Empowering Everyday Living: Exploring IoT-Driven Intelligent Home Automation for Seamless Control of AC Appliances via HAIS App, Bluetooth, and GSM

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ABSTRACT

The Internet of Things (IoT) technology, which has made everything smart and intelligent, has changed every element of the normal person's existence. IoT refers to a system of autonomous, networked things. Owing to contemporary thinking, time management, and for the protection of people from electric attacks during the rainy season as a result of touching switches to run household appliances, water motor pumps, and other high volt electrical equipment. The digitally controlled electronics switches were employed in place of the manual switches to solve this issue. The microcontroller was used to interface these electrical switches with user commands and operate them. Automated components of residential dwellings include draperies, gates, and other objects. Curtains, gates, and other items are some examples of automated parts of residential buildings. Control is automated or at least largely automatic. The ability to view the house from the internet is offered by a number of modern options devices, but this might conflict with the user's application. Due to the fact that users will always require internet access in order to check on the status of their home equipment, this becomes an absolute necessity. In this article, an app based intelligent home automation system is proposed which controls AC appliances through HAIS app, Bluetooth, and GSM, in place of the traditional switch operation method, a new that is simple to use. The primary objective for creating this system was to enlighten the general public about these technologies and ensure that the information is easily comprehensible for the average person. The findings of this study can be utilized to establish a home automation system that remotely manages and automates household devices through a smartphone application. The prototype of the intended home automation system underwent testing and was subsequently installed on the hardware. The outcomes were precise and aligned with the anticipated expectations.

Keywords: Home Automation System (HAS); Infrared Radiations (IR); Bluetooth; Smartphone; Arduino; Home appliances; Internet of things (IoT).

1. Introduction

People touch switches to operate high-voltage electrical appliances like water motor pumps and other domestic appliances during the rainy season, which puts them at risk for electric attacks. This is due to people's modern concepts, their capacity for time management, and for their own security [14], [17]. Since rapid technology innovation continually attempts to help people, the expectation of living a simple yet sophisticated existence is always rising. For social and educational purposes, humans currently largely rely on the internet; without it, they would be entirely worthless. A range of mechanical, electrical, and electronic systems are used in a number of infrastructures and the Internet of Things (IoT) devices control and monitor these systems. These items are communicated or alerted to a single person (also known as the admin) who runs the cloud server, among other things. The network was logged in by every authorized user. Electrical and electronic devices of various devices are connected and remotely operated using various network infrastructures. Simply said, the difficulty of manually turning switches off and on is eliminated when switching them on using a web browser on a laptop, smartphone, or other smart device. Even while smart switches are currently available, they are still fairly pricey because we needed additional gear, such as a hub or switch, in order to use them. With regard to the function of the media used for connection with the equipment and the microcontroller, a number of connecting tools for wireless technology are offered on the market due to the rapid pace of development [1]. As mobile communication technology has proliferated in the modern period, people's lives and work habits are changing. With the quick development of mobile technology, we now have access to the whole globe. Today, a single mobile phone may be utilised with

electronic equipment like a computer, iPod, camera, and other gadgets. With Bluetooth as connectivity options, mobile phones currently have all the features necessary to communicate with other ad hoc network devices. A large number of home appliances come with infrared remote controllers. Home security and automation are the two components of this project. If there is any kind of human activity seen close to the system's present working prototype, it may sound an alarm at the owner's front door and contact him on his phone to inform him of the notification [6]. The owner then comes to the usage at your own risk. It is hard to directly control any such equipment with a basic mobile phone since the system has the potential of sending alarm messages to anxious security personnel as well. To turn a smartphone into an all-purpose remote control that can control IR-based household appliances, some specialised hardware is required. A house is referred to as a "smart home" if it contains certain characteristics that enable its occupants to programme or control a range of automated home electrical devices. For instance, a homeowner who is away from their house can activate a security system, change the thermostat, turn on or off appliances, control lights, set up a home theatre, or modify temperature gauges among many other things, amuse oneself. If manageable, a smart house becomes far wiser [2]. Home automation systems do away with the necessity for manual labour by utilising control and information technologies. We use cellphones more frequently for remote communication as technology develops swiftly in order to run the home's appliances. A robotic gadget can perform your job with diligence, versatility, and no mistakes. The input field used by the user is empty. There is a significant amount of concern among researchers and manufacturers of home appliances regarding home automation systems. Automation makes it possible to save both time and energy, in addition to reducing the amount of labor that is required from humans. Although its primary objective now is to provide elderly and handicapped people with amenities, an early type of home automation was utilised in labor-saving gadgets. They utilise remote controls for their home appliances and for their daily activities [2]. According to Allied Business Intelligence's (ABI) 2012 data, there were about 1.5 million autonomous home appliances installed in the USA, with a growth rate of 45.2% each year. To address this problem, digitally controlled electronics switches were installed in place of the manual switches. The user commands were interfaced with by the microprocessor, which also managed these electrical switches. Switches were controlled using the digital signal given by the user device (mobile phone), and the microcontroller controls the switch depending on the digital signal produced from the user side.

Homeowners, on the other hand, have the ability to turn off the security system if they consider the visitor to be more of a nuisance than a potential criminal. The homeowner also has the option of opening the door and activating a number of connected home appliances that are managed by the microcontroller of the system in order to welcome the visitor. The wireless network is yet another advantage that comes with the project. The method that has been proposed has the potential to assist people who are disabled or elderly, in addition to providing a home automation system that is adaptable and can be integrated into any existing design configuration. When the user enters the room, they can also go through a procedure that is very similar to this one. By utilizing the system, the user is able to make preparations in advance from outside the room, allowing them to unwind as soon as they enter their own residence. They will no longer have to manually turn on the television or fiddle with the remote controls in order to watch their preferred program. Therefore, it is possible to solve problems with home automation and home security

at the same time by utilizing the same sensors. The user can view the alerts and the IoT system's condition even in places with limited access to Internet connectivity (as it is not necessary for that purpose). It is just necessary to utilise a board and a phone [4]. A Bluetooth-based wireless home automation system that is inexpensive to install may be readily implemented in an existing home. According to a study, Bluetooth technologies are quicker than GSM and wireless systems. Bluetooth technology has a maximum serial data transfer rate of 3 Mbps within a physical range. Use an Arduino board and a smartphone application to interact serially with a Bluetooth module that is connected to a smartphone. Although the offered method allows for remote control of the appliances, it also monitors the sensors. The majority of conventional home automation systems available today are intended for use by the elderly, those with disabilities, or anybody else with a specific need. With this, handicapped people may switch between appliances without having to do it manually. In every renowned theatre, auditorium, conference room, etc., it is also used to control the lighting and fans [9]. Arduino and sensors are used in this circuit's advanced design [7]. The home automation system is one of a luxury home's most crucial components. Smart home technology is trustworthy, safe, simple to use, and reasonably priced in addition to offering a comfortable lifestyle. In the current world, everyone wants to live in safety and comfort. Numerous research initiatives have focused on home automation technologies.

An interface using a Bluetooth module HC-05 and control of the Arduino IDE-based IoT-based prototype of a digitally programmable home automation system for controlling appliances. Due to the connection to the server computer, it is easier, safer, and more practical for the user. Additionally, we may view the number of users who are logged in and out of the system. These following are the principal goals of this paper:

(i) Since each button on a remote control corresponds to a particular bit pattern, the URC must be able to quickly recognize new devices. Devices use a variety of bit patterns. For instance, Sony and LG TVs will have different Power on Key bit sequences. The goal of this study is to make the universal remote compatible with any new device that a person takes home and to make learning new bit patterns simpler.

(ii) The infrared (IR) formats or protocols utilized by different IR remote controllers exhibit significant variations.

(iii) Capable of adapting to or unaffected by the underlying information retrieval protocols. There are variations in the bit logic employed by each of these protocols. A genuine universal remote should disregard the underlying protocol being utilized. The device must possess the capability to regulate all protocols and operate with any television produced by any manufacturer, encompassing Sony, Panasonic, and Sharp. Notwithstanding these objections, the global remote should operate and adapt automatically to any changes in protocol that may occur on a daily basis [3].

2. Overview

There are two main parts to the system as a whole. The initial component is the educational module, which is mandatory for understanding novel devices and their corresponding infrared (IR) bit patterns, as stipulated by the URC. The operational module is the second component of the system. This component is activated either during the operation of the URC or when a user intends to utilize their smartphone to control infrared devices, lights, or fans. The hardware comprises three primary components: an Arduino board, a Bluetooth module HC-05, and a

smartphone. The software component consists of the HAIS app and the Arduino Integrated Development Environment (IDE), which facilitates wireless communication between smartphones and Arduino boards. Multiple approaches have been suggested for the advancement of home automation systems. The Internet of Things (IoT) is a method utilized by specific home automation systems to control and oversee a variety of household appliances. GSM provides instructions on how to remotely operate and manage household devices using a mobile phone. The Bluetooth HC-05 module is utilized for interfacing the HAIS application with system-controlled equipment. Individuals can utilize this technique to remotely manage the appliances in their residence prior to their arrival. A user can exercise control over their appliance by sending an SMS command from their phone if they have a computer that is connected to the appliance. Following the reception of the signal by the computer, it will communicate with a microcontroller in order to verify that the appliance is functioning appropriately [11]. The Arduino IDE facilitates seamless and secure communication between the microcontroller and the user via the HC-05 Bluetooth module connection. This method leverages the computer's IP address to control any connected devices. This innovative IoT strategy aims to fix the flaws in the current setup. Since each IP address is unique, it is private and secure and is protected from interference by unauthorized people. Instead of using a mobile application, an anti-hacker and anti-breach authentication approach using the IP Address is used.

3. Objectives

With the help of a mobile application, the project's primary objective was to simplify the process of controlling and monitoring high-voltage machinery, such as water pumps and other electrical components that are utilized in agricultural settings. To provide protection against electrical assaults when the conditions are wet. By building a simple, low-cost circuit, this objective is achieved. To make accessing appliances and other comparable technological things straightforward. The most basic requirements for home automation and security are met by this affordable solution. Because it is not dependent on any particular platform, the system is compatible with a wide variety of mobile devices that run different operating systems. This home security system employs phone digits from the keypad rather than any user interface or smartphone application [10].

The home security system may be used without the user's phone having a data connection switched on. Even if the sensors are not turned on, the user is still able to control their home appliances by using the smartphone app that is available as an optional feature. A user doesn't need any technical expertise to utilise a home security system, allow his phone to connect to the internet.

The user's desire to control his home appliances without the use of sensors is one that can be fulfilled by the mobile app that is optional. Due to the fact that the Launchpad is only permitted to send phone calls to particular numbers that are specified in the web API, there is no need to be concerned about any security breaches. As a result, additional unauthorized users are unable to access the system. The integrity of the security system is increased as a result. This is in contrast to traditional home automation systems, which typically do not permit internet connectivity on the phone and can only be controlled through the use of an IR remote or a Bluetooth HC-05 [5].

It is possible for home automation and security systems to share a single set of motion sensors, which will significantly simplify the system and reduce its overall cost. This method allows the user to analyze the situation

and then activate the security alarm from their phone, despite the fact that they do not need to physically touch anything in order to do so. In light of the fact that the same collection of motion sensors can be utilized for both home automation and security, the system is not only inexpensive but also simple to operate. By using this method, the user is able to assess the situation and then activate the security alarm from their phone, thereby eliminating the need to physically trigger the alert. Users still have the option to evaluate the situation and then activate the security alarm remotely through their phone, even though it is not necessary for them to physically initiate an alert. Due to the systems' inability to recognize a particular situation in which the alert shouldn't have sounded, many existing home security systems frequently trigger security alarms needlessly. This approach resolves this key issue.

4. Proposed Methodology

The electrical appliance is connected to the relay switch that is joined to the Arduino. The physical gadget is mostly controlled by a microcontroller called an Arduino. The Bluetooth HC-05 module is attached to the Arduino Uno, enabling the Arduino to recognize the signal and manage the appliances. The controls for the recommended model were put up in the mobile application [13]. The appliances are managed by HAIS app. The main components of this system are the Arduino, Bluetooth module HC-05 and relay switch. It is managed by the Bluetooth module HC-05 -connected smartphone. The block diagram is shown in Figure 1.
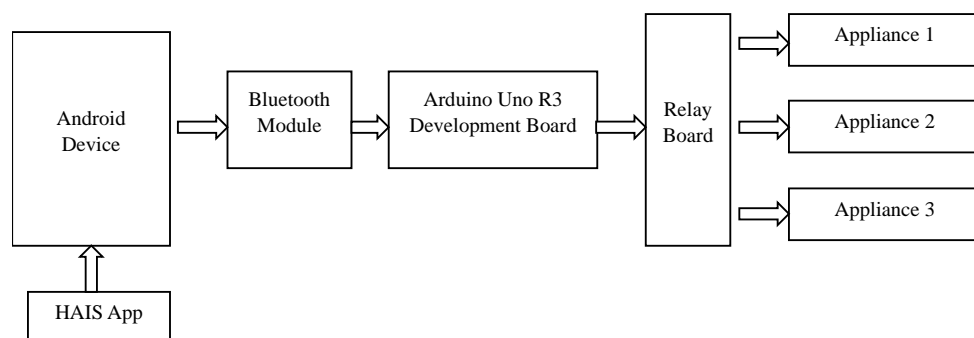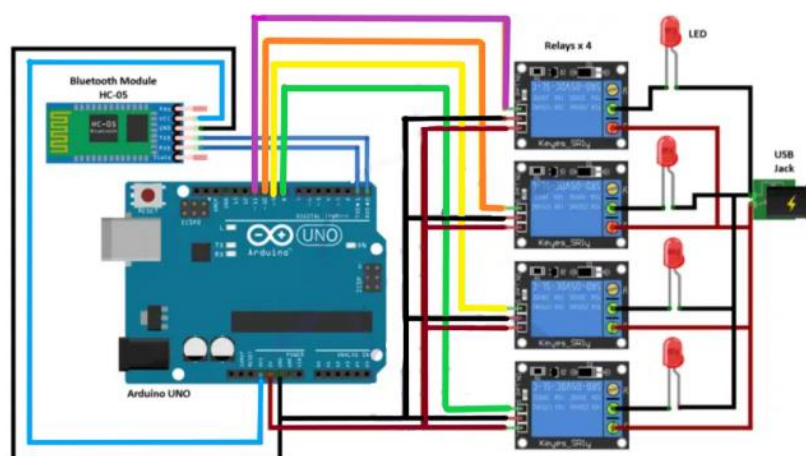

Figure 1. Block diagram

Figure 2. Circuit diagram

When a switch is activated using a mobile phone's switch configuration, a signal is produced that is detected by the Arduino's Bluetooth module HC-05 through a mobile Bluetooth connection. The CPU sensed a signal, and in

response, activated the electromagnetic switch (relay), which switched on the relay switch and activated the electrical devices connected to the relay switch. It is possible to turn off the appliances using the same method. This switching application may be used in a number of industries, depending on the circumstances. The circuit connection for this proposed model is shown in Figure 2.

Due to the fact that they won't require a companion for this reason and we won't have to move from one place to another to turn on the lights, fans, etc., this helps the physically disabled avoid feeling stressed. According to their local language and intricacy, anybody may create the circuit. Using this simple circuit, we may operate electric home appliances with the help of a smartphone or remote-control device. The usefulness of this module will be more clearly illustrated by a particular example [15]. Take the case when the homeowner is expecting company but is unable to provide accommodations. Now the owner will get a video call as soon as the visitors arrive at his home [8]. However, today's owners have the choice of hitting numerals other than 1 (such 3 for lights, 4 for fans, 5 for air conditioning, and so on), or even turning off the security system. This circuit is also used in offices and auditoriums to turn on fans and lights, and it may be especially useful in rainy climates where it is dangerous to handle switchboards.

4.1. Arduino UNO

Numerous electrical applications make use of the easily operated Arduino UNO programmable microcontroller board. Relays, LEDs, motors, and servos are some of the output devices that are available on this board. An additional advantage is that it is possible to connect to other Raspberry Pi models, as well as other boards and shields. Of the fourteen digital input/output (I/O) pins that are present on this microcontroller board, eight of them have been set aside specifically for the purpose of connecting and controlling various home appliances. In addition to that, it comes with a power jack, a reset button, and a USB port. Utilize this technology to interpret signals from various sources, such as infrared remote controls, Bluetooth, and GSM, and then send the appropriate control signal to a relay module. Connecting the Bluetooth module HC-05 and the GSM module SIM800 to the Arduino is accomplished through the utilization of a serial interface. The Arduino Uno's digital input pin is connected to the IR receiver, TSOP 1738.This Arduino UNO is shown in Figure 3 [21].
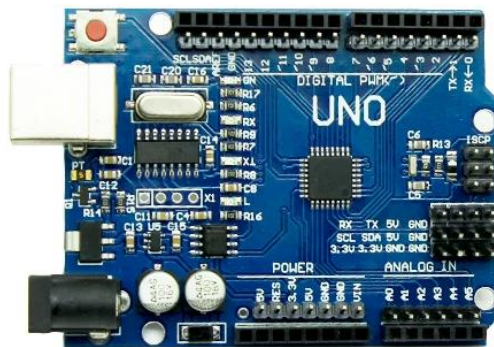

Figure 3. Arduino UNO

4.2. Relay Switch

Electromechanical devices known as relays are utilized in order to open and close circuits in response to electrical signals that are transmitted from external sources. It is common practice to use the term "relay" to refer to a

collaborative effort, such as a race in which competitors pass the baton from one individual to another. In a similar vein, electrical devices frequently have "relays" built in that are able to receive a signal and then switch it on or off in order to send it to other devices. It is used to operate household appliances with voltage and/or current at far higher levels than Arduino could. Additionally, this serves as a means of separation between the Arduino's low-voltage circuit and the high-voltage circuit required to operate household appliances.

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Figure 4. Relay switch

4.3. Bluetooth Module

In addition to facilitating the transfer of data, the Bluetooth HC-05 module serves as an interface for wireless Bluetooth Low Energy connections created between various devices. In order to transmit data, a standard Bluetooth low energy module utilizes particular frequency channels, and its data transmission range extends to several tens of meters. The HC-05 Bluetooth module was utilized in order to accomplish this endeavor. Utilizing the module that has the serial port is a simple process. Establishing a wireless serial connection that is accessible to everyone is the objective of this project. For the module to be powered, a voltage that falls between 3.3V and 5V is required. When a button is pressed within the Bluetooth screen of an Android application, data is transmitted in a sequential manner from the Bluetooth interface of the smartphone to the Bluetooth interface of the Arduino. This data is then interpreted by Arduino, which then takes the appropriate action based on its findings. Arduino concurrently communicates data about the devices' current state to Bluetooth-enabled cellphones. The Bluetooth module HC-05 is shown in Figure 5 [23] & Figure 6 [20].
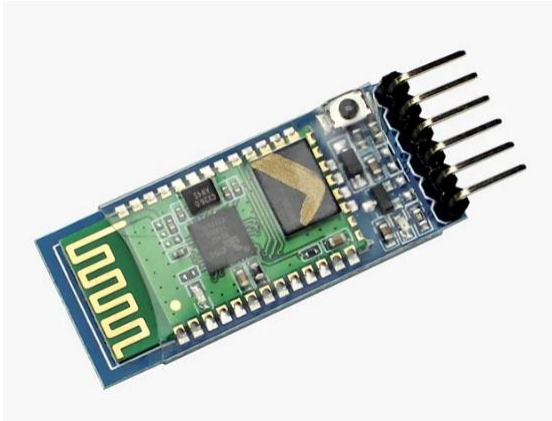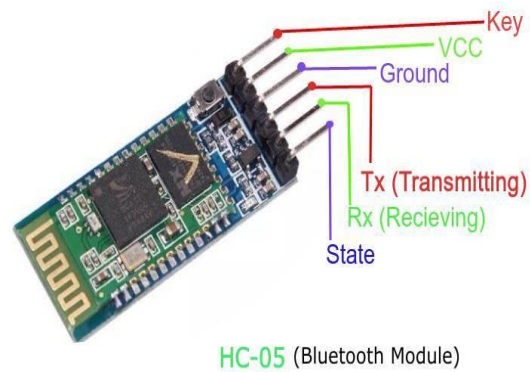
Figure 5. Bluetooth HC-05

Figure 6. Bluetooth module

This circuit's concept may be applied to a number of other businesses by modifying a few ideas. The major objective was to develop a secure interface that enables remote monitoring and control of household appliances as well as the gathering of data on their present state [16]. The suggested system has undergone considerable study and testing and has attained Perfect accuracy within the Bluetooth HC-05 range. This HAIS app is programmed by the algorithm given below:

4.4. Algorithm

int ledPin = 13;
int data;
void setup() {
Serial.begin(9600);
pinMode(ledPin, OUTPUT);
}
void loop() {
while (Serial.available() > 0) {
* data = Serial.read();*
* Serial.println("Received: " + String(char(data))); // Feedback on received data*
* if (data == 'A') {*
* digitalWrite(ledPin, HIGH);*
* Serial.println("LED ON");*
* } else if (data == 'B') {*
* digitalWrite(ledPin, LOW);*
* Serial.println("LED OFF");*
* } else {*
* Serial.println("Invalid command. Use 'A' to turn ON and 'B' to turn OFF.");*
* }*
* }*
}

5. Results and Discussion

A home automation system is the end result of the plan that is proposed in this paper, which ultimately leads to its creation. With the help of Bluetooth HC-05, the automation system that this project has developed makes it possible to easily control a wide range of home appliances. These appliances include lights, fans, tube lights, air conditioners, bulbs, and various other components. One of the goals of the project is to achieve intelligent automation while maintaining high levels of cost efficiency. Furthermore, this document contains information regarding the Arduino Uno, the Bluetooth HC-05 controller, and the relay module. All of these components are included in the document. There is information provided regarding their job. The output of the proposed model is shown in Figure 7.
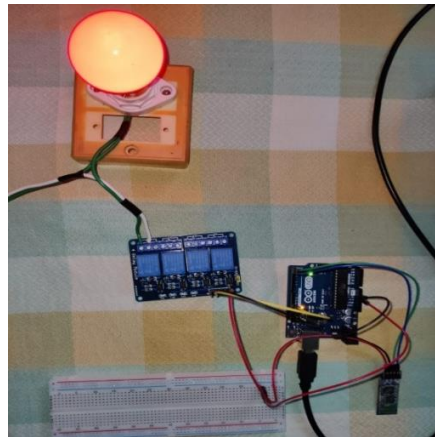

Figure 7. Output

In addition to its constituent parts, the advantages of home automation have also been discussed by this article. It is impossible for anyone to gain access to the system without your authorization because, in addition to being extremely safe, it is also very simple to operate. When the circuit is powered on, the Arduino, which has been customized with predefined libraries and tweaks, switches to the off position before being fully operational. The current load status is displayed on the LCD screen for your observance. The HAIS app is able to obtain the corresponding number from the Arduino Uno whenever an appliance is turned off. This causes the relays of the appliance to become active, which in turn causes the LCD screen to display an updated load status. Additionally, the LED lights up as a result of the forward bias, which indicates that the household appliances are receiving direct current (DC) power. The output and working of this proposed model is shown in Table 1.

Table 1. Obtained Output Values

Input 1 = HIGH(5v)	Output 1 = HIGH	Switch 1 is ON
Input 1 = LOW(0v)	Output 1 = LOW	Switch 1 is OFF
Input 2 = HIGH(5v)	Output 2 = HIGH	Switch 2 is ON
Input 2 = LOW(0v)	Output 2 = LOW	Switch 2 is OFF
Input 3 = HIGH(5v)	Output 3 = HIGH	Switch 3 is ON
Input 3 = LOW(0v)	Output 3 = LOW	Switch 3 is OFF

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The HAIS app is given the corresponding number, and the LCD displays the current status of the load that is associated with it. The relays are triggered to a low state when the Arduino receives the same number, which causes the home appliances to be turned off.

6. Conclusion

More customization options and a more pleasant user interface are provided by this home automation system, which is appropriately named "Home automation," in comparison to other home automation systems that are available. One of the most important aspects of this system is the integration of mobile devices into home automation systems. An innovative design for a home automation system is proposed, and it makes use of the most advanced communication technologies currently available. The HC-05 Bluetooth module, the Arduino microcontroller, and the relay circuits are the three primary components that comprise the system. The Arduino microcontroller can be connected to an Android phone through the use of the HC-05 module, which makes this connection possible. In order to simplify the home automation system and make it more accessible to the general public, we transform the complex ideas into a concise and all-encompassing collection of concepts that are related to one another. This simplification is required in order to accommodate as many features as possible within the constrained space of the screen of a mobile device to the greatest extent possible. The solution that is presented in this paper is one that is not only inexpensive but also secure, easily accessible, self-configuring, and can be controlled remotely. Using HC-05 technology to link system components, the article presents a novel method that satisfies user demands and requirements by enabling remote control of household appliances. This method is introduced in order to fulfill the requirements and demands of users. Compared to other systems, ours will provide you with a more secure environment for your home at a lower cost. Because of this, we are led to believe that the home automation system has been successful in accomplishing its goals and objectives. The architecture and design of the system were the primary topics of discussion, and as a result, we now have a prototype that is operational and enables basic remote monitoring and control of home appliances. In the end, the scalability and flexibility of the proposed system are superior to those of home automation systems that are currently available for commercial use.

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