Scientia Africana, Vol. 14 (No.2), December 2015. Pp 170-178
 ISSN 1118 – 1931

CONSTRUCTION OF AN AUTOMATED TEMPERATURE SENSING ELECTRIC FAN REGULATOR

[1] J. A. Amusan and [2] E. B. Otokunefor

Department of Physics,
University of Port Harcourt
P. M. B. 5323, East-West Road, Choba
Port Harcourt, Rivers State. Nigeria.
[1]Tel: +2348035622473
[1]E-mail : amusanabiodun@yahoo.com
[2] Tel : +2348037104650
[2] E-mail : esijolomi.otokunefor@uniport.edu.ng

Received: 11-09-15
Accepted: 19-12-15

ABSTRACT

An automated temperature-sensing fan regulator which controls the speed with respect to the sensed temperature, is designed and constructed. This design was implemented with simple and readily available electronics components at the local electric shops. The achieved results and its features when compared with available electric fan indicate that there will be a great demand for the product if it is introduced to the market since everybody cannot afford an air-conditioner due to its high cost.

Key words: Temperature, Fan Regulator, C++ programming, Analogue-to-Digital Converter (ADC), Micro-controller, Relay, Liquid Crystal Display (LCD).

INTRODUCTION

Ordinarily a fan is an electric motor attached with blades to provide breeze when the motor is rotating. Fans are found everywhere, where there is the need for cooling such as in car engines, computer central processing unit, power packs, processors, living rooms, warehouses, audio-amplifiers, power supply equipment and others. These fans are configured in such a way as to produce a cooling effect.

Electric fans are used extensively to enhance personal comfort, and there are various types of electric fans available in the market such as ceiling fans, standing fans and oscillating fans. Typically, electric fans are manually operated, and as such the regulator is manually varied to get the desired speed (www.wikipedia.com).

Schislyer Skaats Wheeler designed the first fan which was used for home cooling and since then, there have been more modifications. These developments are as a result of climatic change, changes in decorating styles and the evolution of electronic technology. (www.newsfinder.org).

Philip Deihl invented the electrically powered ceiling fan. Deihl had engineered the electric motor used in the first Singer Sewing machine and in that same year it was used in a ceiling-mounted fan (www.en.wikpedia.org/wiki/ceiling_fan).

John Hunter and sons invented the world's first ceiling fan. At first the fans were water-powered belt driven devices. As time passed by the Hunter Fan Company introduced the " Original" , the electrically powered ceiling fan. It was one of the first products of its kind to operate on electricity (www.newsfinder.org).

The introduction of ceiling fans with four blades instead of original two blades make fans quiet and circulate more air thereby making more efficient use of their motors.

The popularity of the ceiling fan started fading away because of the birth of another device, the air-conditioner in developed countries but the fans are still very popular in other countries, especially those in warm climates and who cannot afford high-energy consuming devices.

The typical parts of an electric fan are, as indicated in the block diagram of Figure 1:

(i) Electric motor which is used for the conversion of electrical energy into mechanical energy by electromagnetic means. Electric motors come in two varieties type, d.c. and a. c. motors. A.C. motors are used in ceiling fan because they are cheap, generate high power and have long life spans.

(ii) One to six paddles, also called blades usually made of wood, metal or plastic mounted under, on top or at the side of the motor. Most residential fans have either three or four blades. Most industrial electric fans have two or three blades.

(iii) Fan control also known as an auto-transformer where all the speed terminals of the electric fan are being connected.

(iv) Drive controller also known as regulator used to vary the speed of the electric fan.

There are different types of electric fans. These include Cast-iron ceiling fan, The Hunter Original, Stack-motor ceiling fans, Direct-drive ceiling fans, spinner-motor fans, skeletal motor fans, Friction-drive ceiling fans, Gear-drive ceiling fans and Belt-driven ceiling fans.

Callaway et al, (2002) presented a standard for home networking applications. The main features of the standard are network flexibility, low cost and low power consumption for many applications in the home requiring low-data rate communications in an ad hoc self-organizing network.

Bai and Ku (2008) proposed a design using both a microprocessor and light sensors for automatic room light detection and control. The design is made up of four blades: the Pyroelectric Infrared (PIR) sensor circuit, the light sensor circuit, the microprocessor and the RF module.

Joon Heo et al, (2008) presented a method for wireless control of a plurality of appliances with reduced stand-by power loss, home automation network and a method for configuring a home automation network to a master controller.

Nhivekar and Mudholkar (2011) designed and implemented an Infra Red (IR) remote control signal decoder which can be used for various home control applications. The design remotely controlled fan regulator and ON-OFF power supply switch. The entire system is based on microcontroller that makes the control system smarter and easy to modify for other applications.

Rahul et al, (2013) have developed an automatic person detection system to control electric fan and lights using microcontroller in museums.

The objectives of this work are to construct an electric fan that:

(i) saves energy.
(ii) has stress-free control
(iii) can assist physical challenged people
(iv) can eradicate wear and tear of mechanical part.

Scientia Africana, Vol. 14 (No.2), December 2015. Pp 170-178
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Design Methodology and Construction.
The circuit comprises of four major units. These are the power supply unit, the input unit, the control unit and the output unit. Figure 1 shows the block diagram of the automated temperature sensing fan regulator.

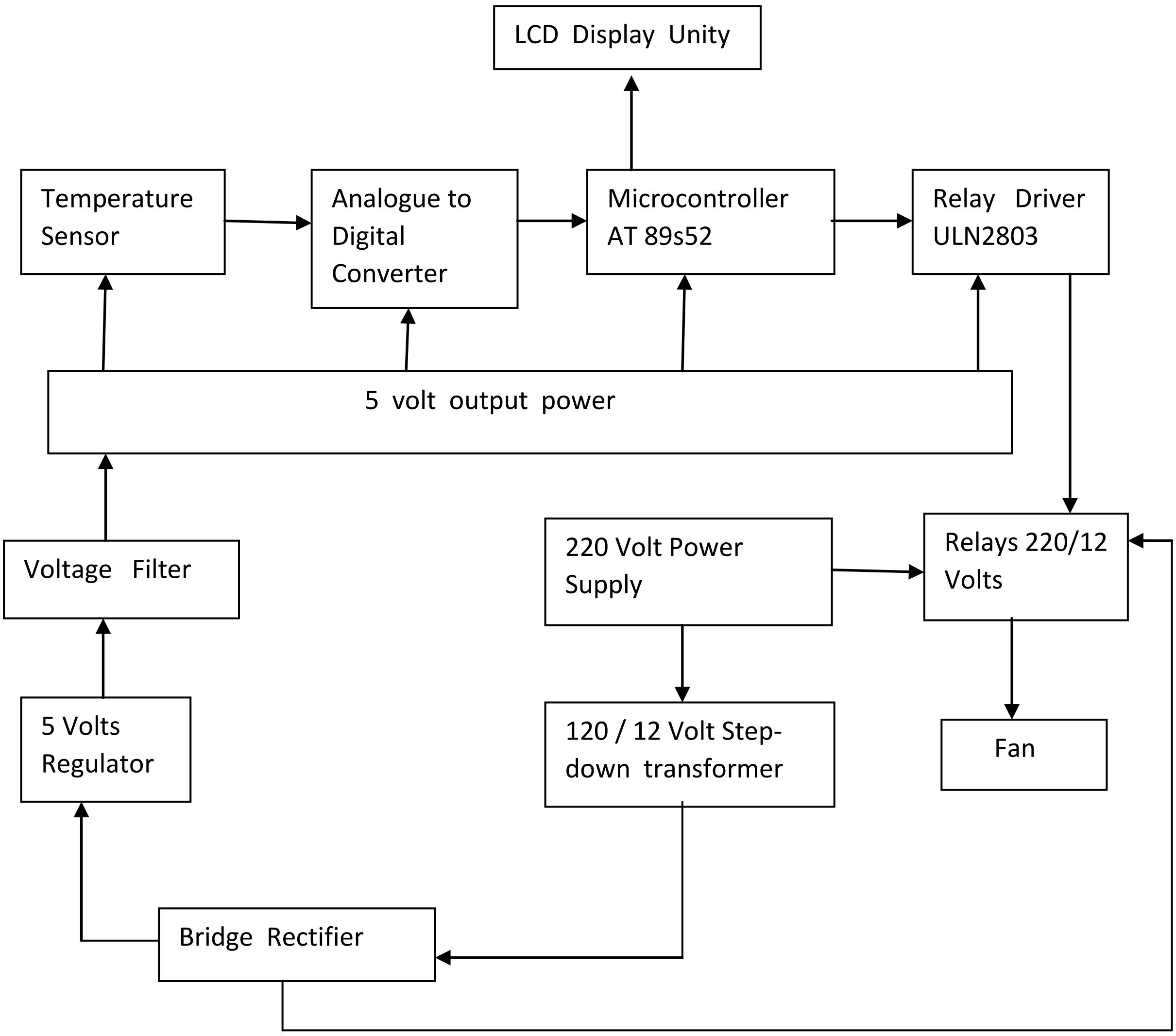

Figure 1 : Block diagram of automated temperature sensing fan regulator.

Automated temperature sensing fan regulator uses power supply as the source voltage to operate it. The power supply unit comprises of step down 220V/12V transformer, bridge rectifier, regulator and voltage filter.
The output voltage from the transformer is expressed as:

$$V_p^1 = V_p - V_f \quad (1)$$

$$V_p^1 = \sqrt{2}V_{r.m.s} - V_f \quad (2)$$

Where:
$V_{r.m.s.}$ is the root mean square transformer output voltage
V_p is the peak transformer output voltage.
V_f is the rectifier forward drop.

In rectification, alternative current is converted into direct current. Four (1N4004) full wave bridge rectifier diodes were employed in the circuit construction.

The unregulated d.c voltage is not constant and therefore not suitable for device operation (Menkiti et al, 2005). It is therefore imperative to use some form of regulation. Zener diode of 9.1 Volts was employed as a voltage regulator to stabilize the output voltage because of its characteristics.

For smoothening the d.c , capacitors, resistors and transistorised integrated circuits, IC were connected across the actual unregulated output voltage.

Thermistor was used as a temperature sensing device in the circuit. It is a type of resistor whose resistance varies significantly with temperature. It serves as the input unit of the circuit. Thermistors are classified into two types : the Positive Temperature Coefficient (PTC) thermistor and the Negative Temperature Coefficient (NTC) thermistor. In this construction, the Negative Temperature Coefficient (NTC) thermistor was employed because it typically achieves a higher precision within a limited temperature range. Assuming a first order approximation, the relationship between resistance and temperature is linear, then :

$$\Delta R = K\Delta T \qquad (3)$$

Where:

ΔR is the change in resistance

ΔT is the change in temperature

K is the first order temperature coefficients of resistance.

The control unit comprises of the Analogue-to-Digital Converter (ADC), Microcontroller, Relay driver and switch relays. The ADC 0804 was used in the construction. Figure 2 below shows the pin configuration of ADC 0804 while Table 1 shows the functional characteristics of ADC 0804.

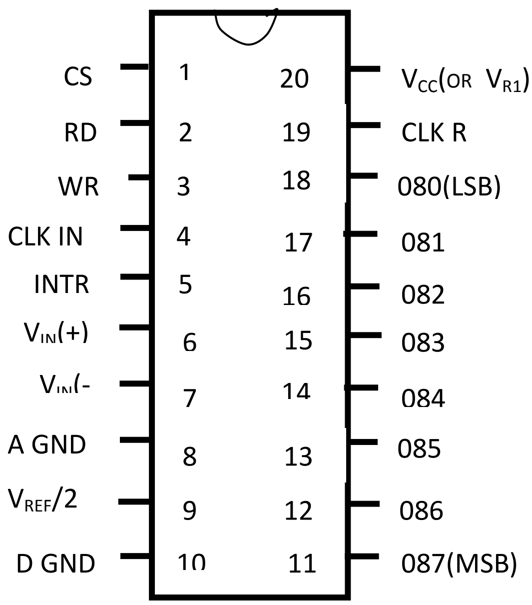

Figure 2: Pin configuration of 0804 ADC.

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Table 1: Pin configuration and characteristics of the ADC 0804.

Pin No.	Function	Name
1.	Activate ADC , Active low	Chip Select
2.	Input pin, High to low pulse brings the data from internal registers to the output pins after conversion.	Read
3.	Input pin, Low to high pulse is given to start the conversion.	Write
4.	Clock Input pin, to give external clock	Clock IN
5.	Output pin , Goes low when conversion is complete	Interrupt
6.	Analogue non-inverting input	V_{in} (+)
7.	Analogue inverting input , Grounded	V_{in} (-)
8.	Ground (0V)	Analogue ground.
9.	Input pin, sets the reference voltage for analogue input	$V_{ref/2}$
10.	Ground (0 V)	Digital ground
11.	8 bit digital output pins	D7
12.		D6
13.		D5
14.		D4
15.		D3
16.		D2
17.		D1
18.		D0
19.	Used with clock IN pin when internal clock source is used	Clock R
20.	Supply Voltage, 5V	V_{oc}

A microcontroller unit is a computer on chip used to control electronic devices. The microcontroller is the heart of the system. The employed microcontroller (AT89s52) receives its signal inputs from the temperature sensor via the ADC. The control action of the microcontroller is initiated using C++ propgraming language.

Upon the reception of signals from the ADC, the microcontroller executes its programs with respect to the input and displays the desired output on the Liquid Crystal Display (LCD). Figure 3 shows the analogue –to-digital converter and microcontroller circuitory.

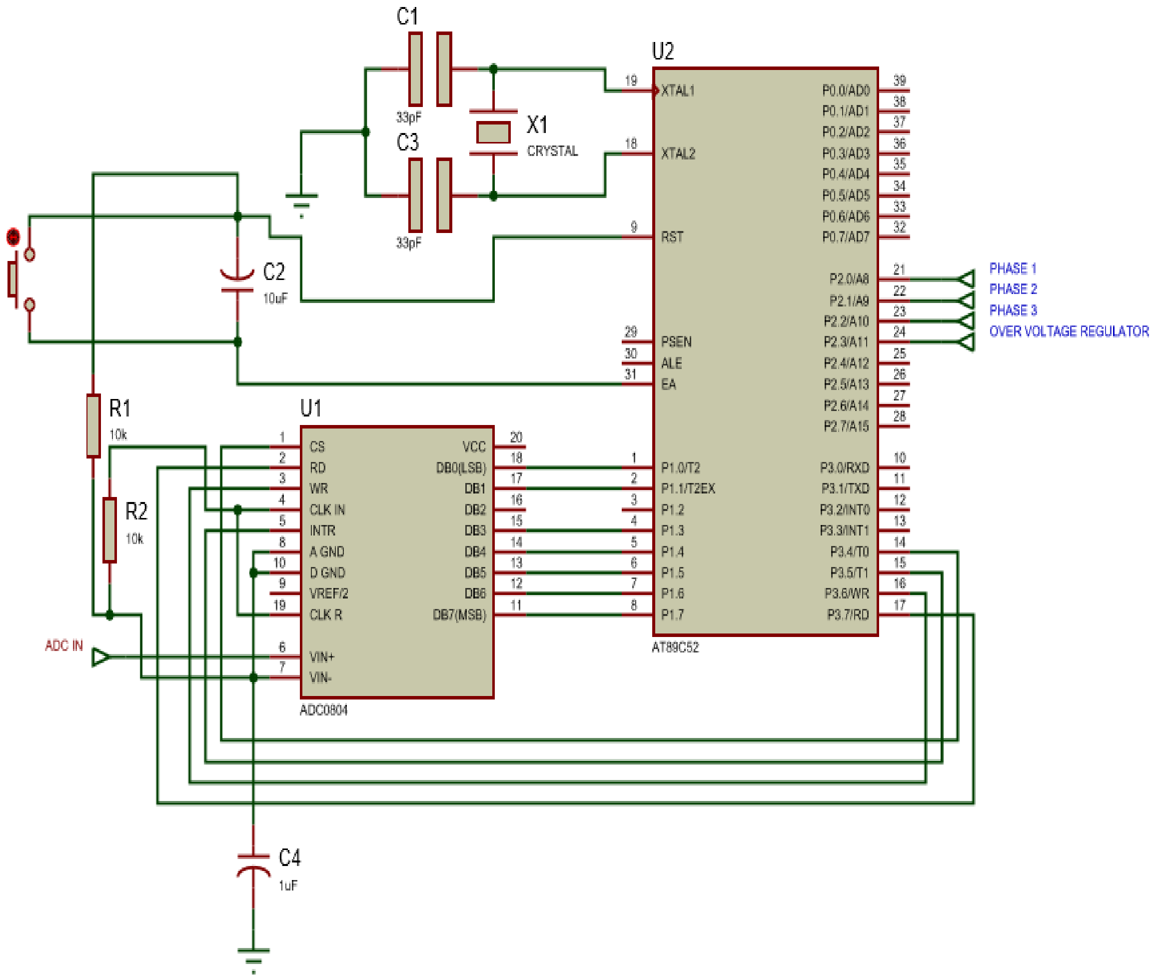

Figure 3 : ADC and microcontroller circuitory (Jack, 2008)

The employed relay closes or opens the circuit by electromagnetic force through the coil. Liquid Crystal Display (LCD) is employed in this construction because of its non- emissive display nature and it requires very small currents.

The LCD does not generate its own light but depends on an external light source (Martins et al, 2009).

The display unit adopted in the design is a 16x2 bits liquid crystal display. Figure 4 shows the schematic of the employed LCD.

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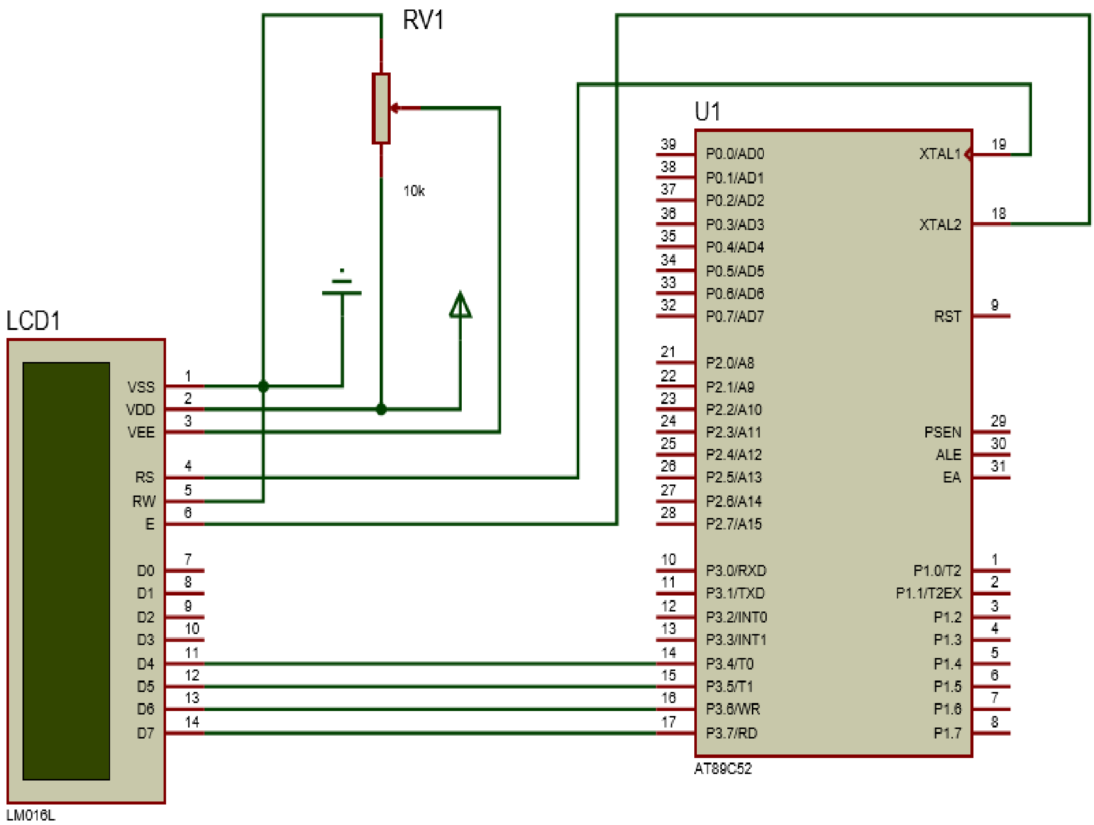

Figure 4 : Schematic diagram of an LCD.

DISCUSSION

Working Principle

The electronic components were procured from the local shops and the construction was carried out on a vero board and Printed Circuit Board (PCB). The Negative Temperature Coefficient (NTC) thermistor senses the temperature of an enclosed environment and then sends to the Analogue-to-Digital Conveter (ADC). The ADC converts the analogue signal into a digital data for microcontroller to understand. The digital outputs vary from 0 to a maximum of 255. The step size can be adjusted by setting the influence voltage at pin 9. When the pin is not connected the default reference voltage is operating voltage i. e. V_{cc}. The ADC sends the signal to the microcontroller AT89s52 manufactured from ATMELIC. The microcontroller is programmed in C++ programming language which serves as the heart of the control unit.

The microcontroller accepts the signal and compares it with the already programmed set points. The microcontroller sends the selected signal to the relay driver. The set points then switch each relay.

Relay 1 triggers speed one (low speed) and switch on at ambient temperature of $\leq 20^0$C ($t \leq 20^0$C) .

Relay 2 triggers speed two (medium speed) and switch on at ambient temperature 20^0C $< t \leq 28^0$C.

Relay 3 triggers speed three (high speed) and switch on at ambient temperature 28^0C $< t \leq 35^0$C.

Figure 5 below shows the prototype of constructed automated temperature sensing fan regulator.

Figure 5: Prototype of automated temperature fan regulator.

The fabrication illustrates the possibility of an automated temperature sensing fan regulator as a device that can be attached to an electric fan. The regulator senses the temperature of an enclosed environment and automatically regulates the speed when powered. The implementation shows that it is effective, reliable and convenient for usage.

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