Design And Implementation of IoT Based Power Theft Detection And Control Systems

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Abstract- *Today the world is facing a major issue in the power system network regarding energy theft. Stealing electricity is a criminal act and such activity will cause lose of millions of dollars for consumers. The Internet of Things (IoT) connects devices that sense electricity to the Internet for the purpose of exchanging data faster. The system for the detection and control of the theft of power using the Internet of Things provides a cost-effective way to transmit and receive information regarding power consumption in wireless manner. The unreliability of electricity consumers is a major problem in such networks. This wireless technology is used to detect power theft by identifying the utilization of excess amount of power than the pre-set limit . In this project, the main objective is to monitor the energy used by the consumers in order to detect power theft. The Identification and control of energy is done by calculating the energy used by the user at a given time with the help of a meter. The electricity meter contains a theft detection unit that will notify us while the meter detected the theft. Further, it will send information about the detection of power theft through online notification. As a result, the customer receives a warning message and if they continue to use more power, then we can cut off the power supply to the customer. IoT activation can be done via a Wi-Fi device that sends data of meter to a web page with an IP address. This IoT-based concept is used to enable us to keep monitoring the energy consumption and also to control the load based on energy consumption.*

Keywords- Internet of Things, Power theft detection, wireless technology, Electricity meter, online notification, Wi-Fi device, IP address

I. INTRODUCTION

OVER VIEW OF THE PROJECT

Electricity services lose a lot of money every year due to the deception of electricity consumers. Electronic fraud can be defined as dishonest or illegal use of electronic devices or services in order to avoid charge. It is difficult to distinguish between honest and deceitful customers. In fact, power utilities will never be able to eradicate fraud. However it is possible to take steps to detect, prevent and reduce fraud. Research is being conducted by power utility companies to assess the impact of technological losses on the production, distribution and distribution networks, and the overall performance of power networks. Electric power monitoring cannot be done properly especially because consumers do not know that they are using their energy. They will only get an idea of their use once the electricity bills have been removed. The installed capacity of the power sector in India is 329.23 Giga Watts as of August 2017, which includes renewable and non-renewable sources. Individual electricity consumption in India for 2016-2017 was 1,122 kWh. Iot has recently become the universal highlight of the global architecture of connected objects. As more and more consumer goods enter everyday life, such as electric vehicles (EVs) and improved heating systems, ventilation systems, and air, the demand for cargo increases significantly and energy is needed at a higher cost. Therefore, in this project it is proposed a system for detecting the theft of electrical energy to detect theft that is carried out in the normal way of committing theft that is, by using power beyond the meter limit. At this stage of technological advancement, the problem of illegal electricity use can be solved electronically without human control and that the meters are connected to the internet using the IoT concept. Therefore, there is a provision for consumers to track their energy consumption from time to time so that they can control their consumption in the way they wish. This method is useful for both the buyer and the supplier. This system allows the supplier to disconnect from the remote server in case the customer fails to pay his electricity bill. This approach eliminates the need for human energy during the disconnection and reconnection of the load.

OBJECTIVEs

- To implement a novel approach to detect theft of electrical energy with no interaction of humans.
- Real time power monitoring at houses.
- To propose a system that uses ESP device i.e., entirely hardware kit based wireless communication method and IOT technology to detect the power theft and line fault in distribution.

II. LITERATURE SURVEY

1 H. Shateri, S. Jamali Impedance Based Fault Location Method For Phase To Phase And Three Phase Faults In Transmission Systems"

Suggested error location method based on phase phase error and phase three errors. This method used the measured impedance for the transmission distance and the maximum set to discriminate the error area. This method is sensitive to the accuracy of the measured impedance with the current set object

2.AbhishekPandey, Nicolas H. Younan Underground Cable Fault Detection and Identification via Fourier Analysis

Methods of calculating impedance by transmitting end-to-end power and electrical power can be used to distinguish between different types of cable malfunctions in phase information. It requires study to be done to find the best way to see the results, especially the big answer

3. H. Shateri, S. Jamali "Impedance Based Fault Location Method For Phase To Phase And Three Phase Faults In Transmission Systems

The author introduced the local error algorithms without using line parameters. By using invalid voltage power and current measurements from both sides of the line without the need for line parameters depending on the parameter line model delivered. The error area measurement is not sensitive to measurement errors while line parameter measurement is sensitive to measurement errors. Therefore more accurate measurements are needed to obtain accurate parameter measurements.

4.Reji Kumar Pillai and Hem Thukral, "ISGF white paper: Next Generation Smart Metering – IP Metering"

According to the India Smart Grid Forum (ISGF), by 2020, almost all urban and suburban buildings in the world will have broadband internet connectivity.

5. S.P.S. Gill, N. K. Suryadevara and S. C. Mukhopadhyay," Smart Power Monitoring System Using Wireless Sensor Networks"

Intelligent grid is a computer-assisted grid and other information technology to collect and process automation to improve the reliability and efficiency of the system. The name smart grid was coined in 2005. Monitoring of transmission lines is critical to reliable electricity transmission. This system uses sensors to monitor certain signals such as temperature or current or electrical monitoring. The sensor module is used to measure the electrical parameters of the transmission line. Parameter values such as temperature, power and current values are calculated using temperature sensors, potential sensor, and current sensor respectively. Program features allow us to view all parameter readings simultaneously on the screen and allow us to maintain a database of changes that meet the parameters. The use of intelligent sensor makes the system more efficient and reliable.

III. SYSTEM STUDY

EXISTING SYSTEM

As we know in our country the timing of electricity billing can be the end of one month or the end of two months. Within a month the electricity consumer cannot use the energy, he can at the end of one or two months when the bill is issued. The main drawback of this method is the user cannot control the power consumption. One of the disadvantages of this system is that theft caused by excessive energy can be easily eliminated and such practices occur and increase rapidly which is one of the major causes of power problems.

PROPOSED SYSTEM

The concept of Internet of Things (IOT) from its initial stage is changing the current Internet into well featured upcoming internet. At present there are billions of gadgets (approximately nine billion) interconnected gadgets and one prediction is that it will reach up-to fifty billion gadgets in 2020. In the design of this smart electricity meter the controller is used, which are placed at the consumer end for the purpose of theft detection and storing the data. This data is transferred using IOT ESP8266 Wi-Fi. Now, the requirement is to get the feature of system from distance yet in a reliable way.For this purpose, we have to combine the system i.e., electricity meter to internet by giving IP address to it. In this project we focused on the detection of energy theft, consumption of power in an optimum manner and notify the information regarding consumption of energy to the consumer side. The detection of Power theft using Internet of Things and regulating devices comprising electricity meter at user side comprises the power source, Wi-Fi unit, theft detection unit and meter unit. The power theft is monitoring in real time based on IOT the load data information can be monitored and view in graph. The controlling of the load is done using electromechanical relay. Power line fault can also be eliminated effectively in this proposed system.

ADVANAGES

- Theft Detects is accurate in power line
- Reduced human effort
- Time saving and faster maintenance
- Less software requirements
- Cost effective
- Less complexity

IV. SYSTEM FUNCTION

ARCHITECTURE DESIGN

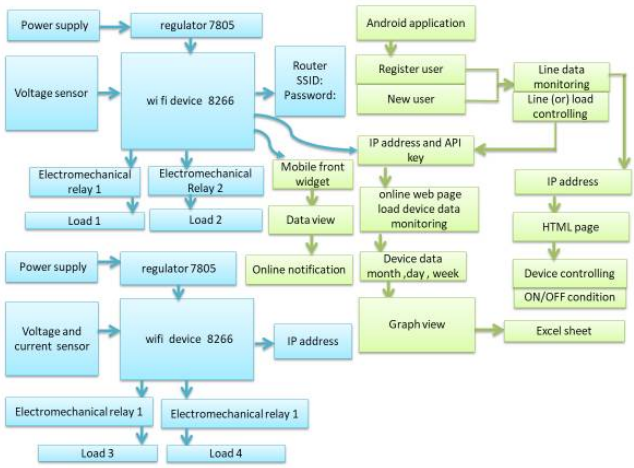

Fig.no:1:Architecture Design

SYSTEM MODULES

There five modules used in this project

- Sensing module
- Theft detection module
- Monitoring and controlling module
- security module
- communication module

Sensing module

In this module power line can be monitored by using voltage and current sensor, and this sensor interfaced to Wi-Fi device for voltage and current viewed in online web page.

Theft detection module

The theft detection module is used to detect if the power consumption is excess than the normal usage and detect that power is being theft by others **Monitoring and controlling module**

The load device can be monitored by using ESP8266 wi -fi device for continues monitor of the load, so that we can easily analyse the load voltage. If the load consumed any excess of voltage is means the power will be theft.

Security module

This module is used for secure the data in online web page and only the registered user can use access the data in the web page..

Communication module

This module is used for communicating with the user by means of sending notification when excess of power is being consumed.

V. SYSTEM SPECIFICATION

Hardware requirements:

- wifi device 8266
- Power supply
- Voltage and current sensor
- Electromechanical relay
- Light
- Fan

Software requirements:

- Keil software
- Embedded C program

INTERNET OF THINGS

The IoT (Internet of Things) is a system of ‘connected things’. The things usually consist of an embedded operating system and a capability to communicate with the neighboring things or with the internet. One among the chief parts of a common Internet of Things system which connects the different ‘things’ is an Internet of Things service. An inspiring suggestion from the ‘things’ consisting the Internet of Things systems is that the things by themselves could not perform any action. At a simple low level, it must possess a capability to combine wih other ‘things’. Yet the actual strength of Internet of Things is attached while the things combine with a ‘service’ directly or through other ‘things’. In these systems, the Internet of Things service plays the vital role of a manager that is not seen by offering abilities varying from usual information collection and monitoring to complicated analytics of information. The following figure

shows where an Internet of Things service fits in an Internet of Things ecosystem:

Fig.no:2: INTERNET OF THINGS

A Simple HTML Document

Example

```
<!DOCTYPE html>
<html>
<head>
<title>Page Title</title>
</head>
<body>

<h1>My First Heading</h1>
<p>My first paragraph.</p>

</body>
</html>
```

EMBEDDED C PROGRAMMING

Embedded C programming plays a key role in every projects that uses embedded system, to make the microcontroller operate & do the desired functions. Now, we usually use numerous electronic devices like security systems, mobile phones, digital cameras, washing machines, refrigerators, etc. The regulating function of such embedded devices could be performed with the use of this program. For instance in a digital camera, while we click a button to capture an image, the microcontroller will execute the function to be performed in order to capture the image and to save it.

Embedded C Programming

Steps to Build an Embedded C Program

- Comments
- Directives of Processor
- Configuration of Port
- Global variables
- Core Function/Main Function
- Declaration of Variable
- The logic of the Program

KEIL C

Keil development tools for Microcontroller Architecture assist each and every stage of Software developer ranging from the professional applications engineer to the student who is just studying about software development in embedded systems. The Keil C51 C Compiler is the very famous C compiler throughout the world. It offers various characteristics more than another C compiler available now days. It enables us to code microcontroller utilizations in C i.e., after compilation, possess the speed and efficiency of assembly language. Extensions of Language in the C51Compiler provide us the entire power to every resources of the microcontroller. It converts source of C files into object modules that are reloadable which comprises entire symbolic data for error clearing with the use of µVision Debugger or with the use of an in-circuit emulator. Besides the object file, it creates a listing file that could add cross reference information and symbol table optionally.

VI.HARDWARE REQUIREMENTS

WIFI DEVICE (NODE MCU)

Specifications & Features

- Tensilica 32-bit RISC CPU Xtensa LX106-Microcontroller
- 3.3V-Operating Voltage
- 7-12V-Input Voltage
- 16-Digital I/O Pins (DIO)

- 1-Analog Input Pins (ADC)
- 1-UARTs
- 1- SPIs
- 1- I2Cs
- 4 MB- Flash Memory
- 64 KB- SRAM
- 80 MHz- Clock Speed
- PCB Antenna
- Little Sized module in order to fit compactly within our Internet of Things projects

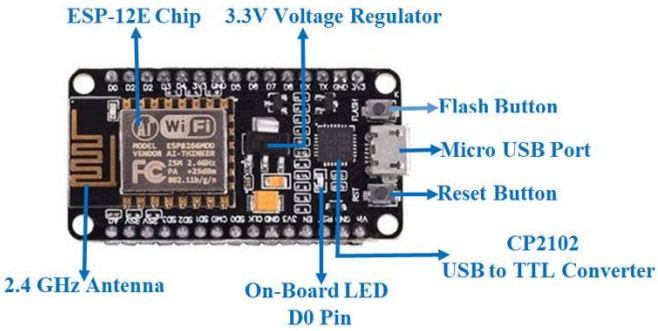

Fig.no:3: Parts in NODE MCU

Applications of NodeMCU

- Internet of Things devices Prototyping
- Applications that are operated by Low power battery
- Projects regarding Networks
- Projects that need multiple Input / Output interfaces with Bluetooth and Wi-Fi operations

POWER SUPPLY

The power supply is from a single source of voltage of vbat= 3.4v...4.5v. In certain case, the transmit burst ripple might leads to drops in voltage while consumption of current increases to characteristic peaks (2A). Thus the power source should be capable of offering enough power till 2A. For the input of vbat, a bypass capacitor (local) is suggested.

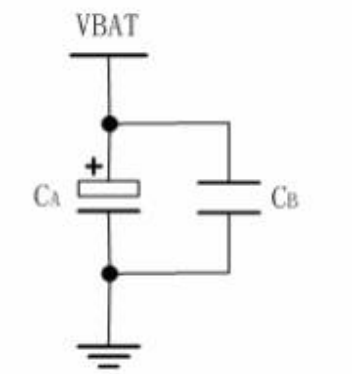

Fig.no:4:vbat voltage ripple

7805 REGULATOR

IC 7805(voltage regulator)is basically a part of the 78xx series of voltage regulator Integrated Circuits. It is a fixed linear voltage regulator. The term "xx" in 78xx refers to the fixed output voltage value that is provided by the certain IC. This type of IC, requires +5V DC regulated power supply. 7805 IC also includes a provision for the purpose of a heat sink. This voltage regulator requires input voltage till 35Volts, and it could offer a stable 5Volt as output in respective to the input which is of value of less than or equal to 35V i.e., the threshold limit.

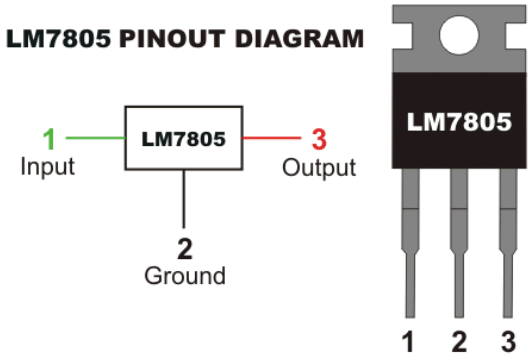

Fig.no:5: Pin out Diagram

PIN 1-INPUT
PIN 2-GROUND
PIN 3-OUTPUT

A. *Applications of Voltage Regulator 7805 IC*

- Current regulator
- Regulated dual supply
- Designing circuits for certain devices like UPS power supply circuits, portable CD player, Phone charger, etc.
- Offers fixed output
- Offers adjustable output etc.

ELECTROMECHANICAL RELAY

A relay is an electrically operated switch. Electricity in the relay coil generates a magnetic field that attracts a lever and varies the contacts of switch. The current in coil could be on or off thereby these electromechanical relays possess 2 positions of switch. They are changeover (double throw) switches. Relays enable one circuit to switch another circuit that is entirely separate from the first circuit.

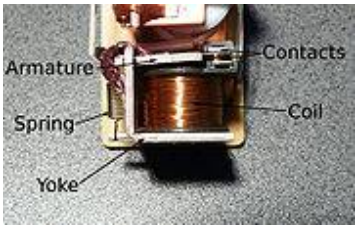

Fig no:6: Simple electromechanical relay

LIGHT

A **LED (light-emitting diode)** is a semiconductor source of light that is two-lead. It is a positive–negative junction diode in which light is emitted while activated. While an appropriate energy is given to the leads, electrons are capable of recombining with the respective electron holes inside the system that result in the release of photons (light). This mechanism is known as electroluminescence, and then the light color i.e., respective to photon energy is estimated by the energy band gap in the semiconductor. They are characteristically little in size i.e., less than 1 mm^2 and combined optical components might be utilized to shape the pattern of radiation.

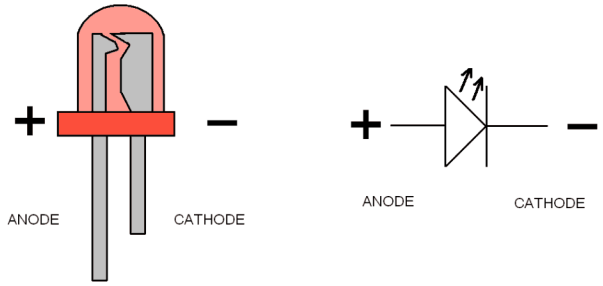

Fig.no:7:light

FAN

A system of exhaust fan offers numerous advantages that include the air purification in polluted areas and in the presence of excessive heat (ventilation).

Fig.no:8:DC FAN

VOLTAGE AND CURENT SENSOR

A Voltage and current sensor is a sensor used to calculate and monitor the amount of voltage in an object. Voltage and current sensors can determine the AC voltage or DC voltage level. The **Voltage and current sensor** technique is a better choice for the traditional voltage and current measuring techniques.

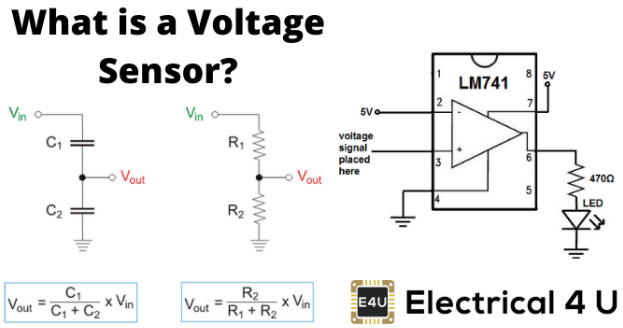

Fig.no:9: Circuit for voltage and current sensor

VII. RESULTS

Our system successfully implemented a novel approach to perform detection of energy theft without human help. It effectively identified the power theft and line faults and notified the user using Internet of Things and wireless communication. The outputs and observations are represented as follows,

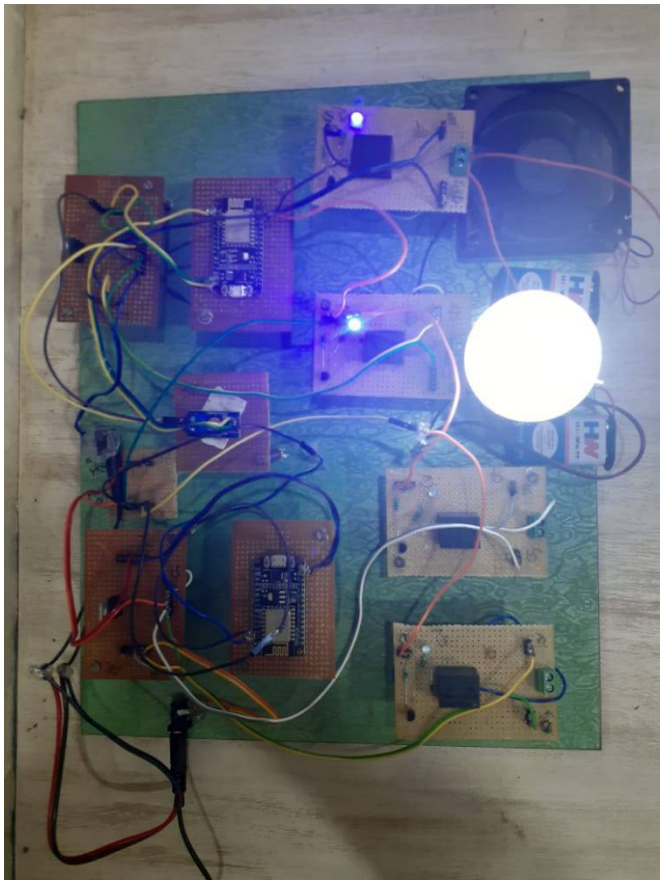

Fig.no:10: Hardware Kit

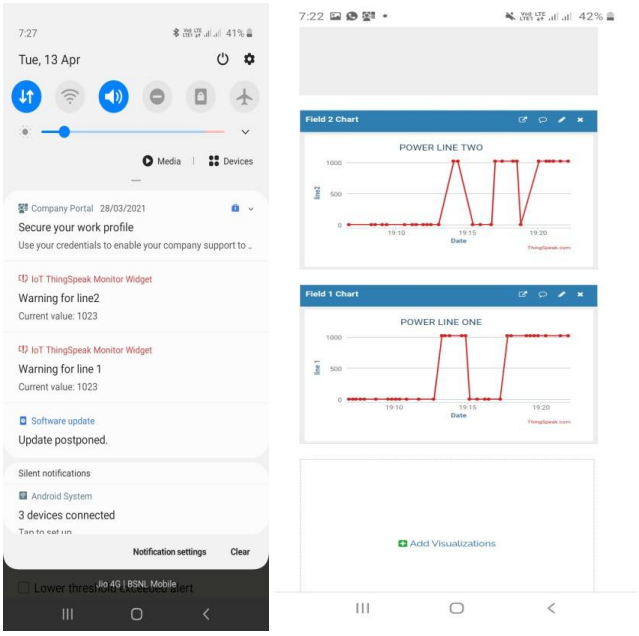

Fig.no:11: online notification (left side) and Representation of line chart (right side)

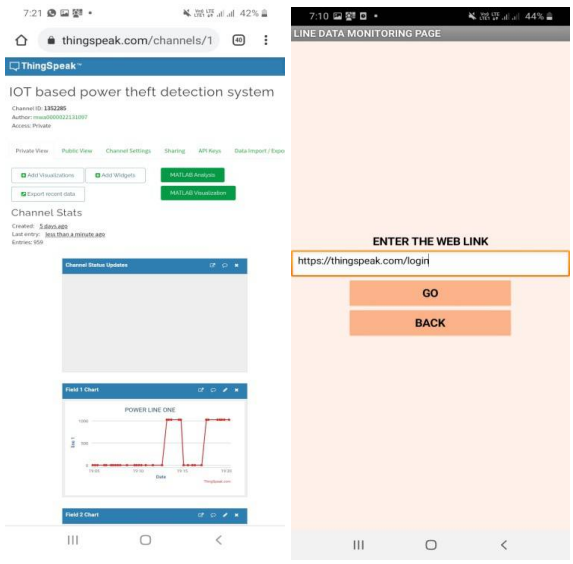

Fig.no:12:ThingSpeak page (left side) and entering the web link (right side)

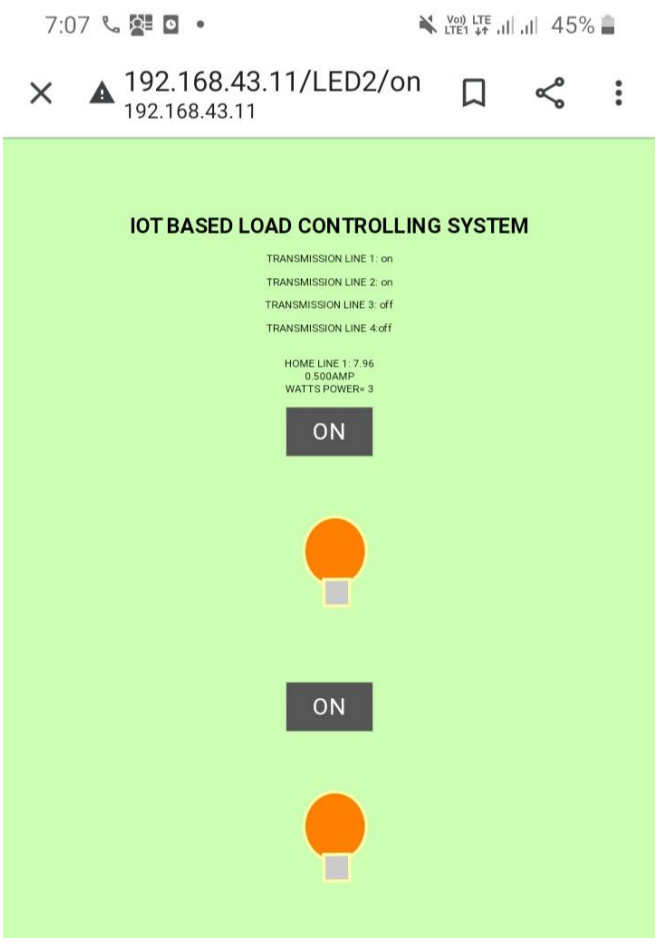

Fig.no:13: IOT page for Load controlling

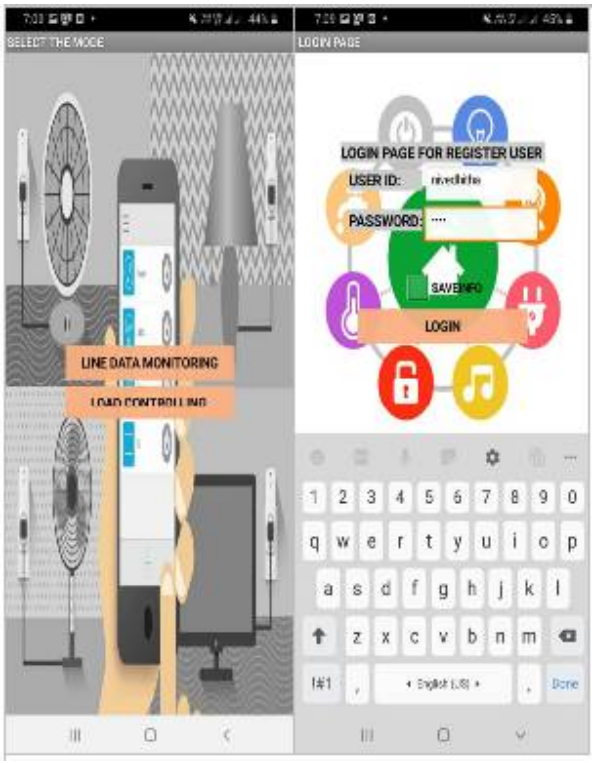

Fig.no:14: Selecting mode in android application (left side) and login page (right side)

VIII. CONCLUSION

Detection of Power theft and regulating system using Internet of Things was implemented in this work. The proposed system will offer an easy way to identify an electrical energy theft with no intervention of humans. In this proposed system, we tend to introduce smart meter for monitoring purpose and online control to access the load controlling at the time of detection of power theft. Since the Indian Government has also proposed formation of Smart Cities which will have effective energy management and resource conservation strategy based on Internet of Things, our system will provide an efficient solution for the problem of power theft.

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