ELEKTRA Smart power monitoring system using Internet of Things

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Abstract—Electricity overconsumption is one of the leading problems, consumers without their knowledge tend to use more electricity than required, and this leads to wastage of electrical energy. To overcome this problem the ELEKTRA smart power monitoring system allows its user to monitor electricity usage through their mobile phones or any other android devices. The current system allows users only to know about billing status through web application. The main problem is that the user remains unaware of their electricity usage until the bill is generated for every two months. The ELEKTRA smart power monitoring system focuses on the concept of Internet of Things (IOT). The main benefit of this application is that it allows the users to monitor and manage their electricity usage which in turn allows them to conserve electricity. The most commonly power meters currently installed in households only display the total real time usage of its power and the amount of electricity available. There is no way to see what the day's, week's or month's consumption was on these meters and often these power meters are placed in an inconvenient location which makes regular viewing somewhat difficult. These power meters also lack the ability to monitor appliances individually, therefore hiding information about individual appliances.

Index Terms— *Electricity, Application, Android,Manage,Elektra.*

I. INTRODUCTION

In light of the increasing cost of electricity, there is an immense need to reduce general electricity usage. There is a growing interest in analyzingpower consumption in households. Furthermore this can also determine whether an appliance is drawing unusually high amounts of power when turned off and whether it should rather be unplugged. In this way electricity consumption and cost can be reduced.

The ELEKTRA smart power monitoring system using IOT is an energy efficient technique that allows the users to manage and monitor their electricity usage. This helps to identify excessive power usage, and detect any unexpected spike in the usage. The ultimate goal is to provide transparency about power consumption and reduce the energy cost through efficient management control. This is achieved by interconnecting components of various purposes namely Light sense module to receive the input from default energy meter, Raspberry Pi 3 to upload the data to online database and then performing various energy calculations in the android application using the data from the database. This process of bringing together various components is known as Internet of Things (IoT)

Internet of Things (IoT) is an ecosystem of connected physical objects that are accessible through the internet. The 'thing' in IoT could be a person with a heart monitor or an automobile with built-in-sensors, i.e. objects that have been assigned an IP address and have the ability to collect and

transfer data over a network without manual assistance or intervention. The embedded technology in the objects helps them to interact with internal states or the external environment, which in turn affects the decisions taken.

In our system the user is only aware of the android application. This application provides all the necessary information about their energy usage. The android application has simple interface. The interface consists of various components such as Graphs/Charts, history of usage, link to payment, analysis and cost display.

The Graphs/Charts component provides the users with various bar graphs and charts, these graphs are generally Unit-Cost graphs. These graphs are believed to provide a detailed insight about the user's energy usage, any spike in the graph can be easily understood as an unusually high usage. The history of usage tab in the application allows the user to view their old energy usage, this helps the users to know if there is any improvement in the efficiency of the system. The history of usage also enables the user to find out when their usage was low and when it was high.

The Cost display is the main feature of ELEKTRA, the cost display provides the live cost of the energy or unit the user consumed. This component obtains the data from the database consistently and calculates the required cost. This cost keeps changing as the energy consumed increases. The user is notified if there is a rapid increase in the energy consumption/ cost, so that the user becomes aware that some appliances is running unnecessarily.

The Tamilnadu Electricity Board (TNEB) has already created a web application for enabling the users to pay their bills. Our application simply connects the users to this web application. Analysis tab allows the user to set the limit for energy usage, which is used by the application for notifications. This limit similar to the internet usage limit, so that the application will keep the user notified as the usage grows near the limit. The notification system is entirely customizable by the user.

The background process of this application is carried out by Raspberry pi 3. The Raspberry Pi is a series of credit card-sized single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside of its target market for uses such as robotics. The Raspberry Pi 3 is capable of performing highly complex functions; here in our ELEKTRA system the raspberry pi simply collects the data form ADC differential Pi. The collected data is sent to the online database. The Raspberry Pi 3 is not capable of directly getting the reading from live wire, therefore we use the ADC differential pi which converts the analog signal into digital reading. This is the reading that is uploaded by Raspberry pi 3

II. LITERATURE SURVEY

- Dr. Jürgen Haufe, Chief Scientist, Division Engineering of Adaptive Systems EAS, Germany presented a paper and created OptPlanEnergie- Optimization Platform for Energy in 2014. But the application was not available for public. This project used IOT methodology and main focused on managing solar power [1].
- Peter Heusinger, Head of Group – Omega solution, is famous for his OGEMA 2.0 created in 2010[2]. The OGEMA 2.0 is a highly sophisticated energy management system whose target audience are major organizations;the major advantage of this system is that it has three tier security systems. It is very expensive.
- D.Sivasankari, K.Ramamoorthy proposed a system for Residential power management

this system uses WSN – Wireless Sensor Network, these sensors easily detect and calculate the energy usage [3]. The main advantage is that this system does not touch the existing connection, i.e., this is a plug and play system. But on the other hand this system did not have a proper user interface therefore making it difficult to understand.

- N.K.Suryaveda and S.C.Mukhopadhyay reported the design and development of smart monitoring and controlling system for household electrical appliances in real time [4], in which it emphasizes the realization of monitoring and controlling of electrical appliances in many ways. They determined the areas of daily peak hours of electricity usage levels and come with a solution by which we can lower the consumption and enhance better utilization of already limited resources during peak hours. This system lacked the ability to calculate the cost of usage but nonetheless this was a great system to monitor usage.
- Suh and Ko proposed an intelligent home control system based on a wireless sensor/actuator network with a link quality indicator based routing protocol to enhance network reliability [5]. It can integrate diversified physical sensing information and control various consumer home devices, with the support of active sensor networks having both sensor and actuator components. Since the system used a number of sensor this system was automatically very expensive and was not received very well by the public
- I.Kunold, M.Kuller, J.Bauer, and N.Karaoglan describe a system concept of energy information system in flats using wireless technologies and smart metering devices. Smart meters offer a lot of new features, for example handling of different dynamic tariffs and in addition to their carrier interface a data access capability for in-house applications. Using these capabilities an embedded [6] in-house energy information system with a smart energy controller (SEC) will be proposed, which allows displaying real-time data information and analysis of power consumption. This paper was a huge success but the system was never implemented in real time.
- K.Gill, S.H.Yan, F.Yao presented a ZigBee-based home automation system in which less importance is given to the home automation. Because however the adoption of home automation system has been slow so that this paper identifies the reason behind slow adoption and also evaluates the potential of zig-bee for addressing these problems with the help of design and implementation of flexible home automation architecture [7]. This system was very expensive and complicated.
- Dae-Man Han and Jae-Hyun Lim Member contributed their work towards the development of ubiquitous home networks, energy savings and user happiness are two major design considerations for modern lighting systems. This paper [8] introduces smart home interfaces and device definitions to allow interoperability among Zig-bee devices produced by various manufacturers of electrical equipment, meters, and smart energy enabling products. They introduced the proposed home energy control systems design that provides intelligent services for users and also demonstrate its implementation using real test bed. This system was never implemented in real time.
- Suh and Ko proposed an intelligent home control system based on a wireless sensor/actuator network with a link quality indicator based routing protocol to enhance

network reliability [9]. It can integrate diversified physical sensing information and control various consumer home devices, with the support of active sensor networks having both sensor and actuator components. This system attempts to manage all the appliances hence making the system harder to implement and expensive.

- Nguyen et al. have proposed building a smart home system with WSN and service robot. In which they have presented the design of optical linear encoder(OLE) based system for function of capturing human arm motion and arm function evaluation for home based monitoring and this system would also find wide range application in field of rehabilitation[10]. This system is highly sophisticated because it uses motion control to manage appliances, example, the user can use arm motion to control their appliance. But the disadvantage is that it is harder to implement in houses that are already constructed. This system needs to be implemented in the construction stages of the building.

III. EXISTING SYSTEM AND LIMITATIONS

The existing system is a simple digital energy meter which displays the current usage and available energy. It doesn't store any previous data, so we cannot access historic data. This in-turn makes it difficult to analyze and derive valuable knowledge on the usage of a household/office. The existing is an web application which mainly focuses on billing. The system also notifies the users every two months about their consumed units along with the bill amount. In this method the system depends on manual labor. An authorized person must come from the electricity board and note down the readings provided in the energy meter then calculate the amount. This will be the final bill amount which is then brought to the knowledge of the user.

Limitations:

- The level of transparency is the existing system is low, the users may not be aware of the calculations involved in the billing process.
- The history of usage is provided only for a very limited amount of time.
- The system depends on manual labour.
- The alert system is only used to notify about bills.
- The system does not indicate about any unusual power usage.
- The system does not show the bill amount whenever we want; the bill amount is displayed only every two months.

IV. PROPOSED SYSTEM AND METHODOLOGY

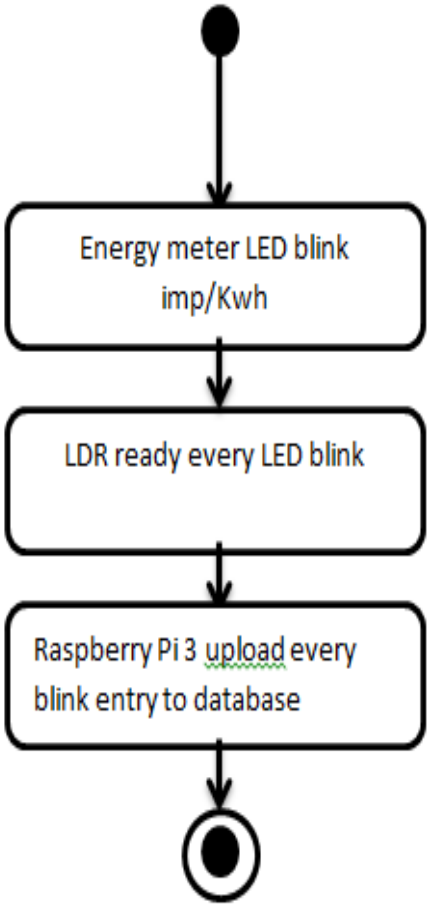
The proposed system should be able to provide the users a clear view about their electricity usage. This helps them to know the cost of their day to-day electricity usage, which induces them to lower their electricity consumption. Since the system is an android application the user will be able to monitor their usage on the go. Android devices are the order of the day, the majority of the population use android devices.

Raspberry is a high efficient low cost computer, this act as an interface between the database and the measurement module. The core module of the entire system which generates input is the Light sense module. TNEB does not allow anyone to meddle with the default energy meter therefore we use this method. In this method we use a simple Light Dependent Sensor to sense each LED blink made by the default energy meter. Based on the energy meter's imp/kwh the python code can be altered. Imp/kwh refers to impulse per kilo watt hour. So if 6400 imp/kwh is mentioned in the energy meter

then it refers that the energy meter's LED will blink 6400 times per unit electricity consumed.

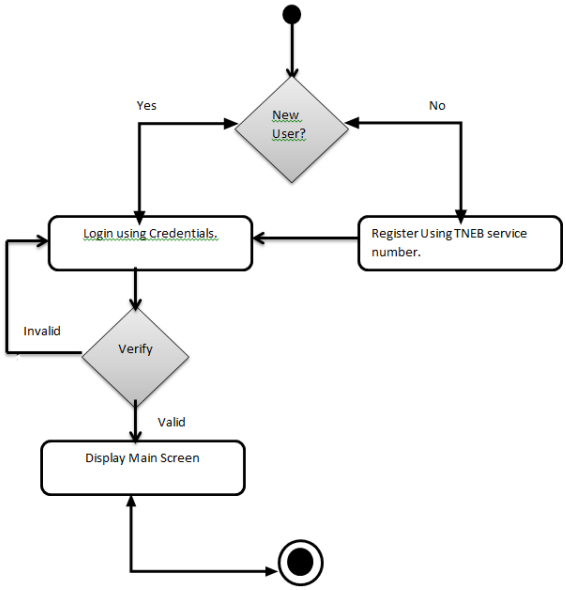
V. WORKFLOW AND MODULES

1. Light sense module:



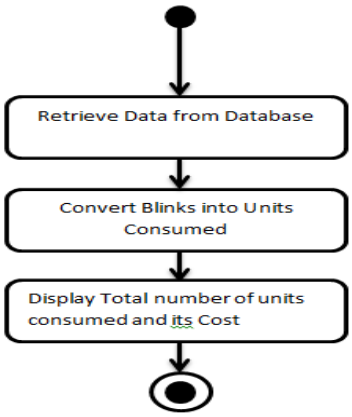
This part of the system does not need any user action it is automated. The LED blinks from the Energy meter is recorded by the Light Dependent Resistor which is connected to the Raspberry Pi 3. Every blink is uploaded to the SQL database by the Raspberry Pi 3 with a python code.

2. Login/Register Module:



If the user is new to this application then user can use the 'New user?' option to register. The user should register using their TNEB service number and set a password to login later. If the user had already registered then the user can simply login and use the various functions.

3. Cost Display Module:



The Cost Display Module displays the Number of Units used by consumer and its cost. This module gets the blink count from the Server and converts them to Unit from which the cost is calculated. For example if the meter has a 1000 imp/Kwh then for every 1000 LED blink the user would have consumed 1 unit of electricity , which will be displayed in the main screen along with the cost.

4. Payment Module:

The payment module is a simple module which connects the user to the TNEB online payment website (http://www.tnebnet.org/awp/TNEB/). This allows the user to make payment right from the android application.

5. History of usage Module:

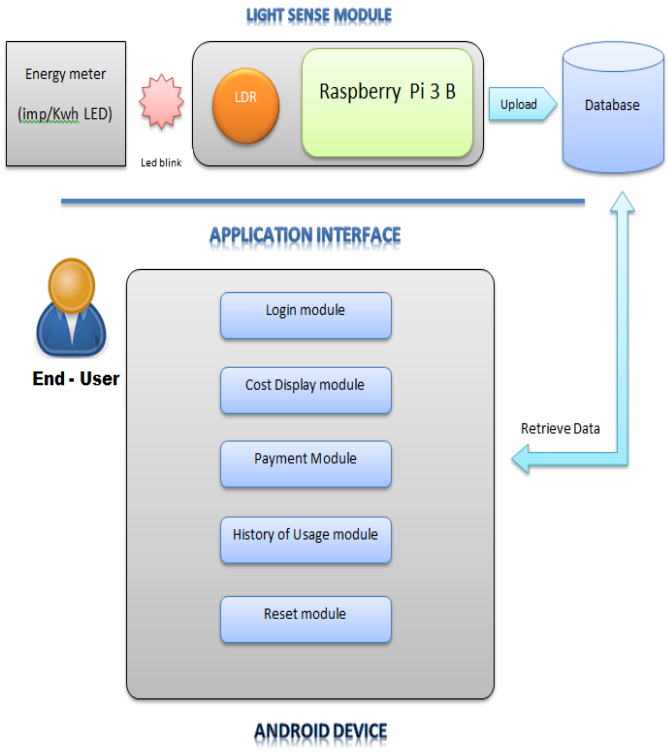
The History of usage module has a collection of the User's usage data. The data varies from 24 hours, a week and a month's usage. The data is displayed in the form table or graphs according to the user's preferences. This will help the user to understand about their usage in a detailed manner.

6. Reset Module:

The Reset module allows the user to reset the unit and cost counter according their billing cycle. As the billing cycle in TNEB is not fixed to particular date this feature helps the user to begin a new cycle when the reading is billed by TNEB.

VI. ARCHITECTURE AND IMPLEMENTATION

ELEKTRA Smart home energy meter using Internet of Things uses the default home energy meter, in each meter there are various LED lights to display the current status of the meter. The LED light which indicates the **imp/kWh** is used here**.** This refers to the number of LED blinks per unit. The LED blinks are sensed using Light Dependent Resistors (LDR) also known as photo resistors. One end of LDR is connected to the power supply pin of the Raspberry pi GPIO (3.3 VDC power).The other end of LDR is connected to the positive side of the 1µf capacitor and to any of the Raspberry pi GPIO general pins. The negative end of the capacitor is connected to the Raspberry pi GPIO ground pin.



The Raspberry Pi 3 Model B is installed with the Raspbian (linux based) Operating system. This operating system is pre-loaded with python compiler. To connect and manipulate database Raspberry pi uses MySQL Server 5.5 which is installed separately. This database and the table is located in a fixed online Server. The ELEKTRA android application is the User End interface. The application end calculates the cost for each unit usage and displays it right after the login screen. The application modules are explained in detail as follows.

VII. CONCLUSION

The proposed systems aim at providing live updates in electricity usage. The main advantage is that it is useful in monitoring the daily power consumption and calculating the electricity bill simultaneously and also provides a notification on over consumption by alert messages, which help the user to reduce the electricity usage. Thus, wastage of electrical energy can be reduced.

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