation refers to the implementation of control system for various operating equipment such machinery or processes in the industry. Apart from saving the labor power, automation also increases the efficiency and reduces the chances of error in the process. Automation can be achieved by various means including mechanical, hydraulic, pneumatic, electrical, and electronic and computers, usually in combination. While working on the real time processes, the process parameter called temperature is the most difficult to control since each block may have some warm up or response time. In this study, an attempt has been made to create a controller board for the automation of home air cooler using the low cost microcontroller 8051. Initial simulations of the system have been done on Proteus, and then the real time controller board has been created.

The initial literature about the home automation using various microcontrollers have been discussed in Section II while literature about the home cooler and its various parts have been discussed in Section III. Section IV discusses the simulation model developed in Proteus while Section V gives the detailed overview of the hardware of the controller board for the study. The results obtained and algorithm implemented has been discussed in Section VI.

II. RELATED WORK

Home automation has always been a part of extensive research, and many researchers have worked to develop the systems for home automation [1-2], thus automating the simple home appliances such as room light and fan controller [3-4] along with speech recognition [5]. Many works have also been done on home security using 8051 microcontroller [6], PIC microcontroller [7] or ATMega Microcontroller [8]. Electronic locks for home security have also been developed in [9]. Since nearly every component of home appliance contains a motor, many works have been found for the speed control of BLDC motor [10-13]. A temperature loop control for home automation has been discussed in [14].

III. HOME DESSERT COOLER

Home coolers are the most economical and environment friendly methods of cooling the environment at the comfort of home. Air coolers use the process of evaporation of water to cool the air when it passes through the air cooler, as some particle on the surface of the water are carried away giving the heat present in the air and thus cooling the air utilizing the simple property of the latent heat of water. Air coolers owe many advantages which makes them suitable for low cost home cooling such as their cost effectiveness, since they are economical for big halls as compared to Air Conditioners (ACs). Apart from this, the air coolers have low operating cost and eco-friendly to provide fresh air blended with cool water. Air coolers owe many disadvantages too, since they are not effective in humid areas and require continuous maintenance.

There are many types of air coolers commercially available like Personal air coolers, Dessert Air coolers and Tower Air coolers. Each type of air cooler has its specific area and weather suitability, and water capacity. Personal air coolers are best for small to mid-size rooms while dessert air coolers work for medium to large size rooms. Personal air coolers carry a water capacity of 20-30 liters', making them best for small and specific rooms while dessert air coolers carry a water capacity of 30-60 liter's, commonly used for outdoors. Tower air coolers generally carry water capacity of 20-40 liters'.

Before selecting any type of air coolers, many features need to be considered such as the capacity of water tank, the air flow levels, power consumption of the unit, the fan types, castor and remote control, since every user has its own specific requirements. The air coolers available nowadays provide various additional features such as working on inverters. This feature is most useful in areas where power cuts are frequent and these types of air coolers consume 50% less power than a standard air cooler.

A standard air cooler consists of various parts such as the grill, the submersible pump, fan blades, floating ball, and the cooler motor. The grill is the outer body of the cooler from which the cool air is sent outwards. The grill uses fins as mechanical system to change the direction of air flow. The grill also acts as safety measure to prevent the user from any shocks and touching the blades of the fan which can result in severe injury. Cooling pads are an important part of an air cooler since the air is cooled when passed through them. It is observed with the increase in thickness of the cooling pad, its efficiency increases. The cooling pad may either be Honeycomb type of Aspen or wood wool type. The honeycomb type cooling pad is made up of cellulose material and requires less maintenance while providing more efficient and durable work life. The aspen or wood wool type cooling pads, made up of wood shavings and synthetic fiber, require high maintenance, but are economical as compared to honeycomb type cooling pad. The submersible pump is used to maintain the water flow within the cooler. The pump picks the water from the reservoir and directs it towards the cooling pads. Commonly the pump is available in 9W, 18W, 19W and 40W powers, with water flow rates varying from 1100 liter's/ hr to 3200litres/hr. These pumps operate at 220VAC, carry a motor power of 0.025HP and weigh around 400gms to 1.2kg. The motor is the most important part of the air cooler since it directs the air flow. The commonly available motor for air cooler is a single phase electric motor, having 1/7HP and 7.9G.cm torque while operating at 230VAC providing the max 1400RPM. The motor has normally 6 wires, which has 2 wires for condenser, 3 wires for speed control and 1 wire for neutral/common. The fan attached on the motor is either a centrifugal or axial fan. The centrifugal fan has a drum type shape, which consumes more energy but makes less noise, while the axial fan consumes less energy and created more noise. The fan blades of the air cooler are made up of ABS plastic or aluminum alloy, but commonly plastic blades are seen, with size ranging from 12" to 15". The floating ball of the air cooler is made up of brass or aluminum rod with plastic ball.

IV. PROPOSED MODEL

The proposed model for the development of controller board first needed to observe the environmental conditions around the system. For this purpose, the system consists of an temperature sensor LM35 along with and analog to digital converter ADC 0809 as shown in Fig 1. ,the output of which is fed to the microcontroller which analyzes the temperature conditions and decides the output state of the system according to the condition's shown in Table 1. The state of the system can be observed from the LCD attached with the system and the speed of the motor is changed with the relay drivers which are actuated by the microcontroller.
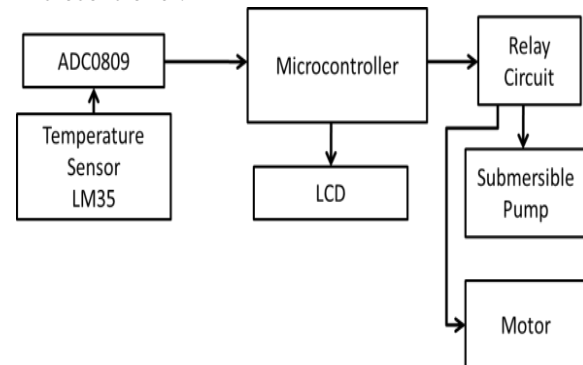
Fig. 1 Block diagram of the proposed model

V. DEVELOPED MODEL USING MICROCONTROLLER 8051

For the development of the controller board, a modular approach has been proposed which focuses on dividing the project in certain sections and working on each section independently and combining all of them to produce the final result.

The modules created for this study are listed as

- Power module
- Input module
- Processing module
- Action module

TABLE I
CONTROL ALGORITHM FOR THE PROPOSED MODEL

| Temperature Range	State of the Motor	State of the Pump
20-30	Speed 1	OFF
30-35	Speed 2	OFF
35-40	Speed 2	ON
>40	Speed 3	ON

Power module fulfills the basic requirement of the necessary operating power for each section of the controller board. This module consists of basic power supply system created via a transformer and bridge circuit as shown in Fig.2. The input module interacts with real world and senses the outside temperature using the temperature sensor LM35 and converts the sensor analog output into digital output using ADC0809 as shown in Fig 3.The processing module is the heart of the system as it consists of the microcontroller 8051 which processes the sensor output and takes the control action. The processing module also displays the output at the LCD attached with the system as shown in Fig 4.


Fig. 2 The power module for this study

The action module controls the final output of the system (i.e. the speed of the motor of the air cooler). The action module replaces the selector switch in the air cooler and regulates the speed of the motor on the basis of the control signal sent by the processing module as shown in Fig. 5. The action module consists of a relay which is controlled by the microcontroller. The basic working of the developed project can be summarized as the temparture sensor LM 35 senses the real time temparture of the surroundings and adc 0809 converts that output from the sensor as well as condition it for the output has to be used by the microcontroller for futher processing. When called by the microcntroller the ADC converts the sensor output and sends it to the

microcontroller. In the microcontroller the input from the sensor is compared according to the database fed by devolpers (our team) ,which is un-editable,and decides wether the speed of the fan should be high, medium or low. The microcontroller also decides that wether the pump should be switched on or off according to the database . now for the real time swtiching of 220V AC. We have used an NPN trasistor as a Switch . this is the base of our project as here we switch 220V AC with the control signals generated by a 5V DC microcontroller. In this way we performed our operation sucessfully and devolped a low cost home automation temparture control loop.
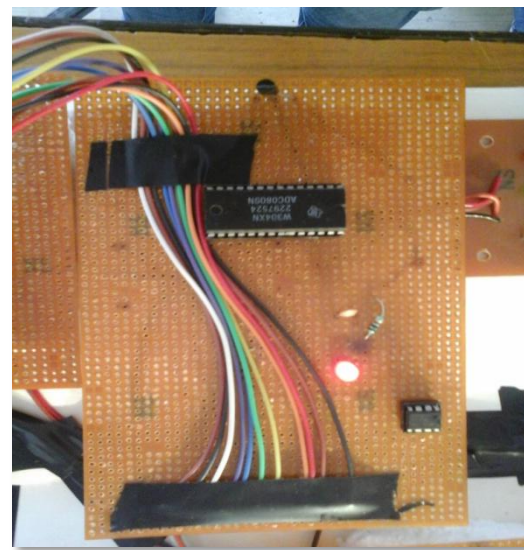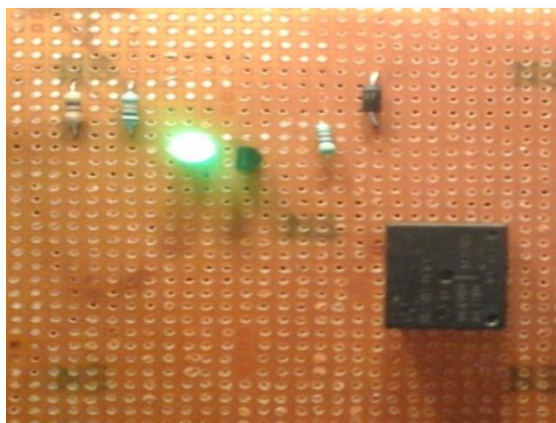

Fig. 3 The Input Module
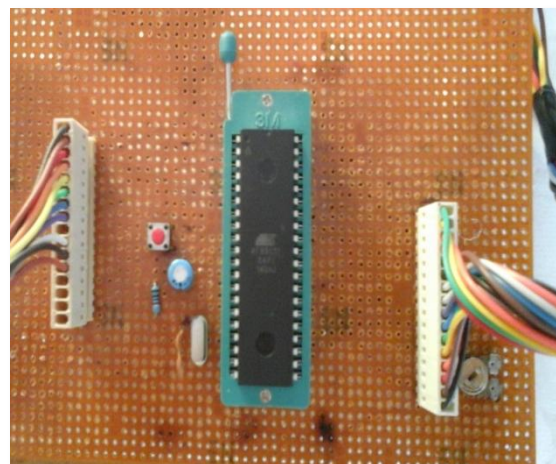
Fig. 4 The processing module

Fig. 5 The Action Module

VI. RESULTS AND DISCUSSION

The created hardware modules worked as per the expected conditions. The microcontroller was efficiently able to control the state of the system. The implementation of the control algorithm shown in Table 1 is the ultimate aim of the system. To validate the working of the system, the system has been tested at known temperatures to check the effectiveness of the developed controller board. The results of the validation are shown in Table 2. It has been found that the system worked quite efficiently as per the requirements and the shift from one state to another occurred within a satisfactory time.

TABLE III
THE VALIDATION RESULTS

Temperature Range	Expected State of the System		Obtained State of the System	
Test Temperature (in C)	State of the motor	State of the Pump	State of the motor	State of the Pump
25	Speed 1	OFF	Speed 1	OFF
32	Speed 2	OFF	Speed 2	OFF
37	Speed 3	ON	Speed 3	ON

VII. CONCLUSION

Home automation is the need of the hour to efficiently control the home appliances'. In this work, a controller board containing the 8051 microcontroller has been developed for automating the home cooler; the controller senses the environment temperature using the LM35 temperature sensor and controls the output using the relay circuit. The developed controller board was placed in an air cooler to observe its working, and the controller board has worked quite satisfactorily.

As a part of future scope, it is proposed to enhance the control algorithm by considering the humidity levels of the surrounding environment

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