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HOME AUTOMATION CONTROLLER BASED ON ATMEGA 328 MICROCONTOLLER

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ABSTRACT
The shortcomings of switches include; power loss due to mechanical contacts, difficulties in their access especially in darkness as well as wear and tear. Likewise, the problems of using a web server and mobile communication include network problems (distortion or attenuation) necessitates the development of infrared radiation home automation controller. Microcontroller- based home automation control was implemented using the passive infrared sensor (PIR) to sense an infrared radiation and output a voltage that serves as an input to the controller. The design was made to automatically switch ON any low power load connected between its output and the grid. The system operational mode is a self-automated mode that makes the controller capable of monitoring and controlling different appliances in the home automatically in response to the signal that comes to the sensor. However, the system was designed to maintain its output in the ON state as long as it senses the infrared radiation and then switch off when it senses no radiation in its vicinity. Flowcode V_5 - software was used in the implementation of the system and the ATMEGA 328 microcontroller as system controller. Also, additional automation was implemented at the controller based on the ATMEGA 328 microcontroller for ease, security, and relatively low cost.
Keywords: Microcontroller, Passive Infrared Sensor, ATMEGA 328, Flowcode, Switches

INTRODUCTION

The adaptation of control systems used in the industrial field to life field created home technology concept. Automation is a technique, method, or system of operating and controlling a process by electric devices with reduced human intervention and time. The fundamentals of building automation system for an office or home are increasing with numerous benefits. Automation makes not only an efficient but also economical use of electricity. Home automation refers to the control of home appliances and domestic features by local networking or by remote control (Gunge & Yalagi, 2016). Home automation usually requires computer with appropriate program, although its control activities can be carried out using mobile phones, voice notes, actuators or sensors (Sivagami et al., 2021).

Smart homes are needed for comfort, energy efficiency, security and protection of property against hazards such as fires or gas leaks (Souaihia et al., 2021, Geethamani et al., 2020). Different Home Automation Systems (HASs) and technologies have been reviewed; several of them use smart phones to communicate with microcontrollers using different wireless communication techniques such as Bluetooth by Sriskanthan et al., (2002), GSM by Jivani, (2014), Zig Bee by Narayanan & Gayathri, (2013) and Cloud Services by Maiti, (2012). Smart phone applications are used to connect to the network for authorized users to adjust system settings on their devices. These systems have drawbacks of cost and reliability of network. Internet of things based home automation system can only work in the presence of internet (Asadullah & Raza, 2016). A home automation controller based on voice recognition was developed by (Kirankumar & Bhavani, 2013, Amoran et al., 2021). Voice recognition based systems are most suitable for elderly and handicapped people. In 2016, Asadullah & Raza reported that such systems are noise sensitive and their accuracy can be affected by signal-to-noise ratio (SNR). The Arduino uno home automation controller, which is based on the atmega 328 microcontroller, is the type of home automation controller that was designed in this study.

By sensing infrared radiation, the home automation system may manage all lighting and electrical equipment in a house or business. The home automation controller was created using an arduino uno with an atmega 328, a passive infrared motion sensor (PIR), and a solid state relay (SSR). When movement or motion is detected, any home or business equipment connected to this home automation controller will instantly be switched on. It eliminates the risk of fire and reduces power consumption by automatically switching itself off when the connected appliances are left on and no motion is detected. The work was implemented on the Flow-code v5.

SYSTEM ARCHITECTURE

DESIGN SPECIFICATION

The design of this home automation controller is divided into two main sections which are:

- Hardware design: The hardware design is the physical component of the system; is the physical implementation in which the various components are incorporated.
- Software design: is concerned with the programs that were written to control the microcontroller at the system's processing center.

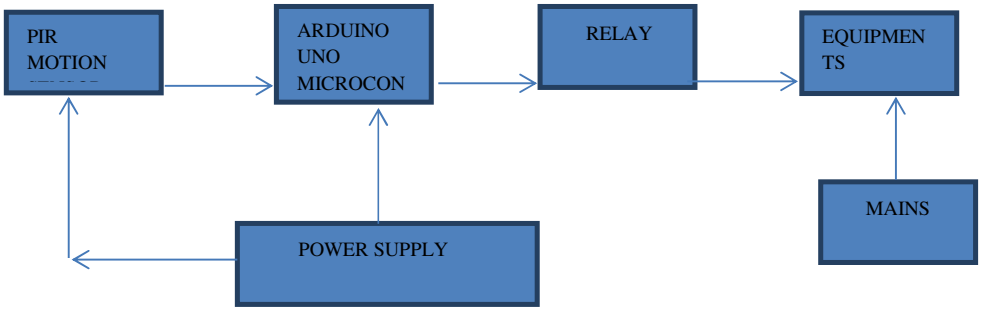

Fig1. System block diagram

Hardware Development

For the design of the hardware, the components that were incorporated are the arduino uno board with an Atmega 328 microcontroller, the PIR motion sensor, 300Ω resistor and the solid state relay.

The schematic for the circuit design of this project is shown below.

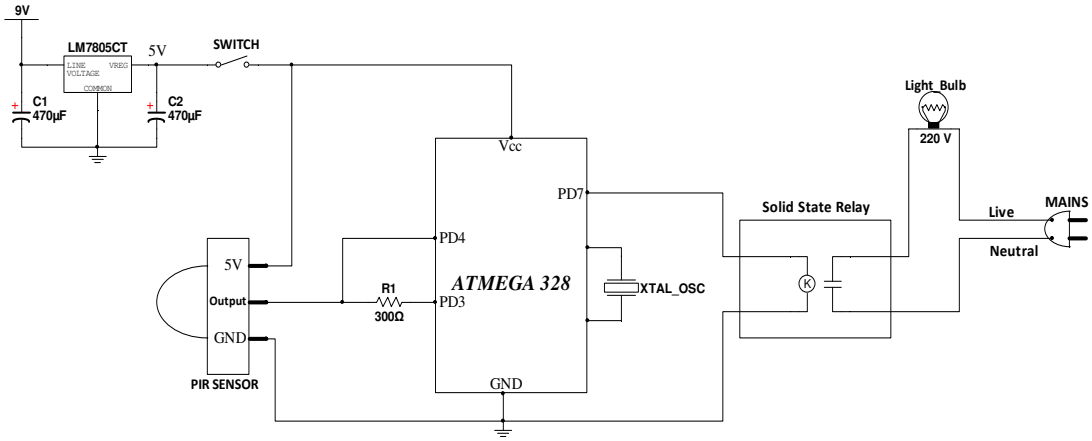

Fig 2.The circuit design of the system (Arduino Uno Home Automation Controller)

Software Development

Flowcode

Flowcode is graphical programming software developed by Matrix Multimedia. It is one of the world's most advanced graphical programming languages for microcontrollers. The great advantage of the software is that it allows those with little or no programming experience to create complex mechatronics systems. Flowcode contains standard flow chart icons and electronic components that allow virtual creation of electronic system on PC screen.

It facilitates the rapid design of mechatronics systems based on microcontrollers by simply dragging and dropping icons on to the flowcode programming environment to create myriad mechatronics systems without writing traditional code line by line. Flowcode has host of high-level component subroutines that allow the use of flowchart programming method by users of all abilities to develop microcontroller programs rapidly. It also allows user to view C and ASM (assembly language) code for all programs created to customize them (Imam, 2012).

Flowcode v5 was used in the implementation of this project which is very high level language optimized programming software.

The simulation of the program was performed to ensure accuracy in timing and effective delay period. The simulation was carried out on the flowchart simulation panel of the Flowcode with a Clock speed 16000000(Hz).

The flowchart that was written and simulated on the Flowcode simulation panel is shown below.

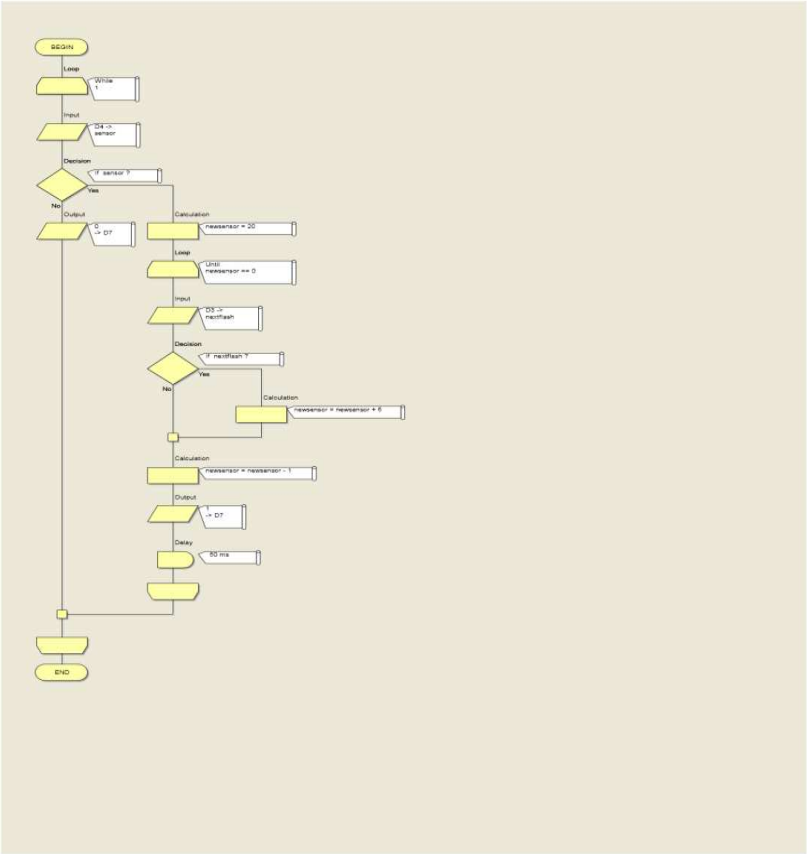

Fig 3. Flow Chart of the System

DESIGN TOOLS

ARDUINO UNO (ATMEGA 328 MICROCONTROLLER)

The Arduino Uno used in this project is a microcontroller board based on the ATmega328. The Atmega328 is a low-power CMOS 8-bit microcontroller based on AVR enhanced RISC architecture. By executing powerful instructions in single clock cycle, the ATmega328 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

The schematic of the microcontroller circuit design is shown in the figure below

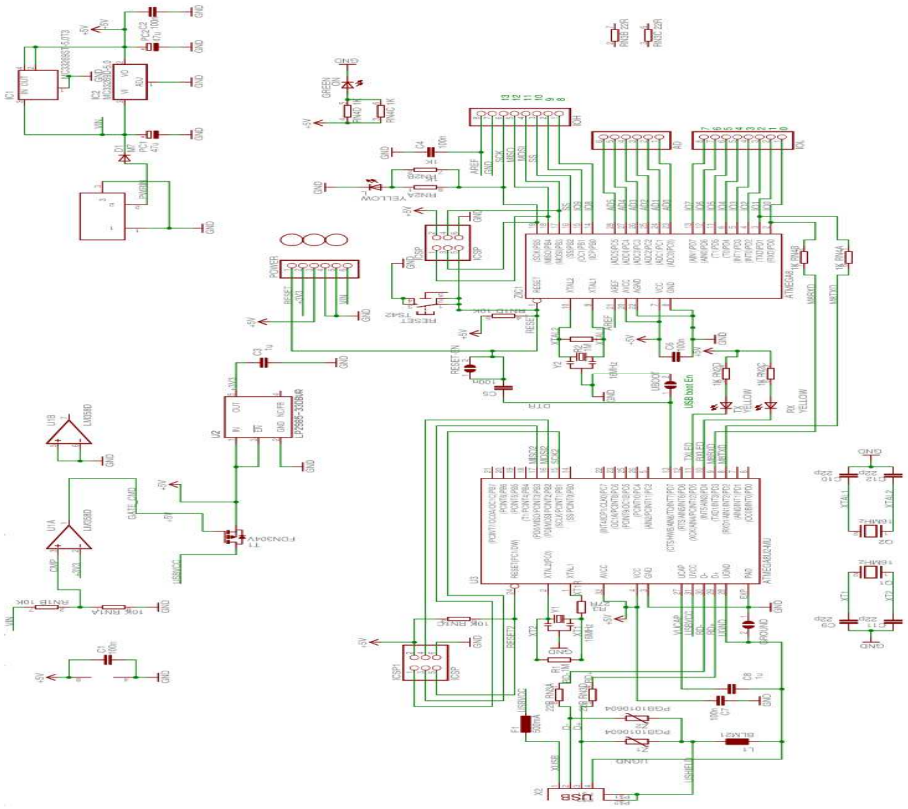

Fig 4.Circuit design of the Arduino Uno(Atmega 328 microcontroller).

PIR MOTION SENSOR

The PIR (passive infra-red) sensor is pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by checking for high signal on single input pin.

PIR sensors allow you to sense motion, almost always used to detect whether human has moved in or out of the sensor range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared," "Pyroelectric," or "IR motion" sensors (Ladyada, 2014).

SOLID STATE RELAY (SSR)

A solid-state relay (SSR) is an electronic switching device that switches on or off when a small external voltage is applied across its control terminals. SSRs consist of a sensor that responds to appropriate input (control signal), a solid-state electronic switching device that switches power to the load circuitry, and coupling mechanism to enable the control signal to activate this switch without mechanical parts. The relay may be designed to switch either AC or DC to the load. It serves the same function as electromechanical relay but has no moving parts**.**

DESIGN PROCEDURE

The PIR motion sensor is a 3-pin device. The pins are VCC (pin 1), output pin (pin 2) and GND (Ground, pin 3).

Pin 1 of the PIR sensor is the pin that receives the positive DC voltage. The power of the positive DC voltage of the PIR sensor from the power supply was 5V.

Pin 3 is the negative DC voltage or ground pin of the device. The negative terminal of the power supply was connected to the pin that is pin 3 for return path.

Pin 2 is the output pin of the PIR module; this is where the output voltage of the PIR was. Whenever motion is detected by the PIR sensor ,it output will go high to 4.5v meaning that it outputs 4.5v from the 5v DC, but when no motion is detected it outputs low voltage(voltage is zero).

Pin D4 and pin D3 are assigned as the input pins of the microcontroller(atmega328).Pin 1 of the motion sensor was connected to VCC pin of the microcontroller i.e., the 5 DC voltage, while pin 3 was connected to the ground pin of the microcontroller. Pin D4 and pin D3 were both connected to the output of the PIR. It is through this pin i.e., pin 2 of the PIR, the microcontroller receives its input. Pin D4 receives the first input from PIR while Pin D3 is assigned to receive the subsequent input from the output of the PIR. An additional resistor of 300Ω was added to the input pin D3 of the microcontroller to limit the amount of current going into the microcontroller. If no motion is detected the output of the PIR sensor remains low and the microcontroller receives no signal (0 voltage), but when motion is detected the PIR output becomes high (4.5V) and input pins of the microcontroller will receive the output voltage from the PIR

Pin D7 of the microcontroller was selected as the output pin of the controller. This is where the solid state relay (SSR) was connected. The relay acts as a switch, it opens whenever there is no voltage detected meaning (0V), and remains closed whenever it receives signal from the microcontroller.

Connecting the output of the relay to the home or office equipment effectively controls the appliances (switches the connected appliances ON/OFF) depending on the voltage detected (4.5v/0v).

CONSTRUCTION

This is the final stage of the project in which the various components used were assembled to perform specific task assigned to them. The Arduino Uno as earlier described is a board that has all its components mounted on it. The atmega 328 microcontroller was placed on it. The interconnection of the circuit was done using connecting wire. This enabled the necessary connections at different sections of the circuit to be made by extending the terminals or connections made with a wire to a desired point in the circuit. Connecting wires are flexible wires made from copper and are used to connect components or subsystems. The Arduino board, PIR sensor and the relay were connected with the connecting wires as shown in fig.5.

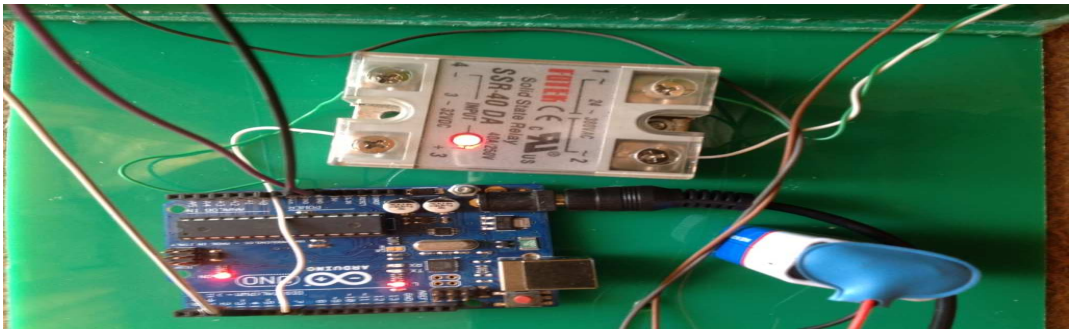

Plate 1.The Hardware Setup of the Home Automation Controller

Finally after connecting all the components it was cased in a plastic material that allowed the sensor to detect infrared radiation

Plate 2. Home automation controller after casing

TESTING

Various tests of the components used and the implemented system were carried out to ensure accuracy.

GENERAL SYSTEM TEST

Before the implementation the flowchart written on the flowcode was first tested by simulating it on the simulation panel and later complied to Hex before finally compiling to the chip (atmega 328) by connecting the USB from the arduino board to the computer, so that the PIR motion sensor knows to turn ON any connected home appliances when motion is detected.

After the implementation of the circuit above in fig 3, the implemented circuit was tested. A bulb of 220V was connected to the output of the SSR where the other output was connected to the mains. The power was switched ON and no light was detected on the bulb, movement was made in front of the PIR motion sensor, after 10 sec the bulb lights which later turns off after some seconds. The Movement was made again and the bulb turned ON. Continuous movement was made around the detection area of the sensor and the bulb continued to light (remains ON).

RESULT AND DISCUSSION

All the components tested were working effectively. When testing the PIR motion sensor the detection distance was found to be about 20 feet from all angles and the startup delay time of about 10sec. The power LED and pin 13 LED of the Arduino board all flash light which indicates that the Arduino board is working (good).The bulb that was connected to relay was to ensure that the relay is working or not. After connecting to the mains the bulb lights indicated that the SSR was working efficiently.

The code written before uploading to the Arduino board determines how long the bulb remains illuminated when motion or movement is detected.

A variable counter was set as new sensor, once the first motion was detected the counter was set to start counting from 1–100 so that it can provide illumination for the time if the person that triggers the sensor stays in the area for the first motion detected. When the first motion is detected, the light bulb connected to the SSR triggers and turns on. After this period has elapsed (counting 1 – 100) and no motion was detected the SSR was triggered and the bulb shuts off.

Another counter was added with a variable set as newsensor +5, newsensor +5 operates after the first motion is detected and the first counter starts counting but before it finishes counting from 1–100 if another motion is detected the variable newsensor +5 adds up 5 to the previous (first counter), i.e newsensor = newsensor + 5.If the person continues to move in the vicinity of the motion sensor, it will be triggered again and continue to add up 5 depending on the motion detected in the vicinity of the sensor and the light bulb continue to stay ON.

A decision was made in the code which decides that if no motion is detected after the counting of (1–100) the system triggers and shuts off, but for continuous motion it remains ON.

The constructed circuit also worked impressively after casing.

CONCLUSION

The home automation controller's design, implementation, and building went off without a hitch. The design technique, flowchart, and microcontroller program are all detailed in this project. The approach used to create this project was a self-automated mode, which allowed the Arduino Uno microcontroller to automatically monitor and manage various appliances in the home in response to any signal received from the sensor. A hardware implementation of the system was carried out to ensure the system's dependability. The established system is simple to use, quick, inexpensive, and adaptable.

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