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DESIGN AND IMPLEMENTATION OF A PROGRAMMABLE ELECTRIC COOKER USING AN ANDROID APP.

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Abstract

The project is based on the design and construction of a Bluetooth based programmable electric cooker. This is a circuit that will enable an android app written into the ROM of an android phone, to control the operations of a normal commercial cooker. The system also has the Added feature in that the cooker can also be programmed using manual switches. After the set time, the cooker will be activated while the display starts a countdown sequence. At the end of the countdown, the cooker stops cooking and an audio and visual alerting circuit will be activated. This feat was done using discreet components such as resistors, capacitors, transformer and logic integrated circuit. The circuit is an embedded system due to the fact that it has one programmable microcontroller integrated circuit. For the sake of this project, the 8052 microcontroller was used and it was programmed using assembly language. After the design and construction and testing, the system behaved satisfactorily as a Bluetooth based programmable electric cooker.

Keywords: Electric cooker, Integrated Circuit, Power Supply, Audio and Visual Alerting Units, Reset Switch, Bluetooth, Android Application.

INTRODUCTION

Automated systems are the current trend in electrical and electronics systems being developed all over the world. Its application spans from industrial to commercial to domestic settings. It is not an uncommon occurrence to see industries reducing their number of staff due to the ability of machines to now operate on their own without the need of the operation of personnel. One of such industries that greatly reduced their number of staff worldwide is the banking industries.

In domestic establishments, there is such desires to reduce the operation of domestic gadgets and electronic by humans and turn them over to machine to operate on their own accord. Many domestic processes such as illumination, temperature control and door access, has already been made automated by the design and implementation of smart lighting electronics, smart temperature fan and automated presence detectors for door respectively. Many more domestic processes has also been replaced subsequently.

As technology grows, SMS technology has been widely accepted as a part of medium of communication [1]. An electric stove or electric range is a stove with an integrated electrical heating device to cook and bake. Electric stoves became popular as replacements for solid-fuel (wood or coal) stoves which required more labor to operate and maintain. Some modern stoves come in a unit with built-in extractor hoods. This technology is based on the principle of GSM network which enables the user to remotely control the operations of electronics by using a mobile phone [2]. This project is based on the control of electric cooker using a GSM interface, the electric cooker can be switched on, timed, switched off and can even be paused using an Android phone which has the Android Application installed on it. A GSM is a modem that works with a wireless network. A wireless modem behaves like a dial up modem, the main difference between them is that a dial up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through a radio wave [3].

The project is based on the design and implementation of an electrical electronic circuit that will automate the basic function of the standard or normal electric stove and can be controlled using an Android phone. Firewood and smoked dry

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charcoal had been used on open bricks by early man but could no longer meet the need of the growing world population [4]. Furthermore the issue of environment safety has become important to the modern man [4]. Most electric cookers available today lack the vital aspect of control, which has led to several losses ranging from food burning, power wastage and human losses [5].

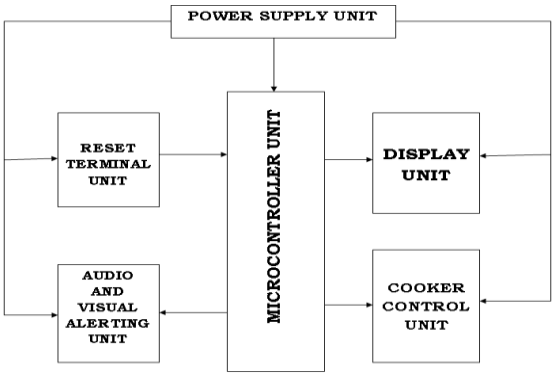

Fig 1: Block Diagram of an Electric Cooker with automatic switch ON/OFF

MATERIALS AND METHOD

The automatic fish feeder complete circuitry is been analyzed here with the different modules in focus.

POWER SUPPLY UNIT: This is the circuit that supplies power to the full system. The power requirements for the circuit are 12 volts dc specifically for the high current carrying relays and a 5 volts dc power for the microcontroller and the rest of the system. This dc power is obtained from the ac power supply from the mains The circuit diagram is as shown below.

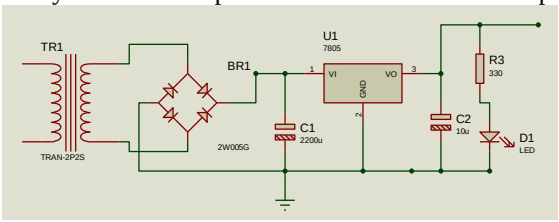

Figure 2: The Power Supply Unit

TRI:

This is the step down transformer. A transformer voltage of 12Vac or above is required. The current should be enough to supply the requirement of the circuit. The transformer (T1) chosen is 12Vac at 300mA.

D1-D4:

These are the rectifier circuit. The diodes chosen must have a peak inverse voltage (PIV) that must be able to withstand twice the peak voltage (V) of the transformers output and a forward current (DC) of 1.5 times the output current of the transformer.

$Vp = \sqrt{2}Vrms$ (1)

where:

Vpis the peak voltage of the transformer output and

rms is the actual output voltage from the transformer = 12Vac

$D(piv)\ 2 \times Vp$ (2)

where:

D(piv) is the PIV of the rectifier diode

C1: This is the filters capacitor. Electrolytic capacitors come with a capacitance and a voltage rating.

Voltage Rating: The voltage of the capacitor (Vc) must be able to withstand 150% of the output voltage from the diode.

VC = 150% of VDP (3)

where VDP is the peak output voltage from the diodes

but VDP is given as

VDP = Vp – VD (4)

where:

Vp is the peak voltage of the transformer and
VD is the voltage drop of the diodes
Capacitance Rating: The capacitance of the capacitor must be such that it could reduce the ripple voltage (V_R) to about 30% of the output peak voltage from the diodes.

V_R = 30% of VDP (5)

From the ripple voltage equation (VR), we could get the capacitance

V_R = 0.3 VDP (6)

where:
V_R is the ripple voltage;
Imax is the maximum current from the diodes/ transformers (300mA);
F is the frequency of supply (50Hz);
C is the capacitance of the capacitor in Farads and
U1 is the voltage regulator.

Regulator specifications are:
(i) Maximum input voltage = 30V
(ii) Maximum output voltage = 5.5V and
(iii) Operating temperature = 0% - 150%
For effective Voltage regulation, the minimum input voltage should be:

V min = Vout + Vref (7)

where:
V min = Minimum input voltage;
Vout = required Output voltage: 5V;
Vref = Datasheet Stipulated reference voltage; 3V and
the regulator chosen is: U1= 7805 C2 is a transient capacitor.
The rating is stipulated in the 7805 voltage regulator's data sheet as 0.1uF.
Hence, C2 = 0.1uF
This capacitor helps for smoothening of the output from the voltage regulator. It is also to prevent spikes in the DC output voltage waveform in the event of transient disturbances. It is known as a buffer capacitor whose value is gotten from the data sheet of the regulator.
Current limiting resistor calculation:

$R1= (V_s-V_d)/ I_d$ (8)

RESET CIRCUIT

In this circuit, a form of reset for the programmable bluetooth electric cooker is important. When the food is done cooking and the alarm is activated, the user has the option of turning off the alarm with the use of a button. This arrangement is called the reset circuit. The circuit diagram is as shown below.

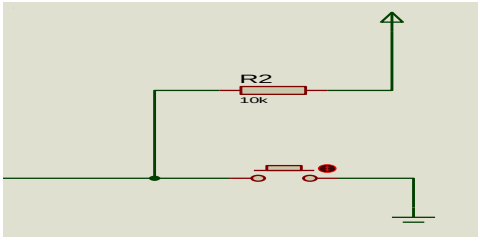

Fig 3: Reset Circuit Unit

R2: this is a pull up resistor that will be set to make the input terminal of the microcontroller to be temporarily high only to be made low whenever the switch is pressed. The value of the pull-up resistor is mostly recommended to be 470Ω to 47kΩ, 10kΩ was chosen.

COOKER CONTROL UNIT

This is the circuit that will be used in the control of the electric cooker. This circuit will be controlled by the microcontroller and it will turn on the cooker when the system is set and turn it off when the timer set by the user is exhausted. The circuit consists of an NPN transistor, resistor, diode and a relay. The circuit diagram is as shown below

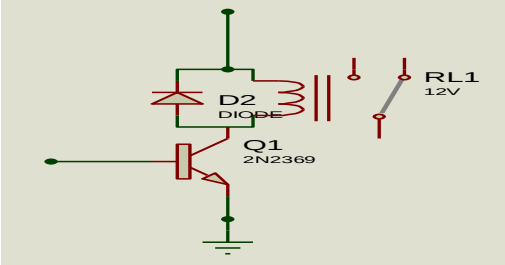

Fig 4: Cooker Control Unit

R_7 this is the base resistor for the transistor. For effective switching, the collector current should be about 10 times the base current.

$I_C = 10 \times I_B$

$R_B = 10 \times Rc$

The resistance of the relay is 400Ω

Thus $R_C = 400\Omega$

Due to availability, 4.7kΩ is chosen. $R_7 = 4.7k\Omega$

MICROCONTROLLER UNIT

The microcontroller unit circuit is the heart of the project. This is where the program for the control part of the project is written and burned using assembly language and a universal programmer, respectively. The circuit diagram is as shown below

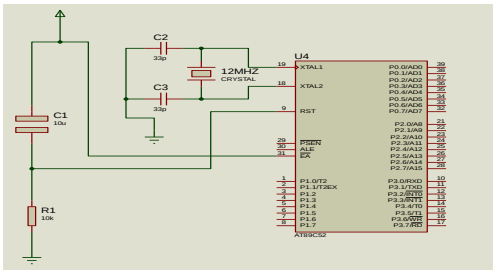

Fig 5: The Circuit Diagram for the Microcontroller Unit

The 8052 microcontroller hardware circuit is usually a very flexible one and all the surrounding components are given a recommended range of values, by the datasheet but the actual values can be chosen by the programmer.

The ranges of values given for the 8052 microcontroller hardware are as follows

Reset capacitor: 4.7µF to 10µF

Reset resistor: 8.2KΩ to 15 KΩ

Crystal oscillator: 4MHz to 32MHz

Crystal capacitors: 27pF to 47pF

For the programming of the microcontroller for the programmable electric cooker, the chosen values are as follows

Reset capacitor (C_1): 10µF

Reset resistor (R_1): 10 KΩ

Crystal oscillator (X_1): 12MHz

Crystal capacitors (C_2& C_3): 33pF

COMPLETE DIAGRAM OF THE CIRCUIT

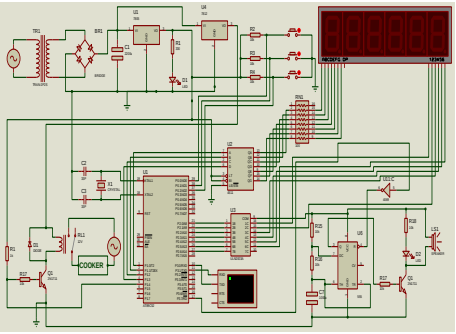

Fig 6: Complete Circuit Diagram

The Mode of Operation

The microcontroller based Bluetooth programmable electric cooker works on the principle that a microcontroller can be used to program the operation of any electrical electronic system. in this case, it is used to write a program that will enable a wireless control for an electric cooker using Bluetooth technology. A mobile app was written using java programming and was installed into an android phone. This enables the Bluetooth of the phone to be used in communication with another Bluetooth device connected wirelessly to a microcontroller. The android phone Bluetooth is the transmitter device while the microcontroller Bluetooth is the receiver.

When the user desires food to be cooked for let's say an hour, the mobile app in the android phone will be launched and the duration in hours, minutes and seconds, will be inputted, and subsequently transmitted. This signal will be received by the microcontroller via the receiver Bluetooth device connected to it. Then based on the program that has been written and burned into its ROM, the microcontroller will display the value of the set time on the display screen, which is made up of 7-segments display units. This is made possible by the common cathode 7-segment display driver 4511.

Meanwhile after the display, the microcontroller will turn on the cooker via the cooker controlled unit which comprise of switching transistor, biasing resistor, spike diode and control relay. The microcontroller will send a signal to the transistor which will in turn switch on the cooker via the relay. This cooker will be switched on for the duration of the timer. The program will start a countdown will show on the display unit. When the countdown is exhausted, the microcontroller will send another signal to the relay via the transistor to switch off the cooker subsequently activate the alerting unit which will trigger the audio and visual indicators to alert the user that the food is finished cooking. This unit is built around a 555 timer multivibrator connected in an Astable mode. The design is to produce an output session of one hertz.

The whole system will be powered by a 5 volts dc power supply which is obtained from a 220volts ac source. This dc power supply system comprise of a step down transformer, rectifier diodes, filter capacitor, voltage regulator and indicator light emitting diode.

Conclusion

The design and construction of an electric cooker which is programmable using manual mode switches and a mobile app to set it is an interesting one. It gives the student an opportunity to be exposed to the programming of a microcontroller and the writing of android phones mobile applications. It has also provided an opportunity to understand the rudiments of artificial intelligence which is the new wave in electronics engineering. After the project is designed and constructed, the system behaves satisfactorily as a programmable electric cooker which is based on a microcontroller and which can be programmable using manual switches and an android phone.

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