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Design and Construction of a Two Channel Microcontroller Based Remote Control for Switching Electrical Appliances

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Abstract: This paper presents the design and development of a microcontroller-based system that can switch off and on Electrical appliances or wall sockets at user's will remotely. This research is aimed at increasing the accessibility as well as response rate to prevent appliances from damage due to transient, intermittent and fluctuations in power supply. This system uses a wireless telemetry technique through an infra-Red (IR) transmitter and receiver to control the switching state of home and laboratory/industrial electrical or electronic devices. The entire circuit is built around ATMEGA-328P microcontroller which was programmed to interpret digital signal sent from the IR transmitter (remote control) to the IR receiver. As the microcontroller receives a real time signal from the IR transmitter through the IR receiver module, a command is sent to the relay switching unit which activates or deactivates the channel(s) based on the software code embedded in the microcontroller. The normally open (N/O) and normally closed (N/C) terminals of the relay are connected to the live terminals of AC sockets for automation. The Liquid Crystal Display (LCD) displays the status of the sockets in any of the two channels (points) as instructed by the microcontroller. The system is cost effective, durable and versatile as it can be applied to any devices connected to electrical socket outlet.

Keywords: Microcontroller, ATMEGA -328P, N/O, N/C, Transmitter, Receiver, LCD.

1. INTRODUCTION

As the world keeps growing technologically, wireless communication and automation remain vital part of the technological development. Everyone is interested in having real time knowledge of events happening near and far. Possibly, we like to monitor and control activities happening remotely. There have been a lot of efforts to ease human burden on switching of electrical and electronic appliances remotely without physically touching the appliances. Several breakthrough involves the use of customized infrared based remote control to power on, off as well as perform other functions on a particular appliance. However, the use of a general infrared remote control in automatic switching of electrical power source have not received good attention. Many people have disposed a lot of remote-control pads mostly because the appliances which they control is permanently damaged or vice versa. The pertinence of remote controls is high in various homes because it provides ease of controlling electrical and electronic devices when we are few meters away from the parent device. A remote control eliminates the inconveniences of moving from one place to another in controlling home, office and industrial electrical or electronic appliances [1]. Infrared remote system is a wireless communication technology which employs the infrared waves in the electromagnetic spectrum for short distance line-of-sight communication. It operates within frequency range of 300 GHz – 30 THz and has transmission distance of up to 10 meters [2]. The line-of-light feature of IR signal makes it more preferred among other waves in the electromagnetic spectrum because it does not interfere with other nearby devices and poses no harmful effect on human health. The infrared (IR) sensor in the remote control sends signals using infrared pulses technique which could be visible to the human eye [3]. A

pulse of infrared light is transmitted when any button in a remote control is pressed [3]. The Light Emitting Diode (LED) is specifically designed at the tip of the remote control and serves as the transmitter. If any of the button in the remote control is pressed, a command (code) that corresponds to each alphanumeric button is generated [3].

Several remote-control systems have been designed and implemented using Infrared signal. For instance, an IR based remote control system was implemented by Daniel and Ochola using an analogue circuit which consist of NE555 timer as the transmitter and TSOP1738 as the receiver. The receiver is connected to a transistor operated as a switch. The transistor output is fed to an electro-mechanical relay which does the switching of the load [4].

Naveen and Prajwal designed and constructed a low-cost infrared based home automation system. The constructed system is capable of switching home appliances on and off remotely with the aid of IR and microcontroller sub-circuits [5]. Also, [6] presented an analogue home appliance switching system that has both transmitter and receiver sections but the major drawback is that the system is made of complex analogue circuit. Moreover, it does not possess integrated display unit which can give information about the switching state of the system. This present study is geared toward addressing the limitations of the previous works by presenting a user-friendly display unit which shows the current status of each channel.

The developed system consists of an Infrared receiver which decodes the sent command and interpretation is done through written code embedded in ATMEGA 328P-PU microcontroller. The problem statement is that most aged people have electric receptacle phobia, in order to avert heart attacks and prevent accidents it is imperative to introduce a more convenient and safer way of switching home appliances. The objectives of this study are: to develop software program that will automatically control home sockets through a set of instructions embedded a microcontroller and provide a liquid crystal display (LCD) to display the real time status of the sockets. There is need for this new technology of switching since most of the available home automation systems are mobile applications based and the range of transmission is short since it is controlled by a Bluetooth wireless technology. This work is centred on domestic and laboratory switching purposes so that the useful life period of appliances could be lengthened. Most household and laboratory devices are highly customized and if carelessly delivered to children and care free scientists, it could create damages, faults or render equipment to the state of complete abandonment \which could cost a huge amount for repairs, replacement and servicing. The commonest type of remote technology is direct switching of devices but this introduced design has infused a digital selection technique through relay switching via a microcontroller directly on the household sockets. The major advantage of this developed technology is that sockets of choice could be turned on and off at the user's will while the major limitation is that the range of transmission could not travel beyond 12 meters.

2. METHODOLOGY

2.1 System Design and the Working Principle

The developed system is divided into five sections: power section, transmitting and receiving section, microcontroller section, switching section and display section.

The power section is a 5v DC supply from a regulated source through a rectified alternating current source. The transmitting and receiving sections are constituted by a TSOP1738 sensors (IR Transmitter and Receiver).

The IR remote sends a code inform of a train of encoded pulses using a 38khz modulating frequency. These pulses are received by TSOP1738 receiving sensor. The microcontroller reads and decodes the train of pulses into a HEX value and compares the decoded value to the predetermined HEX value of the pressed button. If any match occurs, then the transistor amplifies the signal in the relay switching network through the microcontroller digitally selects the appropriate channel and turns on the socket automatically and displays the activated channel/channels on the LCD.

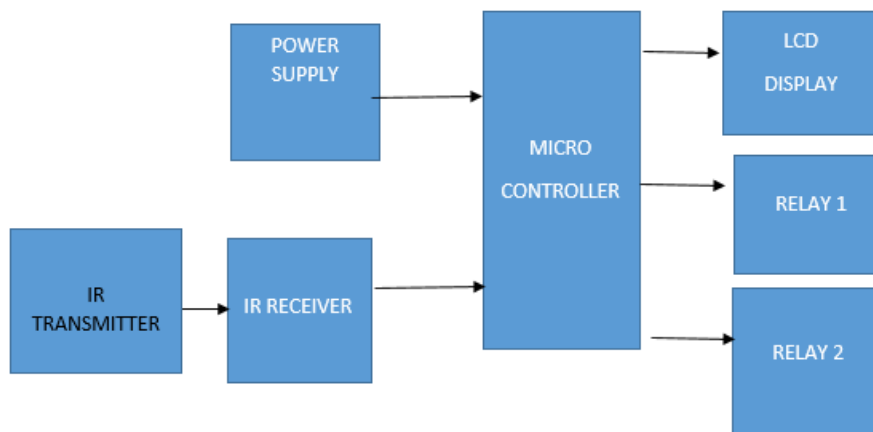


Figure 1: The schematic of hardware components of the designed system

2.2 The Microcontroller and Switching Section

The high-performance Microchip picoPower 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes [7]. The Microcontroller is very versatile in operation being that it can be programmed and reprogrammed at any time to suite the desired purpose. Microcontrollers are being designed into more and more sophisticated products e.g. motor cars, watching machine, mobile phones, robots, measuring and monitoring instruments in various fields such as digital thermometer, ranguage, voltmeters, ammeters, magnetometer and others [8].

By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed. This section is the heart of the whole system as it controls all activities within the circuit. The programming language used was C. The micro controller has been programmed with condition statements. This determines when to send high or low signals to its digital pin 5 and its digital pin 6. The digital pins 5 and 6 are connected to the 5V relay. The automatic On/Off switching ability of the system is achieved with the signal supplied by the digital pins 5 and 6 to the two 5V relays via an amplifying transistor [9]. For example, if pin 5 is low, the transistor is cut off. The relay is not energized via the transistors collector. Hence the normally closed (N/C) Terminal becomes opened while the normally open terminal gets closed.

2.3 The Display Unit

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions and the data is being displayed on the LCD [9]. The LCD module consists of an on-board display controller, which automatically generates a dot-matrix character display. The LCD is configured in a 4-bit mode with read-write control (WR) pin which is grounded [10]. The configuration of the liquid crystal display with the microcontroller requires less number of I/O pins of microcontroller, typically 6 only to enhance enable mode. Figure 3 depicts the pins connections between the LCD and the microcontroller. The LCD displays the status of the relay (the switching mode of the channel/channels) [11].

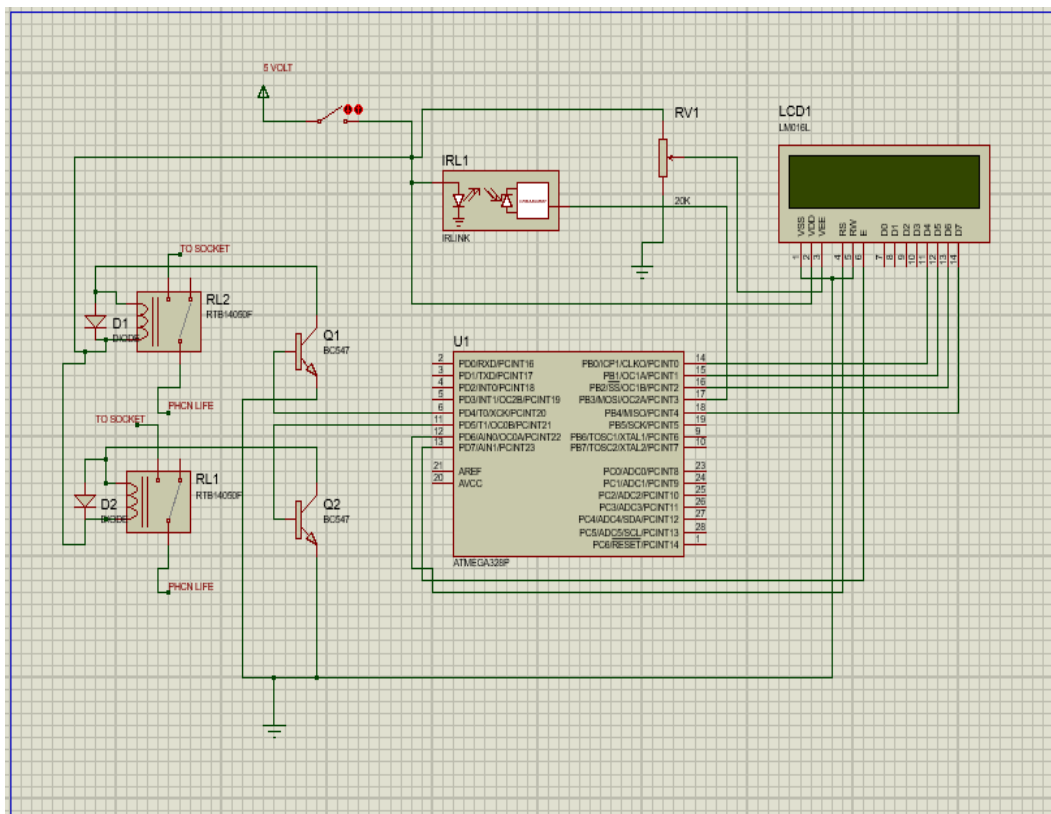


Figure 2: Circuit Diagram of the Designed System



Figure 3: Remote Control (IR transmitter) and the constructed circuit

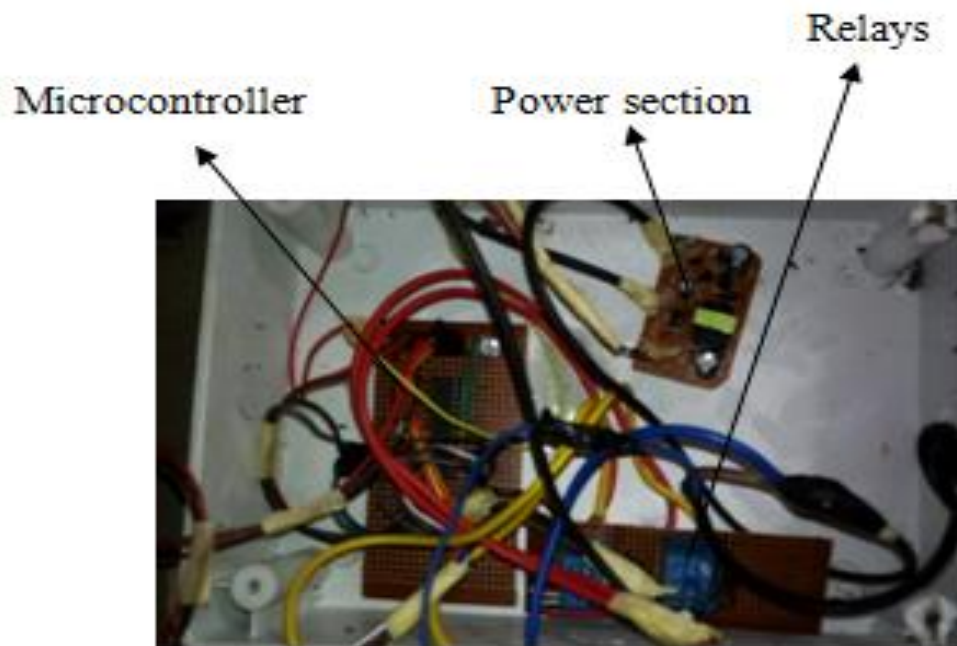


Figure 4: Internal features of the receiver constructed circuit

3. RESULTS AND DISCUSSIONS

Table 1: Decoded received signals from the transmitter by the Microcontroller

Inscription on Remote	Decoded Received Signals	Inscription on Remote	Decoded Received Signals
Stop	FDA857	10+	FDE817
1	FD4AB5	Goto	FDC837
2	FD0AF5	Rev	FD52AD
3	FD08F7	Fwd	FD12ED
4	FDA95	Prev	FD10EF
5	FD2AD5	Next	FDD02F
6	FD28D7	FBC	FD629D
7	FD728D	Display	FD22DD
8	FD32CD	Zoom	FD20D
9	FD30CF	Slow	FDE01F
0	FDF00F		



Figure 5: Point 1 ON and Point 2 OFF



Figure 6: Point 1 OFF and Point 2 ON



Figure 7: Point 1 OFF and Point 2 OFF



Figure 8: Point 1 ON and Point 2 ON

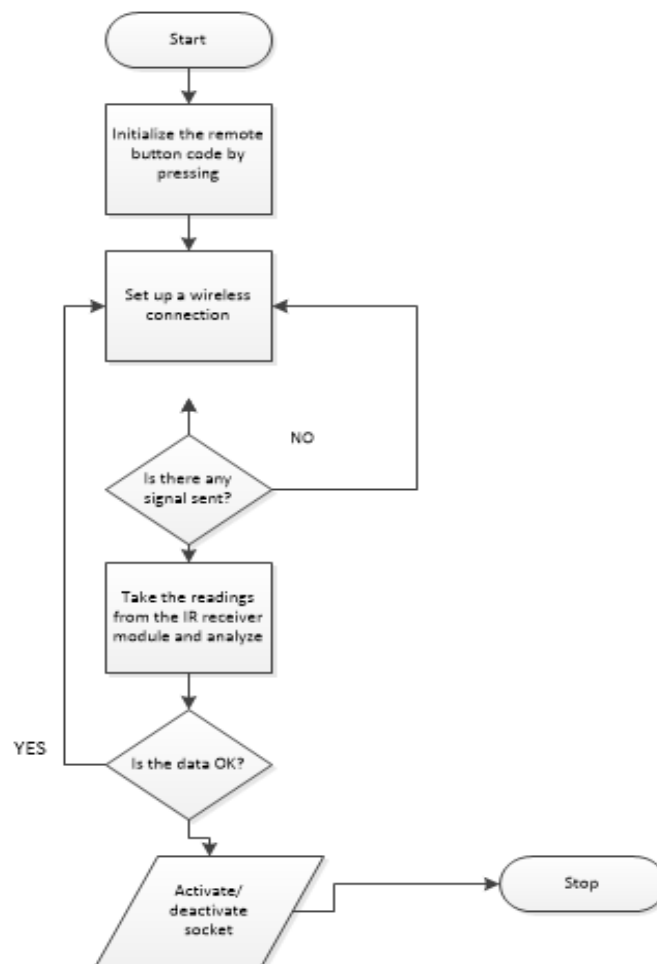


Figure 9: Flow chat of the constructed system

The transmitter and receiver were tested by pointing the IR sensor to its receiver at maximum distance of 12 meters apart. Table 1 shows the button configuration of the transmitter. Each button has been programmed to transmit a specific digital code via the IR transmitter when it is pressed. The receiving IR sensor receives the signal and send to the microcontroller which decodes it using the set of instructions embedded on it. The designed system utilizes four buttons which are;1, 2, 4 and 5 with FD4AB5, FD0AF5, FD6A95 and FD2AD5codes respectively. Buttons 1 and 2 serves as ON and OFF mode for channel point 1 while buttons 4 and 5 puts channel point 2 in ON and OFF states respectively.

Figures 3 and 4 show the exterior images of the device while figures 5-8 show the display status of the two channels (ON or OFF). In figure 5, channel one is activated while channel two is deactivated. Figure 6 shows a deactivated channel one and an activated channel two. Figures 7 and 8 show the deactivation and activation of channels one and two respectively. Figure 9 revealed the flow chat of the constructed system which embeds the initialization, analyses and activation processes respectively.

4. CONCLUSIONS

A two channel microcontroller based home appliances remote control switching system was constructed successfully which is within the aim of the construction in order to increase the useful life periods of both electronic and electrical devices since the switching is conditioned at user's will which means an outsider cannot operate home ,laboratory and industrial devices without the consent of the owner or personnel that overseas them since he/she knows the activation key for the operation of the electrical socket(s) that will power appliances or equipment. The device uses a remote control to turn on/off sockets digitally via transistor relay switching network by software code embedded in the microcontroller. The response time is fast and effective.

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