

IoT Based Home - Substation Automated Coordination Using Arduino

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Abstract - While the cost of living is going up, there is a growing focus to involve technology to lower those prices. It is pretty hard to ignore that smart technology has become an integral part of our lives. Home Automation is one of its kind. With this in mind, the Smart Home project allows the user to build and maintain a house that is smart enough to keep energy levels down while providing more automated applications. A smart home will take advantage of its environment and allow seamless control whether the user is present or away. With a home that has this advantage, you can know that your home is performing at its best in energy performance. This automation system provides great insights to the challenges of software and hardware design. In Smart Grid, customer has two-way communication between customer and substation. Demand side management with load clipping requirement can be satisfied when it gets incorporated with the home automation. This project is aiming for home automation with three party communication, remote control by customer and remote control by substation.

Key Words: Arduino Uno, Current & Voltage Sensor, Internet of Things (IoT), Proteus for hardware simulation, Wi-Fi Module (ESP8266), etc.

1. INTRODUCTION

The home automation systems involve making homes even smarter. Homes can be interfaced with sensors including motion sensors, light sensors and temperature sensors and provide automated toggling of devices based on conditions. More energy can be conserved by ensuring occupation of the house before turning on devices and checking brightness and turning off lights if not necessary. The system can be integrated closely with home security solutions to allow greater control and safety for homeowners. The next step would be to extend this system to automate a large-scale environment, such as offices and factories. Home Automation offers a global standard for interoperable products. Standardization enables smart homes that can control appliances, lighting, environment, energy management and security as well as the expandability to connect with other networks.

In addition to this, we are introducing one more access to communication through substation in home automation system. It is called three party communication. Remote control by customer and by substation. In certain conditions, riders will be provided for customer over substation based on tariff rates, based on time of day and need of customer. It helps individuals in their home by only controlling, they can do what they require. It enables communication gateway for all components of the future distribution substation and improve grid monitoring.

2. LITERATURE SURVEY

Home automation is a challenging one not only to the developer but also to the consumer. Developer has to choose the components as per the customer requirement. As the demands of all the customers are not same, they have to compromise with the existing products. Through detailed study of "Home Automation Using Internet of Thing" proposed by Shopan Dey, Ayon Roy and Sandip Das, it is found that they have used Raspberry pi module to connect ESP8266-01 module to the internet. Through this module they are controlling various devices through webpage and also through android application [2].

K. Venkatesan and Dr. U. Ramachandraiah in their paper have implemented Zigbee module in Arduino Mega through which they are controlling devices. They have used various sensors for various purposes. Also they have provided real time notification, feedback on web-server in which customers can see what is happening in their home [1]. With the help of logic gates, a Raspberry pi, 555 timer and flip-flop, the devices are also controlled from web app.

Paper proposed by Shashank Shiva Kumar Jha, Vishwateja Mudiam Reddy, Tapan Pokharna, Naresh Vinay shows how this is operated and controlled [3]. "Programmable Infrared Accessory Light Switch" by Warsuzarina Mat Jubadi and Normaziah Zulkifli shows how TV remote is used to control room light and other appliances. Here IR remote and one IR receiver is used and programmed in such a way that it stores the frequency of the existing remote and use them directly to control appliances [4]. So, here we introduce Arduino Uno with ESP8266-01 module. This is not only cost-effective but also

proves to be the easiest one when it comes in terms of programming and also implementation.

Esp8266-01 works on 802.11 b/g/n protocol whereas Zigbee uses 802.14.5 protocol. Zigbee consumes least power as 3mW whereas Wi-Fi and Bluetooth consumes nearly 100mW. But if we compare their speeds, Esp8266 has maximum speed up to 11 mbps but Zigbee has only 250 kbps. Clearly Esp8266 defeats Zigbee and Bluetooth not only in cost but also in speed [5]-[6]. Figure is giving a brief idea about the interconnection of microcontroller, peripheral devices as well as sensors and what is the architecture behind it [7]-[9].

3. CIRCUIT DIAGRAM

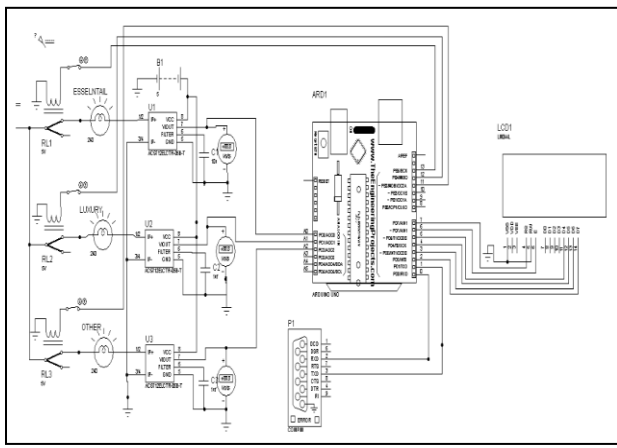
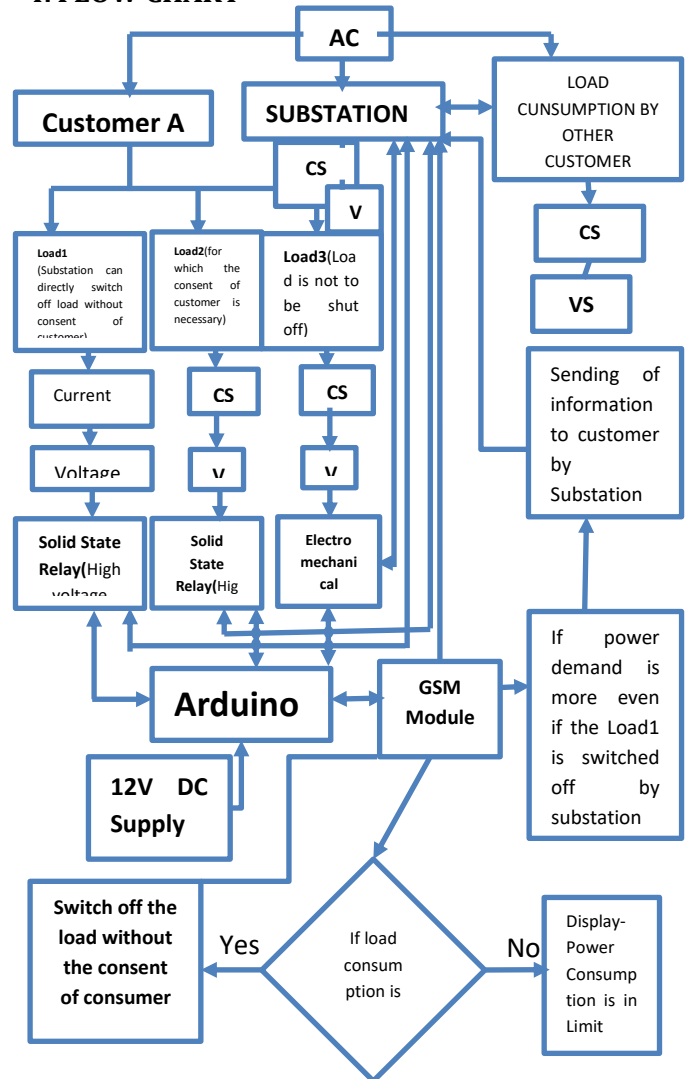


Fig.-1: Circuit Diagram

4. FLOW CHART



- Indicates jumping line

Fig.-2: Flow Chart

Here we will see how the system is actually working. Customers with their respective loads are connected to substation and they are connected to AC supply. All loads have respective current sensors and voltage sensors connected to them. They are then followed by relays, Electromagnetic relays for low voltage loads and Solid State relays for high voltage loads. Then these relays are connected to Arduino.

Arduino has been provided supply of 12V DC. GSM module is connected to Arduino. GSM module is an electronic device that will send the information to the substation which in turn will provide the information to customer. GSM module will follow two types of cases. First one is if load consumption is more than specified limit. This has two conditions again. First, if the case is true, GSM will provide this information to substation, hence substations will switch off load 1. If the case is false then display will show that Power consumption is in limit.

Another case of GSM module is if power demand is more even if load 1 is switched off by substation, then the GSM will

send this information to substation. Here substation now will require the consent of customer to switch off the load. It will send the information to customer regarding consent. If customer replied yes, only then the load 2 will be switched off, otherwise if he replied no then it will not be switched off.

5. BLOCK DIAGRAM

The block diagram shows that there are several customers, in customer A loads are shown and customer B & C are sharing a common load. Customer A has three types of loads, viz. essential load, non-essential load and load that are to be shut down by substation communication portal. As the customer can directly switch OFF the load whenever the customer gets the reminder that the system is overloaded.

We are using Arduino UNO Atmega328p for home automation of smart customers. A 12V DC supply is given to the Arduino. Customer has a choice to switch OFF the non-essential load at all the system is not balanced in that case substation can directly shut down the load. Hence, Substation is connected with the load that can be shut down without consent of customers. For each load, voltage and current sensor is connected. Solid state relay is used as a switch for high load appliances and electromechanical relay is used for low load appliances.

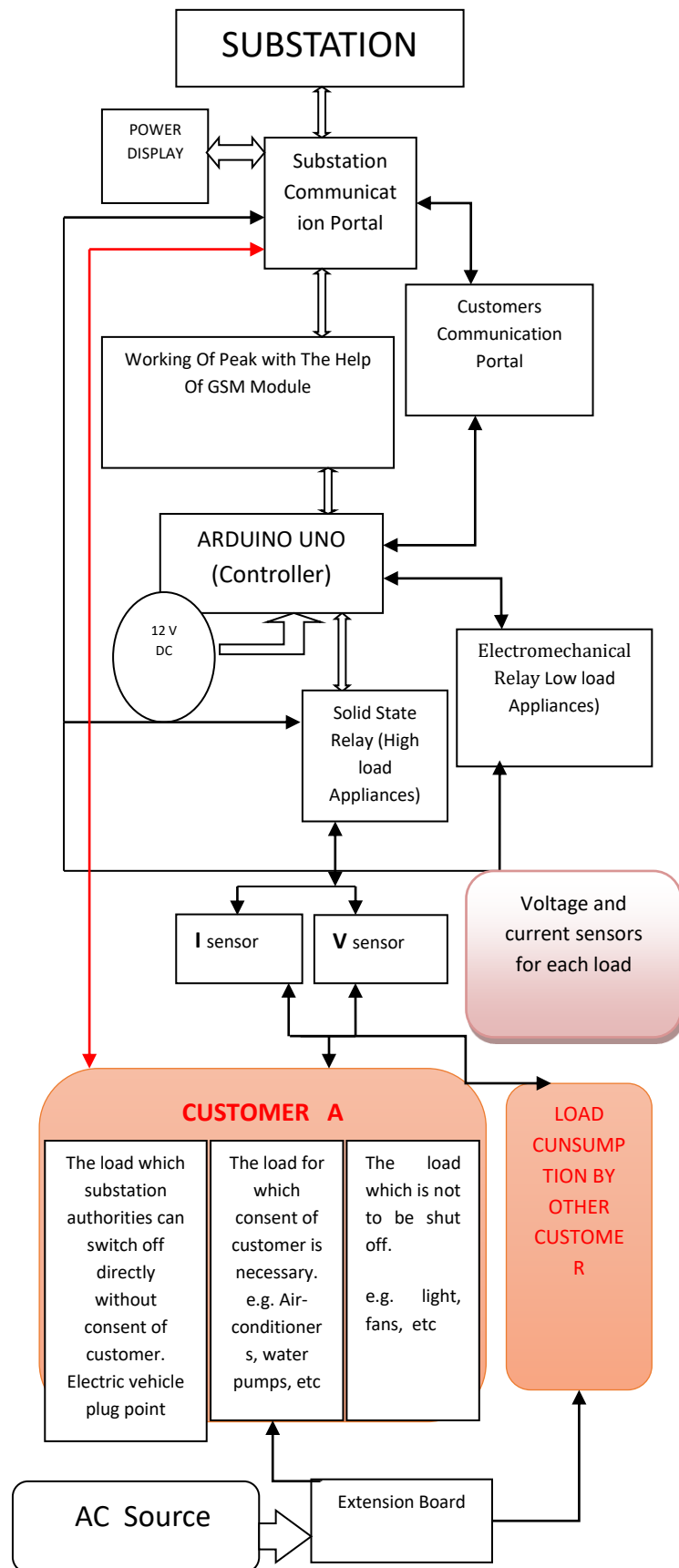


Fig.-3: Block Diagram

6. WORKING

We simulate the Controlling circuit on proteus software and IoT part is done with the help of ESP8266 based nodemcu board and Blynk app. Blynk app is available for iOS and Android devices.

We are considering three different loads here, named as Essential Load, Luxury Load and Other. Load Details are as follows:

Load Type	Internal Resistance	Wattage
Essential	240 Ohm	240 Watt
Luxury	120 Ohm	480 Watt
Other	80 Ohm	720 Watt

Table-1: Load Types

These loads can be controlled by Blynk app via relays. All three load can be controlled with manual switches which are connected in series with relays.

6.1 Load controlling Concept

Essential load can be controlled by user only. It has no access to Substation.

Luxury load can be controlled by user as well as Substation with user's consent only. This action is decided on the basis of load on base station.

Other load can be controlled by user as well as Substation without user's consent.

Load measurement is done using ACS712 current sensor. Current sensor will measure current and give analog voltage according to load current. Analog voltage is calibrated with load current. Current value will give wattage as have constant voltage of 240V. This load value is uploaded on IoT dashboard i.e. blynk app. Substation will monitor the load and accordingly decide whether to turn off the other load directly and luxury with user's consent. Substation will control Other load without user's consent.

Current load is shown on LCD as well as Substation tab of Blynk app.

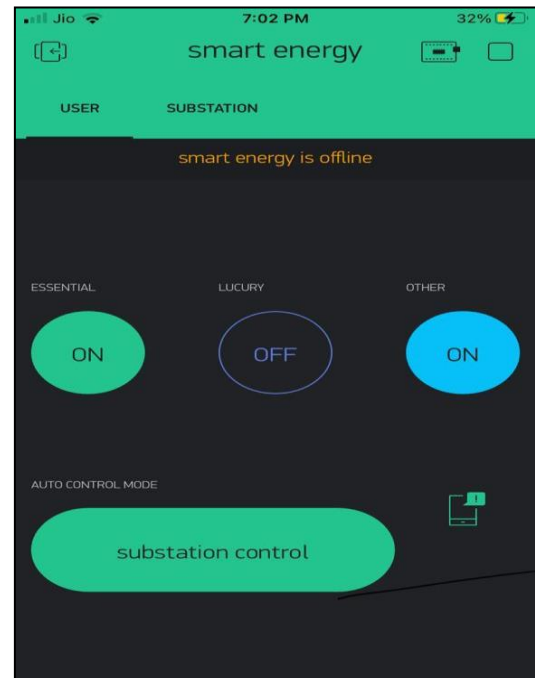
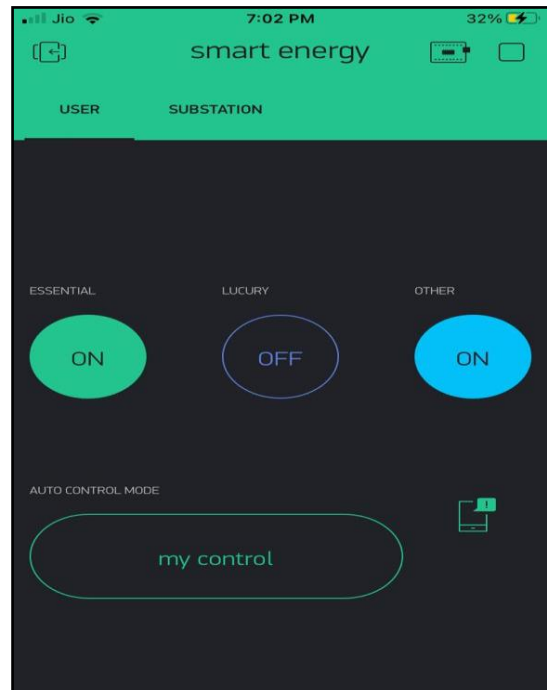
ESP8266 based NodeMcu board is having Wi-Fi inbuilt. It will connect to Blynk app via Wi-Fi internet. NodeMCU will update current load status and get the command from Blynk app to control respective load.

Blynk App has 2 icons- User and Substation

User has control for all the three loads. User can control devices via Blynk app. User has to give consent by toggling status of User Control of substation control. User will get notification if substation control the load any time.

Substation tab has total load widget to show current load on substation. There are 3 more widgets:

- (1) Control Other Type of load directly
- (2) Send consent for control Luxury Load
- (3) Show current status of consent i.e. if user accepted the consent or not.



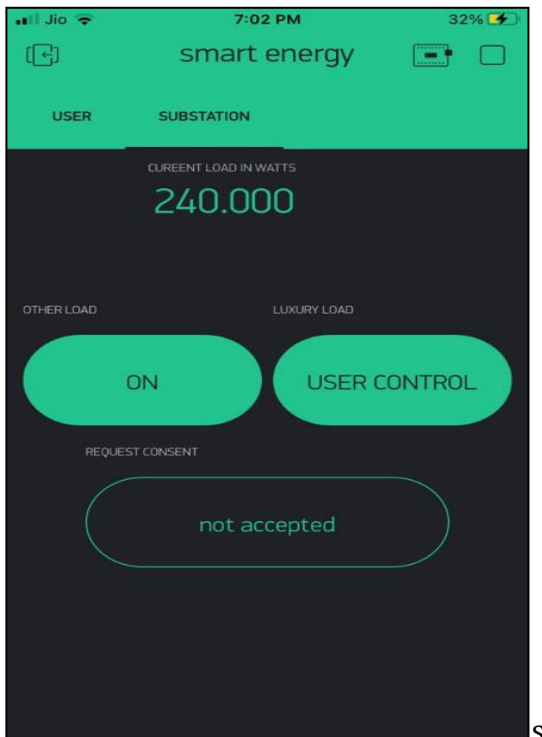


Fig.-4: Blynk App Screens

7. CONCLUSIONS

In this project, a novel architecture for low cost and flexible home control and monitoring system using Android based Smart phone is proposed and implemented. The proposed architecture utilizes a micro web server and Bluetooth communication as an interoperable application layer for communicating between the remote user and the home devices. Any Android based Smart phone with built in support for Wi-Fi can be used to access and control the devices at home. When a Wi-Fi connection is not available, mobile cellular networks such as 3G or 4G can engine thus eliminating the need for an external voice recognition module. In this paper, working of simulation on IoT based home-substation automation is presented.

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