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Smart Home Automation using Arduino UNO Rev2 Microcontroller

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***Abstract*—This paper presents a concept of design and implementation of modern smart monitoring and control systems for building a reliable system for home automatization. The system is designed to enable the automatization of the home appliances without the use of the internet thus eliminating the process of data collection and offering its users full control over their privacy. The system consists of an Arduino UNO REV2 microcontroller with an inbuilt Wireless Fidelity(Wi-Fi) module, Wireless Sensor Network(WSN), jumper cable with an operating temperature range from -40°C to 80°C and a supply voltage of 30 Volts, 4-channel relay board with a supply voltage of 5V and controlled directly by the microcontroller, a custom designed android application named autofy. The electricity flow is controlled and optimized by using an Effective Circulation Control (ECC) algorithm that runs on the microcontroller. The microcontroller communicates with the Android application Autofy over the Wi-Fi medium which serves as an interface that controls the state of the home appliances and also monitors their usage time, and units of electricity consumed. The user can practise seamless control over the appliances in a smart home via the Android application Autofy which is based on Graphical User Interface (GUI) on a smartphone. As the system is not connected to the internet by any means, there is no chance of data collection and thus offering its users full control over their privacy.**

***Index Terms*—Home Automation, Wireless Fidelity, Arduino UNO REV2, Wireless Sensor Network, Android, GUI, Privacy.**

I. Introduction

Recently Google and Amazon were in news for their products Google Home and Amazon Alexa for listening to people's conversation as way of data gathering, people had registered concerns that the devices are listening to their conversation while not being in use. Even their own employees had said that while they're into a private conversation or talking about something which they won't want someone else to hear they completely turn off their devices. This is a very critical issue which should be address with utmost care since it can open up so much vulnerabilities and can break into people's privacy and home as well. This papers suggest the idea of home automation without the need of internet, If there's no internet no data will be collected and people can have their private conversations without worrying about anything else or loosing their convenience of automatizing their home appliances.

The benefit of this inter-linkage is the concurrent monitoring and controlling of smart devices. 'Home Automation' is a concept which involves real time control and monitoring of multiple domestic appliances. Home automation can be defined in myriad ways; the author in [1] portrays home automation as a methodology to enhance the quality of life of people with the introduction of technology in the household. According to the author, the oldest standard for the communication between electronic devices was the X10 industry standard, developed as far back as 1975. This standard utilized the existing electrical power lines, which provided limited control over the home appliances.[2-4] incorporate various wireless communication protocols viz. Bluetooth, ZigBee etc. However, this does not assuage the intrusiveness caused due to the use of wired communication. These systems also use expensive sensors and relays which are intrusive and the whole circuitry becomes cumbersome. There is a paucity of security in such designs.

This paper explores a novel methodology for the automation of home appliances by exploiting their ability to be interlinked and that too without the use of any internet connection. The experimental rig involves the use of an Arduino UNO REV2 model microcontroller, 4-channel Relay, Jumper cable with and an operating temperature range from -40°C to 80°C and a supply voltage of 30 Volts, The user is provided with an android application based Graphic User Interface (GUI) to exercise the desired control over the lights, fan speed regulation, control of appliances, and information regarding the temperature, humidity, water tank level or rain. Fig. 1 shows the proposed block diagram of the Home Automation System.

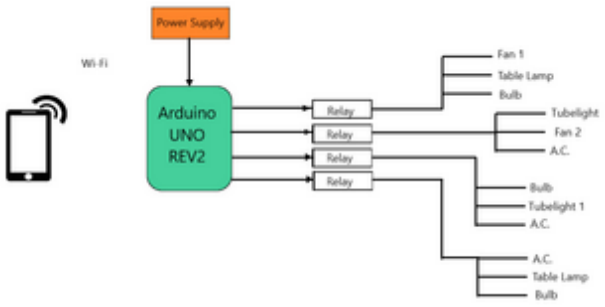

Fig. 1. Block Diagram of the Home Automation System

II. SYSTEM HARDWARE

The primary objective of this methodology is to provide a low cost Home Automation System (HAS). The choice of hardware elements in devising the system is the key in fixing its overall cost and affordability of the system for the end consumer and also to make it more compact and easy to handle and carry. The HAS consists of an Arduino UNO Rev2 model microcontroller which comes with an inbuilt Wi-Fi module. A set of 4-channel Relays is connected to the microcontroller with the help of the jumper cable and a supply voltage of 50V is required to operate the microcontroller.

A. Arduino UNO Rev2 microcontroller

The Arduino Uno Rev2 uses the 8-bit micro controller ATmega328P that is placed on the development board equipped with input/output (I/O) pins, connectors (USB, power) and other necessary components for operation of microcontroller. It has an integrated Wi-Fi module. The board is based on the Microchip MEGA4809 with an ESP32 u-blox NINA-W13 Wi-Fi Module integrated. The NINA-W13 Module is a self-contained SoC with integrated TCP/IP protocol stack that can give access to your Wi-Fi network (or the device can act as an access point). The Arduino Uno Wi-Fi Rev2 is programmed using the Arduino Software (IDE), The code is written in the computer and then sent through USB cable for execution. Its construction simply covers digital input-output pins that are between 9-54 AND 6-12 analog input pins. Its power consumption is less than 0.5 watt.

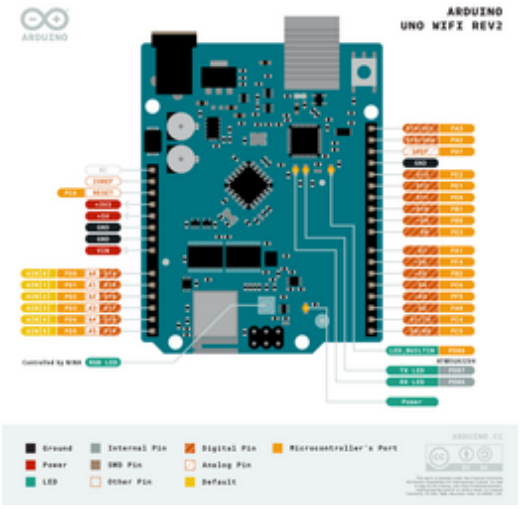

Fig. 2. Arduino UNO Rev2 microcontroller with inbuilt Wi-Fi module

B. Wireless Fidelity (Wi-Fi)

WI-FI signals are radiowave signals which communicate through two steps ,encoding of data into radiowave signals and decoding back into electrical signals to other end. Wi-Fi signal has a transmission range is up to 150-300feet which can be further amplified using external devices. There are several variants of Wi-Fi available in the market we are using the most common and suitable one in order to offer the ability to connect to the microcontroller by a wide range of devices and for the backward compatibility of the newer variants as well.

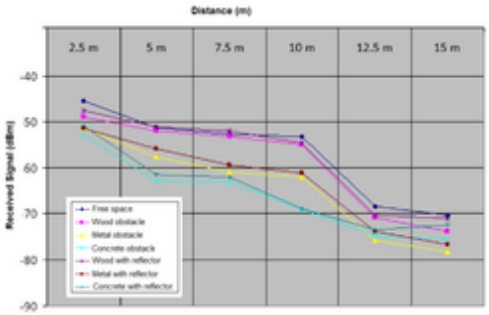

Fig. 3. Wi-Fi Range.

C. Jumper Wires

Jumper wires have connector pins at each end, making them to be used to connect two separate points without soldering. They have an operating temperature range of -40°C to 80°C and requires a supply voltage of 30V. Jumper wires makes it more convenient to connect the different components of the system and also facilates future repairing without any hassle which does not require a skill labor.

Fig. 4. Jumper Wires.

D. Relay

Relays are the switches which used for closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an electronic circuit. When the relay contact is open condition , the relay isn't passing current and output is no current passage. However, if it is closed), the relay completes the circuit, and electricity flows. Moreover relay helps in detecting overload current and useful to ensure safety of device. We are using 4-channel relay board controlled directly by microcontroller (Arduino, 8051, AVR, PIC, DSP, ARM,MSP430, TTL logic).[5] And it needs 50-60mA driver current. It has highcurrent-voltage of 250V, 10A in AC and 30V 10A in DC.The Relay has a effective VCC, Ground power input, and it can relay a separate power supply.

Fig. 5. 4-channel Relay.

III. HARDWARE PROGRAMMING AND APPLICATION DEVELOPMENT

Every system consists of requisite programming to enhance the flexibility and to accordingly entail the promoted traits of compactness and low cost implementation of the HAS. In the proposed system, the software design platforms used are the open-source Arduino Software (IDE and Android Studio along with the Geny motion emulator for android application development. And AdobeXD for designing the user interface for the application. .The flowchart of the system software implementation is as shown Fig. 4.

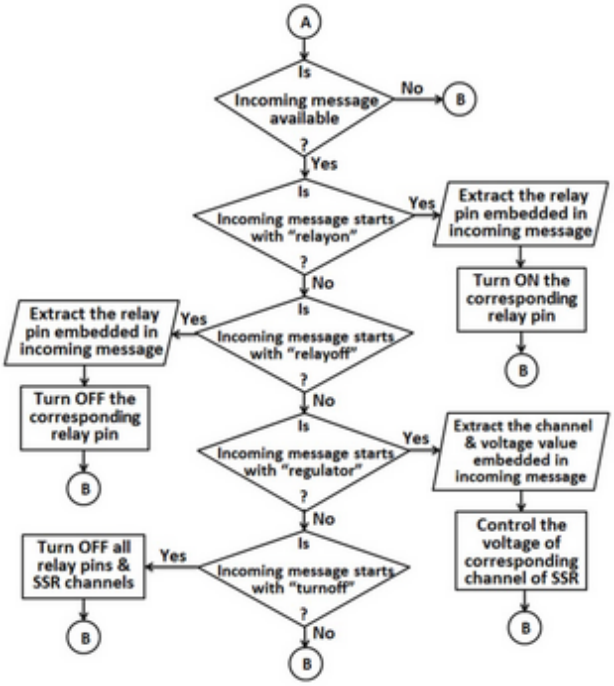

Fig. 6. Flowchart of software implementation.

The coding of the Android Studio is based on Java. The Android Studio is recognized for its built-in cloud support which abates the integration of messaging and application engine. Hence, the user has the privilege of assessment and control of the fully automated home via the state-of-the-art GUI provided on the Android smartphone.

IV. GRAPHICAL USER INTERFACE

The primary requirement of HAS to monitor and control multitudinal devices is accomplished using a Smartphone application. Ther Graphical User Interface for the application is designed by using the software Adobe XD. The application is developed using Android Studio IDE based on JAVA platform. The application comprises buttons to control the activities of devices such as Lights and fans which also give their details about usage time and unit of electricity consumed.

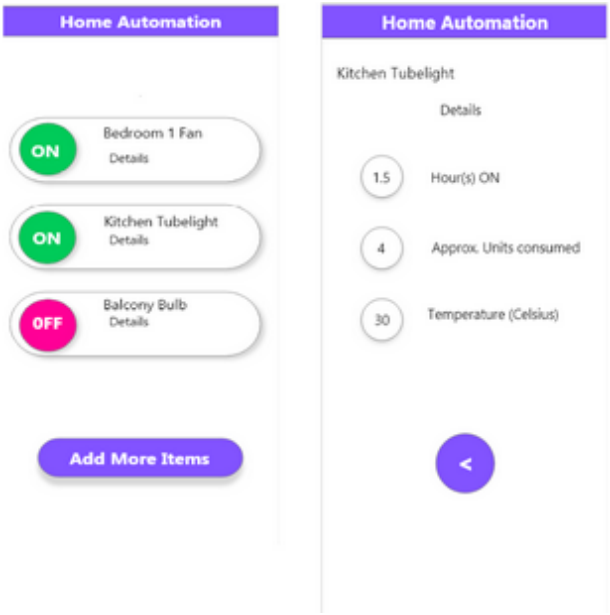

Fig. 7. Application User Interface.

The designed android application provides discrete display screens for each appliance in the system giving the details about its usage time and unti electricity consumed which is demonstrated in Fig 7.

V. CONCLUSION

In this work, the primary focus is on developing a technology which provides a cost-effective solution to Home Automation without the use of internet in order to combat the data collection processess and offer its users a great user experience with full control over their devices and privacy without any third party involved. The flexibility in the control of the designed with help of smartphone is in effect all over the world.In addition to the simplicity of the design, the application software embedded is Android which has billions of users across the world. It offers the most profound smartphone base and an open source which tags the smartphone to be the controller in this project owing to cost reduction aspect. This technology can prove helpful in the societal causes of old age homes and orphanages. The future scope of this work is to develop an iOS application and a desktop application for Linux, MacOS and Windows devices.

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