Advance Payment Service of Saudi Electricity Billing Using Smart Electric Meter System

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Abstract

Recently, the E-Payment Service (EPS) is one of the most important services provided by the Internet, as it enables the organizations and individuals to pay all their financial dues electronically at any time and from anywhere therefore by saving their time and efforts. ESP is more secure and guarantees the rights of every individual user since it contains e-receipts. This paper explains the concept of pre-payment of electricity billing through smart electric meter along with the importance of remote sensing-based technology in the process of pre-payment and controlling the meter. A novel system is proposed in this paper to pay electricity billing through a smart electric meter. The proposed system also aims to familiarize the consumer with all the details about the bill and also provides him with more detailed information on operating the electrical-based devices. This paper also helps the user to connect the meter to a sensor that allows turning it off, run and charging the meter remotely. The proposed system is important in cases when the user does not know the meter consumption and also in the case of cannot control the meter remotely in an emergency situation.

Disciplinary: Information System (Smart Electric Meter System), Business, Management and Commerce (E-service & Payment System).

1 Introduction

Nowadays, Information Technology witnessed major developments and had a direct impact on the global revolution of the economy and its development such as e-commerce which is defined as the activity of buying or selling products online. E-commerce depends on various technologies such as portable commerce, money transfer done electronically, supply chain management, online

marketing, online transaction, Electronic Data Interchange (EDI), inventory management, and automated data collection systems, etc. Many retail shops and microenterprises that did not apply the e-payment gateways, e-banks, and other concepts, etc. which were the business organizations that provide these services based on e-commerce operations. A smart meter is an electronic device that records information such as the consumption of electricity, voltage and current levels and power factors, etc. Smart meters inform the consumer about the process of electricity consumption. The employees working in the electricity company control the system and the bills of customers [18]. The smart meter [19] differs from the normal meter in one function such that it does not pass the electrical current unless it was pre-charged with a consumption value for a specified time period. Saudi Electricity Company (SEC) provides e-services namely (Hasibati Service) that aim to control the consumption of electricity, to identify the estimated value of the forthcoming bill and the subscribers' fees, etc. It also contains a subscriber e-receipt service and (Hisabi) service that aims to subscribe to a fixed or regular bill.

In spite of the services provided by the company, there are some problems faced by the consumer such as the bill which is unfixed and cut-off in electricity supply when the amount of bill accumulates and at the same tile, the user is not alerted [20]. This happens when the consumer does not know how much electricity meters are used, how much is remaining on his meter, and how long he can use the remaining electricity. This drawback can be rectified by proposing and providing the smart electric meter which consists of an e-sensor and supplies the consumer with services including advance e-payment of electricity. The smart electric meter is charged with a specified value purchased from the proposed system or from the banking applications. The system also includes a service called Istihlaki (my consumption) that enables the consumer to know his balance consumed, remaining on the meter, and controls his electricity meter remotely by using the Broadlink RM Pro device.

Broadlink RM Pro is a universal remote control device with enables the user to control infrared / RF devices via his smartphone. Users can control the devices from anywhere at any time as soon as they connect to the internet through a mobile phone through the WIFI or GPRS. This device sends and receives digital signals as radio waves. The Broadlink RM Pro device should be connected to electricity towards a smart meter. It is then turned on with a mobile phone that supports the WIFI. The diagrammatic representation of the smart meter system connecting to the Broadlink device is shown in Figure 1. Initially, the user can log in to the application and has to enter his IP address. Then, he can do the advance e-payment process, control the opening and closing process, read the energy which is consumed and remaining.
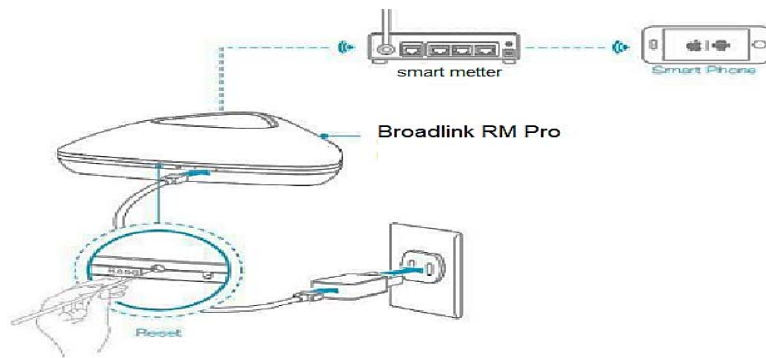
Figure 1: Components of the smart meter system connecting to Broad link.

2 LITERATURE REVIEW

Internet of Things (IoT) plays a vital role in many day-to-day applications [12, 13] and management of energy [21] is one of the main roles of the IoT. Smart meters are digital meters that are of the same size as traditional meters are [4]. The main task of this smart energy mater [22, 23] is to measure more detailed readings than the Kilowatt per hour so that consumption helps to plan the expansion and power quality of the network [5,6]. Authors in [7] proposed a novel methodology for reading the of measurements electricity meter remotely using Short Message Service (SMS). This service has been received with the aid of Global System for Mobile communications (GSM) networks. Authors in [8] proposed a hybrid automated meter reading system for reading the meter readings effectively. Their system combines both the ZigBee and GSM-based technology. The data collector unit will be connected to the central computer by using the module of GSM and the ZigBee which is attached to the electric meter. Authors in [9], proposed the novel design and implementation of a secured low-cost automatic meter reading system. This system measures and transmits the total electrical energy consumption to the main server using General Packet Radio Service (GPRS) based technology. The three main components of their proposed system are the proposal of an accurate digital meter, a facility for transmission, and a novel server for billing.

Authors in [10] depicted the idea of using a microcontroller AT89S52for a prepaid energy meter. Their idea is based on the process of the "Pay first and then use it" method. The total amount of energy consumed is counted by a circuit called the Light Dependent Resistor (LDR) for displaying the remaining amount of energy on the LCD display. In [11], the authors discussed the various protocols for communication for the automatic reading of applications. Various technologies were proposed earlier to automate the reading system of the electricity meter. Power lines are also used to transmit the reading data as well. However, transmitting data in power lines is not as cheap as implementing other technologies.

Various empirical and theoretical researches have been done by earlier researchers in order to analyze various online billing and its payment systems. The studies mainly focus on online bill payment systems such as an online power billing system, an e-payment system, a mobile-based billing system, and so on. These services have not only improved the satisfaction level of customers, but it has also helped in the reduction of processing time and transaction time. The

survey of literature review covers some major works that have been carried out on online electricity billing. These include but are not limited to: Authors in [1] presented the design and implementation of a web-based application with an online capability called Power Billing System (PBS). The PBS is a solution-based system developed with the collaboration of Microsoft Visual Web Development and Microsoft Access with Structured Query Language (SQL) for the back-end database.

Authors in [2] proposed an online payment scheme that uses the traditional e-payment infrastructure but which reveals no payment information to the seller. Authors in [3] presented the design of an advanced centralized billing system using the Internet of Things (IoT). Authors in [14] identified various vulnerabilities present in mobile-based billing systems. Their proposed system can achieve authentication, non-repudiation, and fairness, which are the desirable requirements for an undeniable mobile-based billing system. Their proposed system is based on ToT based systems were proposed by [15]. Considering the performance of earlier proposed four network scenarios for billing purposes was presented and discussed by [16]. Their result reveals that the environments use differentiated services which are convenient for customers as well as to the service providers. Authors in [17] also tried to enhance the e-payment system with the aid of a smart card. In their methodology, the third party can link a payment to a corresponding withdrawal in order to avoid the money laundering problem.

3 Main Purposes of the Smart Electric Meter System

- It records the consumption of electricity and sends it periodically or even daily to the electricity company for further control.
- It provides a highly flexible remote control-based technology for turning the meter on and off.
- It encourages the consumer to rationalize the consumption of electricity.
- It enables the user to control the remotely connected systems to its electrical devices.
- It provides the consumer with detailed information.

3.1 Sensor Components

This section consists of various components of sensors, their working procedure is as shown in figure 1, consist of the following units:
- A sensor unit that collects and processes the data from all sensors
- A data storage unit for storing and processing the readings of the sensor.
- A sending and receiving unit which collects and processes the data from all the sensors.

4 Proposed Advance Payment Service System

Various systems were proposed in this study to use applications with remote devices. In this paper, a novel system is proposed based on the incremental which consists of a development stage, requirements, and then design stage until it reaches the final stage. It is shown in figure 2. The design stage is the phase of testing and implementation [24,25].

The main objective of this paper is to propose a smart electric meter for advanced e-payment to the Saudi Electricity Company using a remote sensing device. The proposed system also provides information about the daily details of the remaining balance on the meter. In the proposed system, the programmer designs, implements, and tests all components of the system. In order to apply this proposed methodology, a system that operates by Broadlink RM Pro technology should also be incorporated.
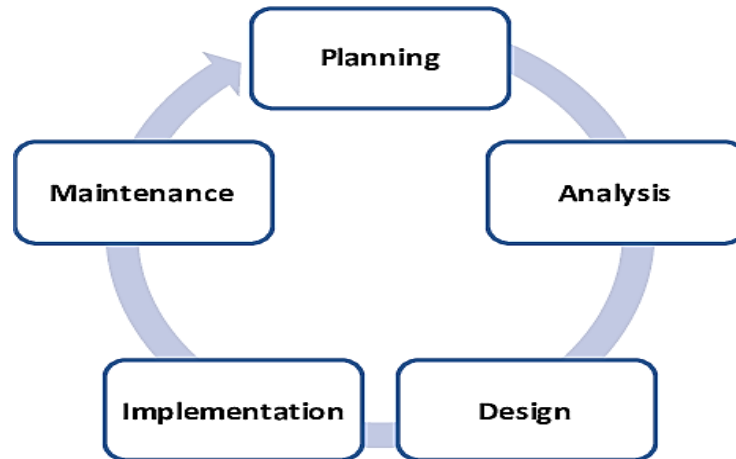

Figure 2: Schematic simple representation of the proposed Model.

4.1 System In-Use Case

The diagrammatic representation of the proposed system as-use case is shown in figure 3. In this figure, there are various actors. The first factor represents the system administrator who has the privilege to access the entire system. He controls the management of subscribers by adding, deleting, following up, and monitoring the system. The second actor registers subscribers into the system. He can write the meter number, feed the meter with the requested card, displays details of the amount spent, and remained remotes and control the meter close and open the meter via the sensor.
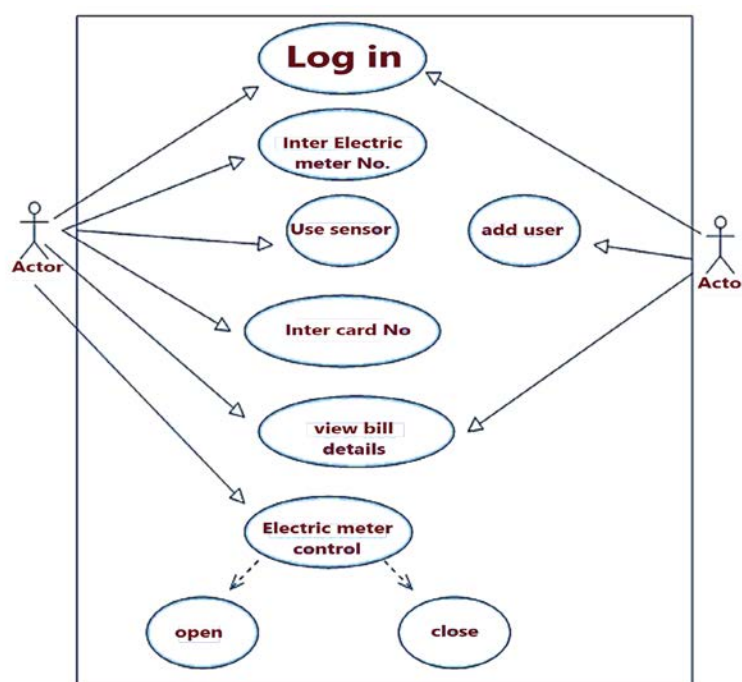

Figure 3: Use Case Diagram for the Proposed System.

4.2 Findings and Discussion

Figure 4 is the user interface that allows the user to transfer money to feed his smart electric meter. After entering the user's bank account number, smart meter number and the amount to be transferred, it will start the payment process.

Figure 4: Main Interface for charging the smart meter from the site.

Figure 5 shows an interface through which the user inquires about the spent and remaining balance on the smart electric meter and enquires about whether the user is asked to enter his smart electric meter number or not.

Figure 5: User interface how to query their balance

Figure 6 shows the user interface that allows the user to enter the data of his counter number and address number of the network. The user can run and turn off his smart meter after turning on the sensor connected to the smart meter and the system through this interface.

Figure 6: Interface of a smart meter shutdown

Figure 7 shows the Hasibati Service where there are icons to select consumption amount for used devices, to select the device type and its operating duration in hours, then press to submit.

Figure 7: Calculation of consumed energy for electrical appliances

5 Results

It can be observed from the monthly bill that the data is irregular and therefore, as shown in Figure 8 when the electric company tries to take an average of the regular bill to provide a fixed bill beforehand to the user it can create problems. As the customer is unaware of how much more energy is left for consumption during that specific month, therefore there is always a potential scenario and a constant fear of electricity getting cut off because of overuse.

Figure 8: Average (Fixed Bill) Taken from Regular Bill

The designed system provides information about the daily details of the remaining balance on the meter. Although there was some variation noted in a real monthly amount that was paid and the monthly total amount expected to be used up based on the daily details of the remaining balance on the meter it is comparatively very low. The statistical evaluations are performed on a 1-year data to inspect this margin.

Paired sample comparison is done on the monthly actual amount paid and monthly total amount expected to be used up based on the daily details of the remaining balance on the meter with the results in Figure 9.
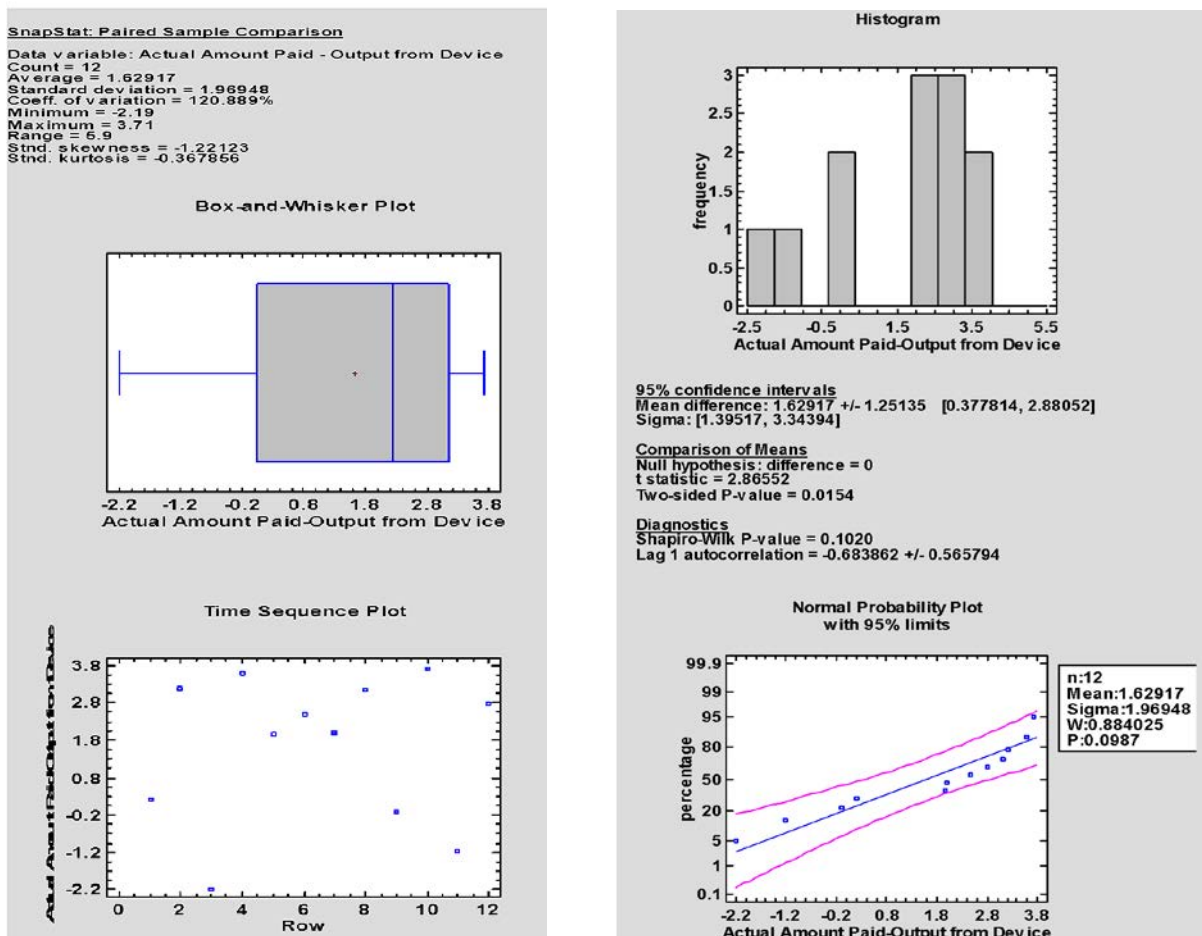

Figure 9: Paired Sample Comparison.

The results demonstrated to have a negligible difference margin and are within the 95% confidence limits of normally expected values with a standard deviation of approximately two.

6 Conclusion

Electricity Online Bill Payment System is a novel technique of utilizing IoT-based devices for paying electricity bills. This paper proposes a method of paying the consumers' bills and also enables the administrator to generate monthly reports. In this method, the user can be aware of the payment to be made in respect of their bills for the current month, thereby improving the billing accuracy, reducing the consumption and workload. The proposed system aims to familiarize the consumer with all the details about the bill and also provides him with more detailed information on operating the electrical-based devices. This paper also helps the user to connect the meter to a sensor that allows turning it off, running, and charging the meter remotely. The proposed methodology provides a highly flexible remote control-based technology for turning the meter on and off by enabling the user to control the remotely connected systems to its electrical devices. The future work is to enhance the proposed methodology by including the agent-based systems for the effective detection of illegal use of electricity.

7 Availability of Data and Material

All information is included in this work.

8 References

[1] Adegboye A, Ayeni GA, Alawode JA, Azeta IV. Design and implementation of an enhanced power billing system for electricity consumers in Nigeria. African Journal of Computing & ICT. 2013;6(1):49-58.

[2] Sai RK. Advanced Centralized Electricity Billing System Using (IOT). International Journal of Advanced Research in Computer Science and Software Engineering icrosoft Developer Network (MSDN): http://msdn2. microsoft. com/en-us/default. aspx. 2016.

[3] Chandler T. The technology development of automatic metering and monitoring systems. In2005 International Power Engineering Conference 2005 (pp. 1-147). IEEE.

[4] DECC. Smart meter Implementation Strategy Prospectus. 2010, Of gem/Ofgem E-Serve.

[5] Faisal MF, Mohamed A. A new technique for power quality based condition monitoring. InCIRED 2009-20th International Conference and Exhibition on Electricity Distribution-Part 1. 2009 (pp. 1-4). IET.

[6] Wasi-ur-Rahman M, Rahman MT, Khan TH, Kabir SL. Design of an intelligent SMS based remote metering system. In 2009 International Conference on Information and Automation. 2009 (pp. 1040-1043). IEEE.

[7] Nayan MY, Primacanta AH. Hybrid System Automatic Meter Reading.

[8] Ciuciu IG, Meersman R, Dillon T. Social network of smart-metered homes and SMEs for grid-based renewable energy exchange. In2012 6th IEEE International Conference on Digital Ecosystems and Technologies (DEST) 2012 (pp. 1-6). IEEE.

[9] Ganurkar S, Gour P. Prepaid energy meter for billing system using microcontroller and recharge card. International Journal of Core Engineering and Management. 2014;1(1).

[10] Khalifa T, Naik K, Nayak A. A survey of communication protocols for automatic meter reading applications. IEEE communications surveys & tutorials. 2010;13(2):168-82..

[11] Suganthi N, Arun R, Saranya D, Vignesh N, Nadu T. Smart Security Surveillance Rover. International Journal of Pure and Applied Mathematics. 2017;116(12):67-75.

[12]   Vanitha V, Sumathi VP, Cynthia J, Illakia B. Next Generation Vehicle Diagnostic Systems. International Journal of Pure and Applied Mathematics. 2017;116(11):251-9.

[13]   Li S, Wang G, Zhou J, Chen K. Fair and secure mobile billing systems. Wireless personal communications. 2009;51(1):81-93.

[14]   Al-Ani MS, Noory R. Billing system design based on internet environment. Editorial Preface. 2012 Sep; 3(9):224-30..

[15]   Barreto PS, Amvame-Nze G, Silva CV, Oliveira JS, de Carvalho HP, Abdalla H, Soares AM, Puttini R. A study of billing schemes in an experimental next generation network. InInternational Conference on Networking 2005 (pp. 66-74). Springer, Berlin, Heidelberg..

[16]   Bo Y, Dongsu L, Yumin W. An anonymity-revoking e-payment system with a smart card. International Journal on Digital Libraries. 2002; 3(4):291-6.

[17]   Tam HH, Phat V, Tuan DH. A new routing method used for automatic meter reading in buildng. InThe 2012 International Conference on Advanced Technologies for Communications 2012 (pp. 314-318). IEEE.

[18]   Neto JR, Yokoyana RS, Villas LA. A robust and lightweight protocol for efficient and scalable automatic meter reading using an unmanned aerial vehicle. IEEE Latin America Transactions. 2015; 13(9):3044-50.

[19]   Elrefaei LA, Bajaber A, Natheir S, AbuSanab N, Bazi M. Automatic electricity meter reading based on image processing. In2015 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT) 2015 (pp. 1-5). IEEE.

[20]   Khan MY, Ibrahim M, Ali M, Khan H, Mustafa E. Cost Benefit Based Analytical Study of Automatic Meter Reading (AMR) and Blind Meter Reading (BMR) used by PESCO (WAPDA). In2020 3rd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET) 2020 (pp. 1-7). IEEE.

[21]   Mai X, Li W, Huang Y, Yang Y. An automatic meter reading method based on one-dimensional measuring curve mapping. In2018 IEEE International Conference of Intelligent Robotic and Control Engineering (IRCE) 2018 (pp. 69-73). IEEE.

[22]   Osman AS, Osman AS. Evaluating employee performance using automated task management system in higher educational institutions. Indian Journal of Science and Technology. 2019;12(9):1-8.

[23]   Khalil EG, Osman AS. A Novel Method for Patients Identification in Emergency Cases using RFID based RADIO Technology.

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