Prepaid Electricity Billing System using Mobile Application

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Abstract

India possesses a commendable electricity producing capacity; nonetheless, it has encountered certain deficiencies in its billing framework. This is mostly due to the usage of traditional meters, reliance on human labor, and the need for monthly meter reading. These problems are leading to economic losses in the country. To address these enduring difficulties, the billing structure necessitates a move from traditional meters to smart meter technologies. This article examines the efficient operation of smart meters using advanced technologies, specifically Arduino and IoT, through integration with a mobile application. The proposed concept, known as the 'prepaid billing framework', built by the mentioned technology, implements a "first pay first serve" approach to decrease the need for human resources. This can be regarded as an improvement upon traditional energy meters, allowing consumers to efficiently control their electricity consumption. The aim of the suggested technique is to provide convenient access for consumers and minimize the wastage of electricity and human resources, while also reducing the occurrence of power theft.

Keywords: Conventional meters, Arduino, IOT, prepaid billing framework.

1. Introduction

Electric energy consumed by the power devices is measured by a gadget known as an energy meter since 1980s. It has taken many advancements and currently it is existing as digital meter, the newly digitized meters measure energy usage by highly integrated circuits, by capitalizing the voltage and current that gives the instantaneous power in watts. Digital meters show usage of electricity in digits with a liquid crystal display and those meters are highly accurate, inexpensive, theft reluctant, etc.,

Fig.1 Conventional meter

Despite of all these merits, the digital meters are prone to different problems like, there is no way to upgrade these energy meters. Accuracy of these meters is limited and easy to manipulate. ‘Prepaid electricity billing system’ is an effective concept in which the consumer can recharge their balance, like mobile phone recharges. This concept is already existing in

India and other countries. But those existing systems need recharge cards and the consumer have to go to electricity board office for recharge purpose. So, in this proposed work, an automated system is built by using Arduino and GSM module, in which consumer can recharge the electricity balance through this automated system i.e. in mobile phones without standing in queue. It disconnects the power supply when the balanced is used up. This system will read the energy meter readings and also automatically send some updates to user's mobile phone and to User Interface Application (UIA) like low balance alert, recharge alert and meter reading updates.

The prepaid energy meter recharges are available in various ranges which are set by the authorised department. When the recharge is done through UIA then the meter is recharged with the amount and depending on the power consumption, the amount will be reduced. A relay system has been used to shut down or disconnect the energy meter and load through main supply when recharge amount is depleted. A buzzer is installed with the system which alarms before the recharge amount reaches to null value.

2. Literature survey

Many papers have discussed various problems faced in power distribution board as follows:

[1] The paper describes the problem being faced in electricity department like reliable use of energy. The problems are due to the gap between the consumer and energy provider. In this method a web portal has been designed for consumers. It is a web portal-based recharge process using gateways and if the consumer wants to know their bill payments details then consumer every time has to login in the consumer login tab with their ID proof.

[2] The paper has explained the need of consumer's awareness about reducing the utilization of electricity, although there are measures taken on how to reduce the consumption (like energy saving systems). So, this paper proposed a model of a monitoring device named as Electricity Monitoring Device (EMD). EMD records the utilization of electricity of single day, this device also enables the user to compare the utilization with previous day utilization and hence the user is now aware of excess consumption.

[3] The paper focuses on domestic utility; the paper describes that in medium and long run, users do not keep concentration on the energy saving measures. Hence, this paper is on home energy monitoring system and proposed a method in which, depending on the user's requirement an application is designed known as LINE Application. It calculates the electricity bill and reports the user via e-mail. This application also compares the data of every 10 days and report it to the consumer.

[4] The paper discussed intelligent energy meter in their paper which deals with three aspects i.e. power theft, power quality, and unpaid bills. IEM predict per day consumption of consumer. In case if there is sudden drop in consumption then one can check for energy theft. It provides solution to improve power quality and protects appliances from overvoltage and under voltage with automatic circuit tripping feature. To work on billing system, wireless billing and for action against unpaid bills, supply cutting from the control server with help of a single SMS.

[5] The paper presented a method of Prepaid Electricity billing machine implemented on Xilinx FPGA. This machine facilitates the user to get the automatic update of billing amount and unit of electricity consumed along with various recharge options as per requirement. The hardware implementation of this machine consumes .034W power and uses 264140 Kb of memory on the FPGA device.

The proposed method focuses not only on domestic utilization but also other utilizations, every utilization has the common problem faced that is excess use of power, this

can be controlled by introducing the concept of prepaid. As the user is habited for simple ways of recharging with the advanced technology, the prepaid method can be considered as the simplest method to overcome the existing problems in the bill payments**.** So, in this paper we proposed a method of prepaid and an application for user interface through which user can recharge the system, the user ID number will be the user's mobile phone number. For payments updates user need not to login every time in web portals, the system will notify the user every time through the application. Hence the user need not to put special efforts for recharging, checking payment details and balance inquiry. Another advantage of this system is that the implementation, maintenance and operation is simple and also economical.

3. Proposed Method

The electric sector of India has divided the consumers depending upon usage of power supply as industrial, commercial, institutional, agriculture and household establishments. Electricity board charge the amount depending on the purpose of application of power supply. The Energy consumed is calculated in Kilowatt per hour (Kwh) and the amount for consumption is calculated as

Consumed amount= (Kilowatt per hour) * (number of units). **(1)**

Units are set by Electricity Distribution Board depending on electricity tariff for different applications of supply or depending on the slab range. Below is the list by Andhra Pradesh Government: https://www.apeasternpower.com/downloadByFullpath?filePath=/upload/IntranetUploads/WSS_UPLOADS/NEWS/10012020035715_Tariff%20Order%20FY%202020-21.pdf

Table 1 Charges for units depending on utilisation category

Consumer category	**LT supply**		**Billing units**	**HT supply**			
	Fixed/demand charges per month (Rs/HP or kW)	**Energy charges (Rs. /Unit)**		**Fixed/demand charges per month (Rs. /kVA)**	**Energy charges (Rs. /Unit)**		
1.DOMESTIC (A) Consumption<75 (B)75>consumption<=225 (C) Consumption>225	- - -	 1.45-2.60 2.60-6.90 2.65-9.95	kwh	- - -	- - -	- - -	-
2.INDUSTRIAL (A) general industry (B) Seasonal industry (C)energy intensive industry (D) cottage industry	 75/kW - 75/kW 20/kW	 6.70 7045 - 3.75	kWh/kVAh	 475 - 475 -	 5.30-7.30 7.00 7.65 5.80	 4.85-6.85 7.00 6.95 5.35	 4.40-6.40 7.00 6.70 4.95

During the time of installation of the prepaid system only the authorised person is allowed to set the system function for particular power consumption application. The authorised person will enter the valid password set for that particular applications, so as to set the units for the particular slab and then the system is ready for user.

In user's point of view the prepaid billing meter begins with user interface. The user interface, provide a protection for the system against misuse of unauthorized users who want to use the power without paying. Therefore, only the system developers and authorized user were granted controls and privileges to access features and perform related operations. The interface used in this proposed method is Blynk application.

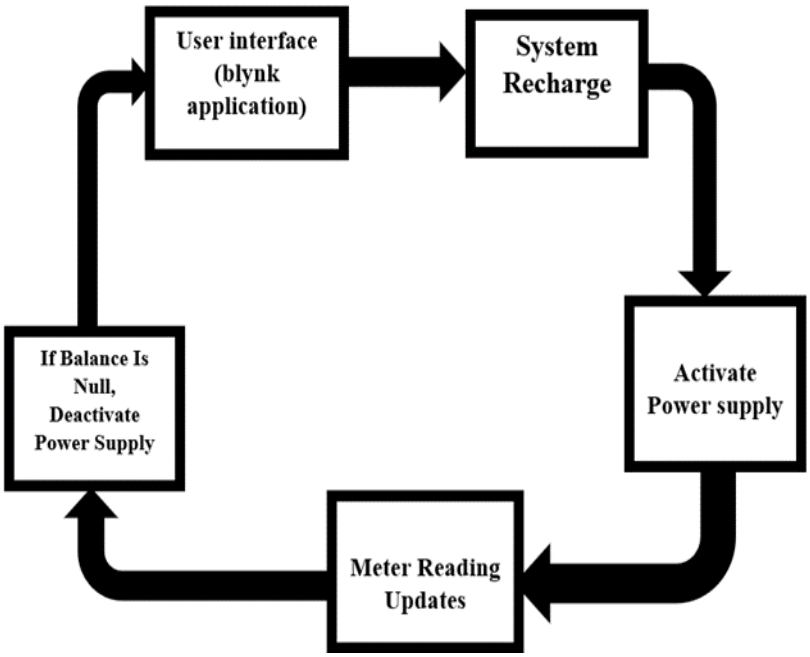

Fig.2 Cyclic process of prepaid energy meter

Through the Blynk application the user is able to recharge the system, this application consists of slider buttons for recharge (the recharge amount by sliders is set by the electricity board depending on the application of utilisation), once the system is recharged with minimum amount, the power supply is automatically activated and the user is now able to consume the power. As per cycle (in figure 2) once the balance becomes null the user will not be able to consume the power as the power supply is disconnected automatically. The user has to recharge again for having power supply.

The discussion clearly defines the architecture of smart metering system. In this proposed method, Arduino –uno is the controller, which acts as centralized element for all peripherals. NodeMCU is used for long range communication purpose through IOT technology.

NodeMCU is used to recharge the EB meter through IOT concept. Hardware equipment that can be used in this method is the keypad which differentiates whether it is commercial purpose or household purpose. Once, if recharge is done, current meter reading will be noted down by Arduino through an electric sensor. After that, remaining units will be calculated and makes relays on/off based on remaining amount. Here, GSM module is used for communicating whole information to the particular user through text messages.

4. Experimental Results

4.1 User access

Login verification, the first step is to login into the prepaid system using valid password set by the authorised person. The authorised person should be from electricity board who enters the password depending on the consumer's category (table 1) of power consumption. After the completion of the process of login verification the proposed device is handed over to the consumer.

In the project mentioned in this paper the password set for household purpose is 12 and for industrial is 22. After activating the system consumer will get a text message to the registered mobile number, for this project the user will get text message from EB meter through this mobile number +91 7893631197 (as shown in figure 3).

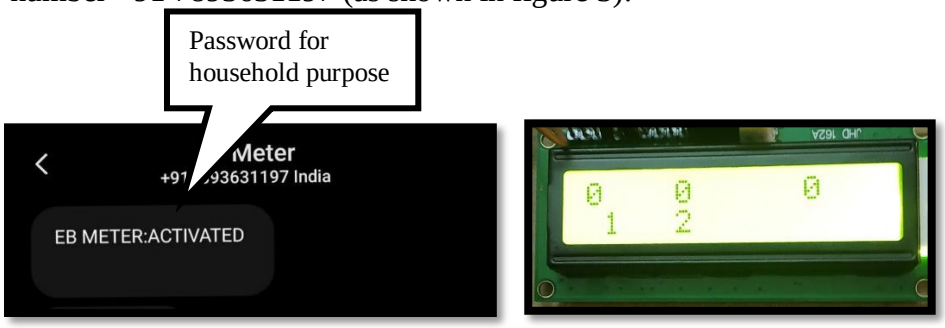

Fig.3 Installing password and activating the system.

To maintain the privacy of the consumer category of power consumption, the password is made invisible to the consumer after the system is activat

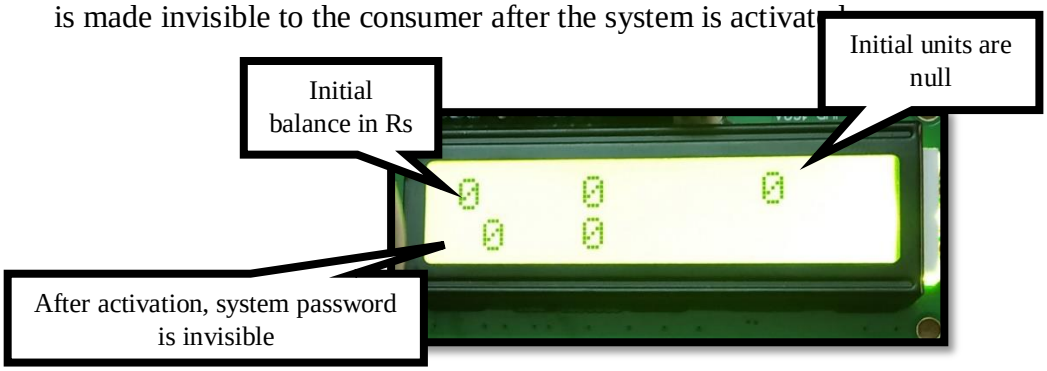

Fig.4 LCD screen of the system after activating

Fig.5 Blynk application initial state after activating the system

4.2 System Recharge

For recharging the system through Blynk application, the user interface is provided with two slider buttons, by sliding those sliders system is recharged, after which consumer will be notified through both Blynk application and registered mobile number.

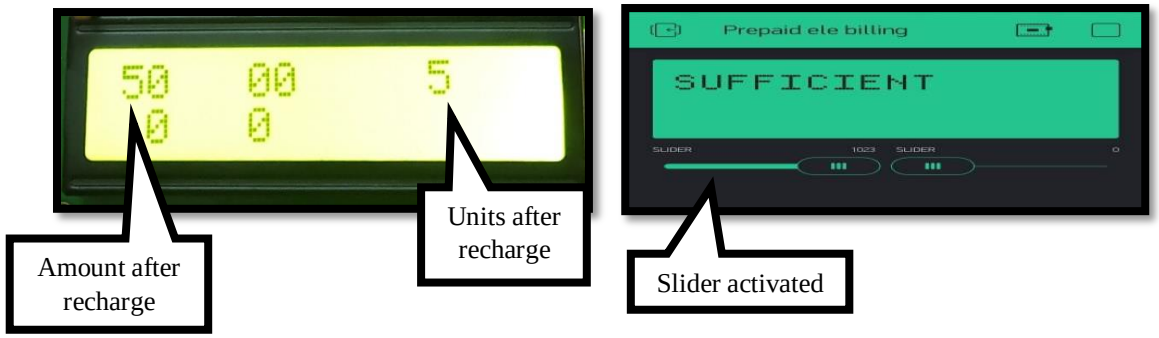

Fig.6 LCD screen and Blynk application after recharging.

4.3 Final Balance

Consumer receives the message of balance alert to their mobile, when the recharged amount in the system reaches the threshold value. A warning notification appears in Blynk application and the text message of "low balance" is sent to the consumers mobile. At the same time buzzer in the kit becomes active with a beep sound and finally when the amount becomes nil a text message "Nil balance" is sent to the consumer.

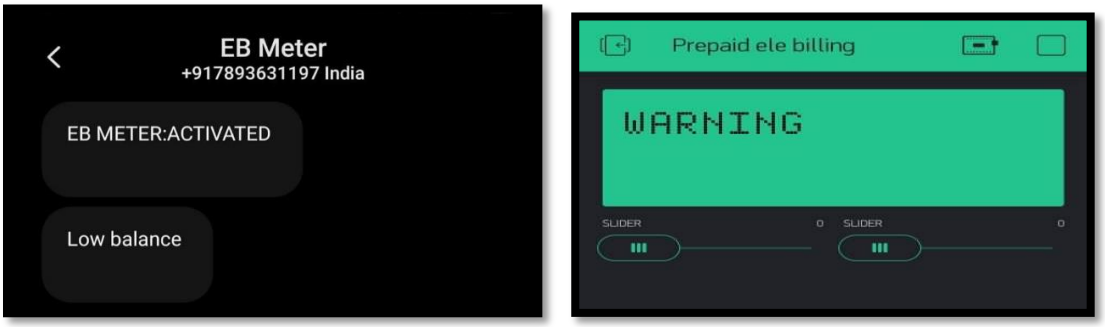

Fig.7 Warning message alerts.

Fig.8 Nil balance alert.

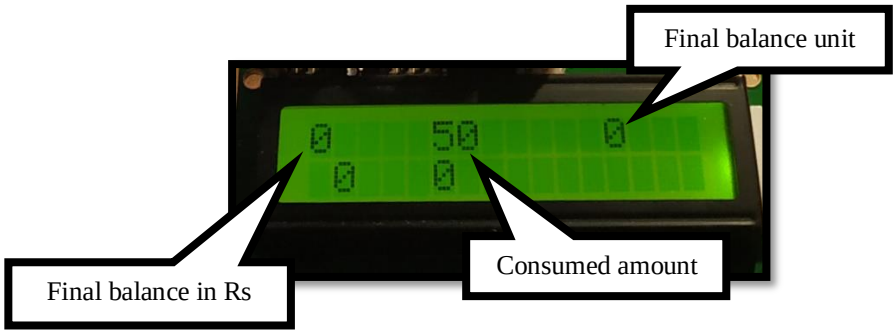

Fig.9 Final balance in LCD screen.

5. Conclusion

This paper discusses a new method of wireless communication based prepaid energy meter that controls the usage of electricity on consumer side to avoid the wastage of power, as the power supply will automatically stop when power is used completely. Prepaid energy meter is a concept to minimize the electricity theft with a cost-efficient manner. The users are bound to pay the amount according to their requirement. It can reduce problems associated with billing and reduce deployment of manpower for taking meter readings. When Prepaid energy meter is taken to IOT platform then it has become more reliable and user friendly. Hence, we can conclude that if this prepaid energy meter is implemented it can become more beneficial to both the consumers and the board of Electricity.

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