JOURNAL OF SCIENCE TECHNOLOGY AND EDUCATION 14(1), MARCH, 2026
E-ISSN: 3093-0898, PRINT ISSN: 2277-0011; Journal homepage: www.atbufstejoste.com

Home Automation System using Android and WiFi Module

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ABSTRACT

The primary objective of this project is the development of a smart home automation system that enables remote control of household appliances using an Android-based smartphone and a Wi-Fi communication module. In conventional home settings, electrical appliances are operated manually through wall-mounted switches, which may be inconvenient, especially for elderly and physically challenged individuals. To address these limitations, the proposed system introduces a wireless and user-friendly approach to appliance control. The system utilizes an Android application that provides a graphical user interface (GUI) through which users can send control commands to connected devices. A Wi-Fi module (such as ESP8266) is interfaced with a microcontroller to facilitate seamless communication between the smartphone and the home appliances. The microcontroller receives and processes the transmitted signals, compares them with predefined instructions, and executes the corresponding actions to switch appliances ON or OFF. This approach enhances convenience, accessibility, and energy efficiency by allowing users to monitor and control home devices remotely within a wireless network. The system is cost-effective, scalable, and suitable for modern smart home applications, offering an efficient solution for automated home management.

ARTICLE INFO
Article History
Received: August, 2025
Received in revised form: December, 2025
Accepted: February, 2026
Published online: March, 2026

KEYWORDS
Home system, PIC Microcontroller PIC16F877A, ESP8266, Android Module, WiFi Module, Automation

INTRODUCTION

Pervasive (ubiquitous) computers monitor and control the physical world through the use of sensors and actuators [1] . Smart living involves the remote control of consumer devices and media sharing. The new trend in Information and Communication technology is the provision of ubiquitous access to the networked electrical gadgets in the home using mobile phone. Most people nowadays have access to mobile phones and thus the world indeed has become a global village. At any given moment, any particular individual can be contacted with the mobile phone [2], [3].

Today's smart phones are mobile always on networked computers that are with us all the time, they are already part of the digital home ecosystem. They resemble the consumer notion of universal remote controls, but are also personal and much more capable (e.g. processing, storage, multimedia, networking) and with support for a multitude of user interaction modalities (e.g. GUI, voice, gestures, touch) [4], [5]. The emergence of smart spaces in the computer world is going to change users' experiences with the computers [6].

The smart home is equipped with sensors that record inhabitant interactions with many different devices, medicine-taking schedules, movement patterns, and vital signs. Smart environments can sense their own well-being and can request repair or notify inhabitants of emergencies [7], [8]. This project focuses on remote monitoring and control of home electronic appliances through the use of mobile cell phone. The notion of smart spaces cannot be real without mentioning pervasive computing. Pervasive computing has launched us into a world of

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numerous, easily accessible computing devices connected to each other and to an increasingly ubiquitous network infrastructure. The vision of pervasive computing emerged from seamlessly integrating technologies into the fabric of everyday life [9]. Pervasive computing allows users to access and manipulate information anywhere at any time while in control of some privacy issues [10].

In this project a ubiquitous system is developed using microprocessor PIC16F877A and WIFI module D8266 which forms the server side of the system. The PIC16F877A is not just a controller but a single board microcomputer dedicated to embedded control applications. Therefore, the complexity of the system is managed on the software side; this ensures lower component size and increased system reliability.

The system developed a customized message system that communicates with a mobile phone, electrical gadgets via a GSM module interconnection with a SIM card. The system was designed and carried out successfully. With the system, multiple appliances could be switched OFF or ON simultaneously compared with the existing ones that are capable of handling one appliance at a time. The outline of the article is as follows; section one is the introduction, while section two shows the materials and methods used, while section three displays the testing process, and section four is the results and discussion. Finally, section five gives the conclusion.

MATERIALS AND METHODS

Materials

This section elaborates on the materials used for the successful completion of this article.

The Pic Microcontroller PIC16F877

The PIC microcontroller PIC16f877 is one of the most renowned microcontrollers in the industry. This controller is very convenient to use; the coding or programming of this controller is also easier. One of the main advantages is that it can be write-erase as many times as possible because it uses FLASH memory technology. It has a total number of 40 pins and there are 33 pins for input and output. PIC16F877 is used in many pic microcontroller projects. PIC16F877A also have many applications in digital electronics circuits [11], [12]. The pic microcontroller PIC16F877A is shown in Figure 1.

Figure 1: Pic Microcontroller PIC16F877A [11]

LM7805 IC Voltage Regulator

The regulator receives the input of a fairly constant DC voltage and supplies, as output, a somewhat lower value of DC voltage, which maintains fixed or regulated over a wide range of load current or input variation. The 7805 regulator maintains a 5V DC supply voltage to the system. Normally, the input voltage to the regulator should be at least 2volts greater than the output from the regulator [13], [14]. The voltage regulator is shown in Figure 2.

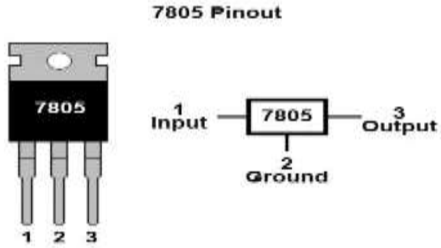

Figure 2. Infrared Obstacle Sensor [14]

Data EEPROM and Flash

The data EEPROM and Flash program memory is readable and writable during normal operation (over the full VDD range). This memory is not directly mapped in the register file space. Instead, it is indirectly addressed through the Special Function Registers. There are six SFRs used to read and write this memory; EECON1,

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EECON2, EEDATA, EEDATH, EEADR, EEADRH. The EEPROM data memory allows single-byte read and writes. The Flash program memory allows single-word reads and four-word block writes [15]. Program memory writes operations automatically perform an erase-before write on blocks of four words. A byte write in data EEPROM memory automatically erases the location and writes the new data (erase-before-write). The write time is controlled by an on-chip timer. The write/erase voltages are generated by an on-chip charge pump, rated to operate over the voltage range of the device for byte or word operations [16]. This is shown in Figure 3.

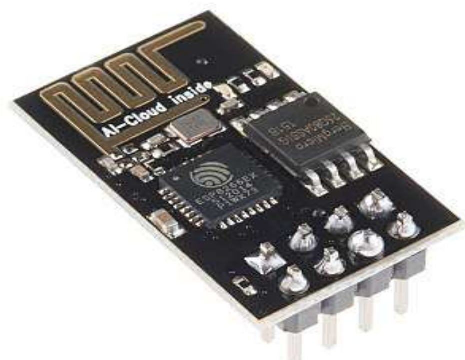

Figure 3. Power Supply [17]

System Software

The program was written in the MPLAB integrated development environment and debugged from an assembler-language into machine code (hex- file). The pseudocode for the implementation of the developed system is given in Algorithm 1.

BEGIN

Algorithm 1

```
  // System Initialization
  Configure_Port_Pins()
  Initialize_Shift_Registers()
  Initialize_Program_Variables()
  // Indicate system power
  Turn_ON(Power_LED)
  // Initialize communication module
  Initialize_WiFi_Module()
  // Continuous operation loop
  WHILE (System_Is_ON) DO
    // Read incoming message
    message ← Read_WiFi_Message()
    // Check if a valid control message is received
    IF (message IS valid) THEN
      Turn_ON(Signal_LED)
      // Process and execute command
      command ← Decode_Message(message)
      Execute_Command(command)   // Switch appliances ON/OFF
      Turn_OFF(Signal_LED)
    ELSE
      Turn_OFF(Signal_LED)
    END IF
  END WHILE
END
```

Testing

The complete circuit was build and tested for a period of six hours and it worked according to specifications, pulling a current of 7.5mA, 5V from the 5V regulated power supply. It was assembled on a testing board and tested later constructed, permanently on copper stripped vero board and it was found to be working, the test was repeated several times and the project was working perfectly.

Testing Procedures

After successful construction of the project, each unit was tested using appropriate tools and equipment, the following procedures were used:

1. The circuit was then constructed on a testing board
2. The circuit was observed to identify any open or short circuit and partial contact.
3. The power supply was powered on by switching the switch on
4. The circuit was tested and working satisfactory, then it was finally and permanently constructed on the copper stripped board for final testing.
5. Procedures 2, 3 and 4 was repeated again

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6. The permanent constructed circuit was tested and it was working according the circuit specifications.

RESULTS

After the testing of the system, it was found to be working satisfactorily with a minimum or no error with very high reliability. This means that, the project meets its objectives and requirements.

Figure 4: Control Panel

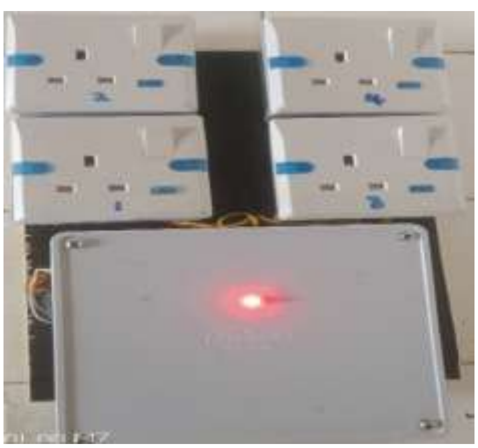

Figure 5: Switches to be Controlled

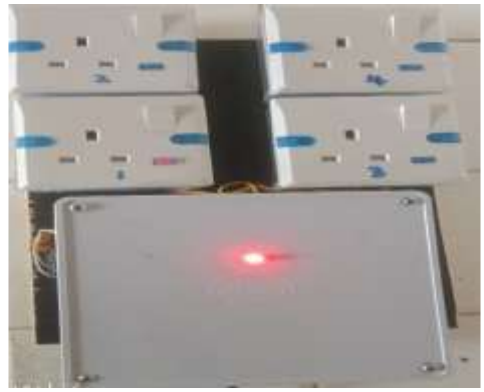

Figure 6: When switch 1 is ON

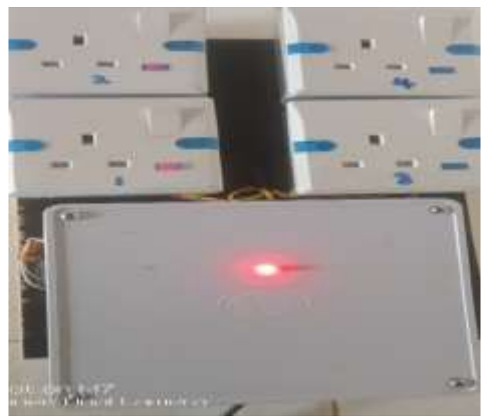

Figure 7: When switch 1&2 are ON

Figure 8: When switch 1, 2 & 3 are ON

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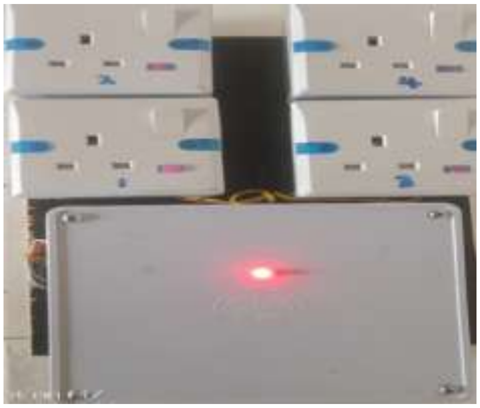
Figure 9: When all switches are ON

CONCLUSION

This project presented the design and implementation of a home automation system using an Android-based application and a Wi-Fi communication module for remote control of household appliances. The developed system successfully eliminates the limitations of conventional manual switching by providing a wireless, user-friendly, and efficient control mechanism. Through the integration of a microcontroller and a Wi-Fi module, seamless communication between the user's smartphone and home appliances was achieved, enabling real-time monitoring and control.

The system demonstrated reliability, low cost, and ease of implementation, making it suitable for modern smart home environments. It also offers significant benefits in terms of convenience, accessibility—particularly for elderly and physically challenged individuals—and improved energy management. Furthermore, the modular nature of the design allows for scalability and future enhancements, such as integration with IoT platforms, voice control systems, and advanced security features. In conclusion, the proposed system provides a practical and effective solution for smart home automation, contributing to the advancement of intelligent and connected living environments.

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