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IoT Home Control an Android Application for Appliance Management

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***Abstract*— This paper is mainly focusing on building an automated home for a small family in low cost budget. The Internet of things has gained much popularity due to easy connection establishment between electrical appliances, which makes our lives easy and helps in many ways such as reducing power consumption by automating devices, providing security. This product is mainly designed for bachelors who live by themselves. This study suggests a low-cost smart home automation solution that uses Bluetooth to control using an Android-based application, devices may be controlled remotely via an Arduino Uno microcontroller, Bluetooth, Wi-Fi, and many sensors, including an LDR, an LM-35 temperature sensor, and a smoke sensor. And a keypad-based security has been provided to open the door. The proposed system can help us to efficiently control home appliances using Bluetooth and android application.**

***Index Terms*— Internet of Things (IoT), Bluetooth, Wi-fi module, Home Automation, Smart Home, Arduino Uno, Microcontroller, Android Application, Sensors, LDR (Light Dependent Resistor), LM-35 (Temperature Sensor), Smoke Sensor, Keypad-Based Security, Remote Control, Power Consumption Reduction, Connectivity.**

I. INTRODUCTION

In an era marked by the rapid expansion of IoT devices, the proposed system presents an innovative and forward-looking approach to seamlessly integrating electrical appliances within the home environment. By harnessing the power of connectivity, the system not only promises to enhance convenience but also offers the potential to significantly reduce power consumption and elevate security measures within the home.

At the core of this visionary system is the convergence of cutting-edge technologies, including an Android-based application, an Arduino Uno microcontroller, Bluetooth module, Wi-fi module and an assortment of sensors such as LDR, LM-35 temperature sensor, and smoke sensor. These components collectively form the backbone of a sophisticated infrastructure designed to empower homeowners with the ability to remotely control and monitor a wide range of home appliances and environmental systems. The seamless communication facilitated by Bluetooth technology lies at the heart of the system, serving as the conduit through which users can exercise control over their home environment. Through the integration of an Android-based application, users are afforded a user-friendly interface through which they can effortlessly interact with and manage various aspects of their smart home. This interface represents a pivotal bridge between the physical devices and the user, offering a streamlined and intuitive means of engagement. Furthermore, the system's inclusion of a diverse array of sensors, ranging from

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light and temperature sensors to a dedicated smoke sensor, underscores its commitment to comprehensive environmental monitoring and control. By leveraging these sensors, the system not only enables users to remotely regulate their home's climate and lighting but also provides critical safety measures through the detection of hazardous conditions such as smoke or fire. In addition to the core functionality of home automation, the proposed system incorporates a keypad-based security feature designed to fortify door access. By integrating this security mechanism, the system expands its utility beyond mere convenience and environmental control, embracing the imperative of safeguarding the home and its occupants. In the next section, we will begin to explore various IoT devices, home automation systems, and smart home devices more broadly. Through this detailed analysis, we aim to better understand the proposed low-cost Bluetooth- based home automation system and its potential to improve daily life.

II. ARCHITECTURE

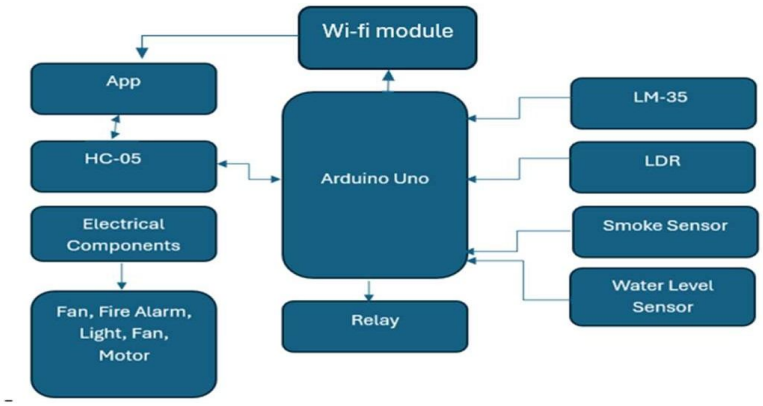

Fig 1: Architecture For Home Control

The architecture depicted in the image illustrates a comprehensive system designed around an Arduino Uno microcontroller. Let's delve into the details:

1. *Arduino Uno*: Arduino Uno is in place and serves as the brain of the system. It's a versatile microcontroller board widely used for prototyping and educational purposes. Its flexibility allows for easy integration with various components.

2. *App and HC-05*: On the left side, we see an 'App' connected to an HC-05 module. The HC-05 facilitates Bluetooth communication between the Arduino and the app. Users can remotely monitor sensor data or control connected devices (like fans or lights) via their smartphones or computers.

3. *Electrical Components*: These could include actuators (like motors), lights, fire alarms, or other devices. The Arduino directly controls these components based on sensor readings or user inputs from the app.

4. *Relay Module*: The component has a "relay" module. It works with an electronic switch that accepts Arduino. Operate the device safely at higher voltages or currents. This will prevent damage to your Arduino board.

5. *Sensors*: On the right side, four sensors connect directly to the Arduino Uno:

- *LM-35:* A temperature sensor that provides real-time temperature data.
- *LDR (Light Dependent Resistor):* Measures light intensity, useful for applications like automatic lighting control.
- *Smoke Sensor:* Detects smoke or fire, triggering alerts or safety measures.
- *Water Level Sensor*: Monitors water levels (e.g., in tanks or reservoirs).

6. *Functionality*

- The Arduino processes sensor data and executes actions based on pre-set conditions or thresholds.
- For instance:
  - If the temperature exceeds a limit, the Arduino may activate a fan or send an alert.
  - If smoke is detected, it can trigger a fire alarm.
  - Water level changes can prompt pump activation or notifications.

7. *Applications*

- *Home Automation*: Users can remotely control lights, fans, or other appliances via the app.
- *Environmental Monitoring*: The system tracks temperature, light, smoke, and water levels.
- *Safety Systems*: Fire alarms and water level alerts enhance safety.

III. CONCEPTUAL FRAMEWORK

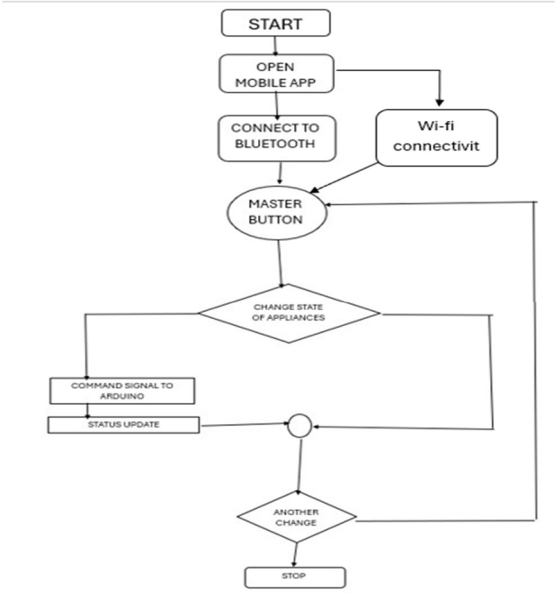

Fig 2: Conecptual Framework

A. Components used in home automation system

1. Arduino UNO

A well-known microcontroller board built on the ATmega328P is the Arduino Uno. It has inbuilt LEDs, USB connectivity for programming and communication, digital and analog input/output connectors, and extensive support for sensors, actuators, and other electrical components. The Arduino Uno, with its open-source hardware and software architecture, is a popular choice for hobbyists, educators, and prototyping applications due to its adaptability, simplicity, and welcoming community for both novice and seasoned users.

2. Step down Transformer

A transformer that steps down the input voltage to a lower output voltage is called a step-down transformer. There are two coils wound around a magnetic core called primary and secondary windings. When alternating current (AC) passes through the first winding and changes the magnetic field in the core, a voltage is created in the second winding. The change is the number of turns in the first winding multiplied by the number of turns in the second winding. Step-down transformers are widely used in electrical and electronic equipment to provide the required power, as well as in electrical equipment to reduce the voltage to the appropriate level for customers by dissipating the pressure.

3. Relays

A relay is an electromechanical switch that uses an electromagnet to mechanically control the switching of one or more circuits. It consists of a coil of wire that, when turned on, attracts the armature, and creates a magnetic field that opens or closes the electrical contacts. Relays are often used in industrial control systems, automotive electronics, automation systems, and other applications with weak signal control high-power circuits. Specifically, they are available in a variety of configurations, including single pole/single throw (SPST), single pole/duplex (SPDT), and double pole/double throw (DPDT). Type conversion. Requirements. Provides isolation between the control circuit and the load, ensuring safe and reliable switching of electrical loads.

4. Bluetooth Module

HC-05 Bluetooth module is based on Bluetooth 2.0/2.1 and is a widely used wireless communication module. It provides an inexpensive way to connect electronic devices at 2.4 GHz frequency instead of traditional cable connections. The HC-05 module is widely used in applications requiring Bluetooth connectivity, such as data logging and remote control, due to its small size and ease of use. It is suitable for many industries and hobbies as it supports Master and Slave mode and is compatible with different microcontrollers and embedded systems.

5. Keypad

A 4x4 keypad is a type of input device that is frequently used with Arduino and other microcontroller-based projects. It has 16 buttons organized in a grid pattern to allow the user to enter data. Every button has its own key that often represents a letter, number, or symbol.Digital input/output pins are used to link the keypad and Arduino different pins are attached to the rows and columns. Through row and column scanning of the keypad matrix, the Arduino is able to determine which button is being pressed.

B. SENSORS

1. LDR

A resistor whose resistance varies according to the amount of light it is exposed to is called an LDR (Light Dependent Resistor), sometimes referred to as a photoresistor. The resistance of the LDR increases in the dark and reduces in the presence of light. Because of this feature, LDRs can be used to detect light levels in a variety of settings, including automatic outdoor lighting systems, streetlights, and exposure control in photography. LDRs are passive electronic parts that work on the basis of photoconductivity, which is the theory that a material's conductivity varies in reaction to light. They are frequently used in conjunction with other parts, like operational amplifiers or microcontrollers, to build light- sensing circuits that can do things like turn lights on and off automatically.

2. LM-35

The high-precision analog temperature sensor LM35 produces an accurate output voltage proportional to the temperature in degrees Celsius. This small integrated circuit (IC) sensor requires only external devices to operate. The LM35 is rated at 10 mV/°C and provides a linear output voltage proportional to temperature over a wide temperature range.

3. Smoke Sensor

The MQ-2 sensor is a multipurpose gas sensor module that can identify smoke and a variety of flammable gases in the surrounding air. It works on the basis of the idea that certain gases cause conductivity to vary. A semiconductor gas sensor is linked to a heating element and a resistance measurement circuit. Methane, butane, propane, alcohol, hydrogen, smoke, and other gases can all be detected by this sensor, which converts the concentration of the gases it detects into an analog voltage output. The MQ-2 sensor, which is widely used in air quality monitoring devices, gas leak detection systems, and fire detection systems, provides sensitivity, affordability, and simplicity of integration with microcontrollers or other electronic devices for a range of commercial and residential applications.

4. Water Level Sensor

The instrument used to measure and determine the level of water in a reservoir, tank or other container is called a water meter. A circuit that converts the water level into an electrical signal and a sensor probe or array that comes into contact with the water usually make up this type of device. Float switches, capacitance sensors, and ultrasonic sensors are common kinds of water level sensors. With float switches, a switch is turned on when the water level increases or lowers by means of a buoyant float fastened to a lever arm. Ultrasonic sensors use sound waves to detect the distance to the water's surface, while capacitance sensors measure changes in capacitance as the water level changes.

5. Wi-fi Module

A WiFi module is a piece of hardware that allows a device to connect to a wireless network. It includes a transceiver, antenna, and often a microcontroller for managing communication. Commonly used in IoT, consumer electronics, and industrial automation, WiFi modules provide wireless connectivity without the need for cables.

6. IC 7805

A well-liked integrated circuit (IC) for voltage regulation that produces a steady +5 volt DC output is the IC 7805. It is a voltage regulator from the 78xx series and is frequently used in electronic circuits to control voltage and supply a steady power source. An input voltage (Vin), ground (GND), and a regulated output voltage (Vout) make up the three terminals of the IC 7805. In order to maintain a consistent voltage level even when the input voltage varies, it compares the output voltage to a reference voltage and modifies the output accordingly. The IC 7805 is appropriate for a variety of electrical applications since it can withstand input voltages of up to 35 volts and has a maximum output current of 1 ampere.

IV. BACKGROUND

A key feature of the “Internet of Things” is home automation, commonly known as smart home technology, which assigns everything an IP address and allows remote monitoring and access.Anytime and anywhere. It is the process of connecting to other devices and appliances to manage all the basics of a smart home.Home electronics have been used to control basic appliances and lighting for years.The concept of social networking has become a reality as the latest technological developments allow us to manage the quality of our home from anywhere. Why, how and when field equipment can be controlled from home operations. Provides cost savings, full control and convenience.

Additionally, home automation systems can alert users to emergencies such as fire, gas, and unauthorized access to their homes. The user can adjust the settings of the automation system to his needs and preferences at any time using an Android application or other controller.The above-mentioned smart home systems have changed traditional home settings through the integration of the latest technologies.Basically, the system uses various sensors and actuators to automate the maintenance of various parts of the building, thereby increasing the efficiency, safety and comfort of the residents.One of the system's most notable features is automatic lighting control, which uses light sensors to identify changes in ambient brightness and initiate the proper lighting response. By only lighting areas when needed, this not only maximizes energy efficiency but also improves user comfort and convenience.

Moreover, the incorporation of a mobile application, enabled by Bluetooth connectivity, confers unparalleled flexibility and energy savings to consumers by enabling them to remotely operate the lighting system. Another essential component of the smart home system is temperature monitoring and fan management, which dynamically modifies fan speed in reaction to temperature variations in real time to provide ideal thermal comfort. By reducing wasteful energy use, this clever climate control system improves occupant comfort while simultaneously improving energy efficiency.Additionally, the addition of gas and smoke detectors improves home security by quickly identifying any threats and sending out alarms in case of an emergency, giving residents priceless piece of mind.By automatically controlling the water level in the overhead tank, water level monitoring and motor control features completely transform how water is managed in homes, reducing waste and overflow. This feature reduces the possibility of water-related mishaps while simultaneously increasing efficiency by doing away with the necessity for manual intervention.

The integration of a keypad-based security door further enhances the security of the system by providing strong control, preventing unauthorized attempts to enter the home, and increasing the overall security of the home. Additionally, the system's strong integration with mobile applications allows customers to remotely access and control various home controls, taking the smart home experience to an unprecedented level. Simplicity and personalization.Essentially, the smart home system is the perfect fusion of innovation and technology, transforming the contemporary house into an oasis of effectiveness, security, and unmatched comfort for its residents.

V. METHODOLOGY

Integration of smartphones with devices has become standard practice in the modern era of smart homes and automation, providing convenience, efficiency and improved management across all our locations. The network system combines software applications with hardware, including Arduino boards, sensors, motors and actuators, to create a social-intelligent environment. The smartphone app acts as the main control center, enabling users to monitor and control a range of electrical equipment from a distance, including doors, fire alarms, fans, lights, and motors. People can effortlessly toggle switches, change settings, and get real-time status updates on any device thanks to an intuitive interface. This system's ability to react to external variables is one of its most important features. Light-dependent resistors, or LDRs, are used to track the amount of ambient light in space. The Arduino code is set up to turn on the necessary switches when the light level drops, signaling low lighting. This keeps the lights powered on and maintains ideal vision. Another essential function that this system facilitates is temperature regulation. The application dynamically modifies fan speed to maintain a comfortable environment based on temperature sensor data. The device minimizes energy consumption while maintaining occupant comfort by continuously monitoring temperature variations. In smart home installations, safety features are critical components. The smoke alarm acts as an early warning mechanism in case of a gas leak or fire outbreak. The Arduino board receives analog data from the alarm and uses a Bluetooth module to quickly deliver alert messages to users' mobile devices. By enabling residents to act right away, this real-time alert may help prevent dangerous circumstances.

Water level sensors are integrated to address water management as well. By keeping an eye on the water level in overhead tanks, these sensors help to ensure effective use and avoid overflow or depletion. Refueling the tank is accomplished by activating the motor when the water level falls below a certain threshold, signifying low supply. The smart door entry feature of the system further improves security. Doors can be operated with two different methods: utilizing the mobile application or inputting a pre-set password. Secure and practical access control is provided by the Arduino board, which communicates with a servo motor to open or close the door upon accurate password entering.
Bluetooth connectivity has been so that even if the internet connection has a problem Bluetooth works as the backup tool. All things considered, the combination of cutting-edge technology, clever programming, and smartphone applications with electrical appliances results in a sophisticated and user-friendly ecosystem for smart homes. This integrated system, which combines environmental control, safety monitoring, and access control, with other features to improve comfort, efficiency, and security in living areas, is a prime example of how technology can be seamlessly integrated into daily life.

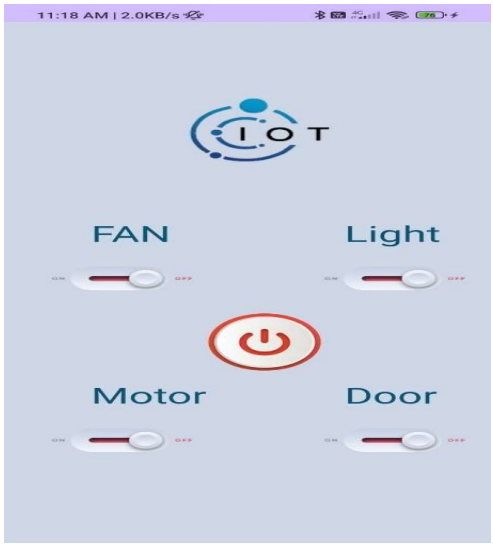

Fig 7: Mobile App Design

Model-view view-model architecture has been employed in the design of the mobile application.
Model-View-ViewModel, or MVVM for short, is an architectural paradigm for software development that is mainly applied to creating user interfaces (UIs) for applications. It's especially well-liked when used with cross-platform mobile application development frameworks like Xamarin and WPF (Windows Presentation Foundation).
An outline of the MVVM architecture is provided below: Model:
Application data and business logic are represented by models. It captures, without reference to the user interface, the information and actions of the application's domain.
It usually contains of classes that handle data manipulation and business rules in addition to classes that represent the data entities.

View:

A view is a representation of the application's user interface elements with which users interact. This includes text boxes, buttons, text, etc. Can be used for.
The View in MVVM is kept as simple as possible, with the main emphasis being on data presentation and user interactions.

View Model

The View Model functions as a bridge connecting the View and the Model. It acts as an adaptor, converting data from the Model into a format that the View can easily use, and vice versa.
It includes the application's presentation logic, which includes commands that are activated by user interactions, validation of the data, and formatting of the data.

The View Model exposes the attributes and instructions that the View binds to, rather than having direct references to the View.

Fundamental ideas of MVVM

Separation of Concerns: To encourage a more modular and maintainable codebase, MVVM divides the concerns of data presentation (View), data manipulation (View Model), and data storage (Model).
Testability: MVVM makes it easier to conduct unit tests by allowing View Model logic to be tested separately from the user interface. This improves code coverage and the general quality of the software.
Data Binding: Using the platform/framework's data binding techniques to create a communication channel between the View and the View Model is one of the fundamental components of MVVM. This minimizes boilerplate code needed for synchronization and allows changes in data to propagate automatically between levels.

Advantages of MVVM

Maintainability: MVVM facilitates easy maintenance and updates of various application components independently by providing a clear separation of concerns.
Reusability: Code reuse and consistency are promoted by components like View Models, which may be used again and again across several Views.
Testability: The design of MVVM makes unit testing simpler, which results in applications that are more reliable and error-free.
Scalability: MVVM scales with the application, allowing developers to add new functionality or modify existing functionality without major infrastructure changes.
All things considered, MVVM is a strong architectural pattern for creating contemporary user interface apps, especially on platforms and frameworks that facilitate data binding and promote concern separation. Because it encourages testability, scalability, and maintainability of code, it is a preferred option for developers creating intricate user interfaces.

VI. Conclusion

In summary, the proposed low-cost Bluetooth-based home automation system offers new solutions for smart home use using Internet of Things (IoT) technology. By integrating Arduino Uno microcontroller, Bluetooth module and various sensors such as LDR, temperature sensor (LM-35) and smoke sensors with Android applications, the system allows users to They can easily manage their home appliances remotely. One of the most important advantages of this system is that it is cheap and can be used by many users. By utilizing readily available components and open-source software platforms, the system provides an economical yet effective solution for home automation.

Furthermore, the system enhances convenience and efficiency by allowing users to control devices remotely through the Android application. This not only saves time but also enables users to optimize energy consumption by automating devices according to their preferences and needs. Moreover, the inclusion of sensors like LDR and temperature sensor enhances the system's functionality by enabling it to respond intelligently to environmental variables such as light levels and temperature. This contributes to energy conservation and creates a more comfortable living environment for users. Additionally, the integration of a keypad-based security feature for door access adds an extra layer of security to the system, ensuring the safety of the user's home and belongings.

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