# SMS-Based Automatic Billing System of Household Power Consumption Based on Active Experts Messaging

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**Abstract.** The study about SMS-based Automatic Billing System of Power Consumption aimed to change the conventional way the power utility provider gathers and handles billing data. The system is composed of two basic parts such as the remote site and the base station. The former calculates and sends power consumption while the latter retrieves meter readings, calculates billing charges and processes payment of the customers. Microsoft Visual Studio 2008 was used to develop the Main Server Software with Visual Basic 2008 as the Integrated Development Environment (IDE) or programming tool and Visual Basic as the programming language. The database was created in Microsoft SQL Server 2005 and ActiveXperts Messaging Server 4.1 was use as an SMS framework that allows the system to send, receive and process SMS. The use of this system will give greater benefit to the electric company and its customers because of the ease and less impediment in gathering meter readings in remote locations and an instant delivery of billing statements to the customer's cellular phones through SMS technology.

**Keywords:** SMS messaging, automatic billing, Active Expert, power management.

## 1    Introduction

Conventional electricity billing system in the country has been lagging in terms of technology in gathering and processing power consumption data for billing purpose. It is done by an assigned person who visits each meter location periodically and reads the meter manually. Data collected are then processed either manually or via specialized software into the customers" bills which in turn are distributed manually to each respective customer.

As such, conventional meter reading poses several problems wherein adverse effects extend to the customer himself. Misreading of the power meter for instance can

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inadvertently increase or decrease the customer's bill.  The recent technology of automatic meter reading (AMR) [1] has solved the problems of conventional meter reading. AMR has promised fast and accurate collection of meter readings, however, incorporating this with manual computation of electric bills does not fully utilized its functionality.

With the development of the text messaging in the country and the dependence of the people on it, the researchers took advantage of the GSM network and SMS technologies available to solve these inefficiencies. The convergence of SMS and GSM network allow more mobile and wireless applications to be implemented such as automatic meter reading and billing. Although many related projects have been presented in some other countries, the development and implementation of this study in the Philippines is not yet totally accomplished.

The proposed SMS-based Automatic Billing System of Power Consumption will elaborate further on some existing technologies and studies that focus on Automatic Meter Reading and Remote Meter Reading since it will give more effort and attention in developing the billing system interface of power consumption. The development of the system will not only focus on the communication network but on the application side wherein a secure and reliable Automatic Billing System will be developed.

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## 2     Related Studies

The study on Fixed-Network Automatic Meter Reading (AMR) System [2] was a graduation project of Awad and Gosh presented to the Department of Electrical Engineering, University of Jordan. The project discusses about utilizing already available fixed communication networks (e.g., the cellular network) for exchanging data to minimize cost and human effort. The purpose of their project was to introduce a Fixed-Network AMR design that manages the reading of the electricity meters at the consumers' side. This design was intended to replace the existing manual methods of gathering data. The approach to the solution for this problem was made with the use of the GSM network and a custom RF solution. Different hardware modules were introduced to help exchange data between a central office and any node in the system (i.e., customer's side). The GSM and RF communication media were fully utilized by introducing their own GSM and RF protocols.

A paper on Networked Remote Meter-Reading System Based on Wireless Communication Technology [4] studied meter-reading system based on Bluetooth wireless communication technology and GSM. The remote meter-reading system employs distributed structure, which consists of measure meters, sensors, intelligent terminals, management centre and wireless communication network. The intelligent terminal which designed based on embedded system and Bluetooth technology was used to realize acquisition information submitted from meters and sensors control the energy-consuming devices moreover in residence.

While in a paper on Real-time Energy Management over Power-lines and Internet [17], explore the creation of an infrastructure for energy management that should enable the enhancement of existing applications like automatic meter reading, distribution grid management, and remote control. The system allows for direct communication with equipment at the customers' premises via a two stage hierarchical power line communication system and an IP (Internet Protocol)-based private network.

A paper on Novel Approach for Remote Energy Meter Reading Using Mobile Agents [15] incorporated power or energy meter systems with embedded controllers such as micro web-servers with Ethernet port to transmit the reader data over the Internet. Such data can be then fed and integrated into existing energy management systems located at power companies and organizations. Mobile agents are executing programs that migrate during execution and present methods for maintaining and using distributed systems. However, the problem of efficiently collecting data from a large number of distributed embedded Web-servers in the energy meters is still a challenging problem.

On the other hand, in [1] developed hardware structure consisting of a digital energy meter module, another digital meter for water and a telephone module, all lined with a single chip microcontroller were equipped with credit card reading capability to automatically read and charge the consumption on site. Also, all service metering modules were facilitated with an automatic service connection and disconnection based on the available credit. The software structure commands the whole process via the microcontroller input/output ports.

Furthermore, the study of Jabundo et al. [9] about prepaid kilowatt-hour meter aimed at reducing certain problems such as pilferage and excessive use of electric energy in establishments. This system was composed of a customized digital power meter that was prepared for prepaid use. Occupants of the establishment will purchase energy load–equal to its corresponding energy based on the current energy rate–from the establishments' owner. When the occupant totally consumes the energy load, the current will be cut off by the magnetic switch.

Based on the reviewed literatures, the researchers are motivated to study an automatic billing system of power consumption that automatically acquires meter readings from a remote station, calculates billings and sends SMS bills to the customers. The proposed system used a digital power meter designed to send meter readings directly to the system through GSM network, an SMS Messaging Server as its middleware and develop a multi-level system that handles data collection, billing computation and payment processing.

## 3    System Architecture

Theoretically, the proposed system will help ease the collection of billing data, thus saving the utility provider and customer time, money, effort and inconvenience. It also eliminated the cost incurred by the traditional meter data collection process, thus lessening the burden cast upon the customers.

The proposed automatic billing system is composed of a remote site and base station as shown in Figure 1. The digital meter that is located in the remote site (homes and buildings) will send the meter readings in the base station's billing system via SMS using the stable GSM network for cellular phones.
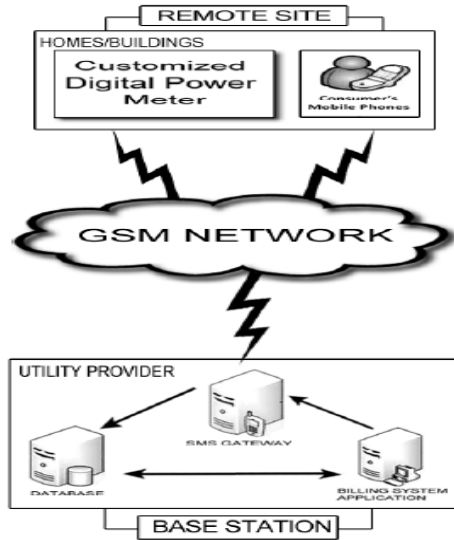
**Fig. 1.** The proposed System Architecture

## 3.1    Remote Site

The remote site is the digital power meter customized to receive queries and send its own meter reading to the base station via SMS. The device consists of a microcontroller unit, GSM modem, LCD display, current and voltage sensor attached to the main power supply.
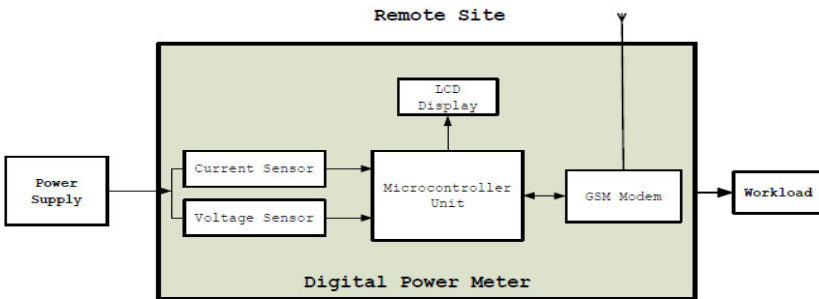


**Fig. 2.** Architectural design of the remote site

As shown in Figure 2, the remote site's current and voltage sensors receive energy that passes through the meter reader from the power line to the customer's workload — appliances or other AC devices at a maximum of 2 amperes. The two sensors measure current and voltage respectively, which can be viewed from the meter reader's LCD display.

Microcontroller unit calculates the input from the current and voltage sensors, converting the results into kilowatt per second, representing the customer's power consumption.

The resulting data are then sent to the GSM modem in the event the remote site receives an SMS request from the base station with this *format:'check data'*. The data are then processed into an SMS message in this *format: "Meter ID, Reading"*. The message is then sent to the server.

## 3.2   Base Station

The base station acts as the central server where all the commands and processing of data are executed. It is composed of another GSM modem, an SMS Messaging Server and the main server software.
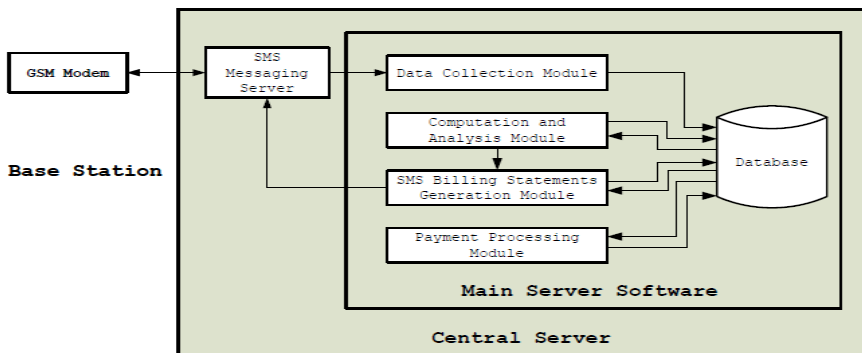


**Fig. 3.** Architectural Design of the Base Station

As shown in Figure 3, GSM modem is used by the base station to communicate with the remote site by sending an SMS request to the customized digital meter, which sends back the current kWh reading in return. The GSM modem is also used to send billing information to the customer via SMS.

## 4      Simulation and Results

The SMS Messaging Server manages SMS messages sent and received by the GSM modem. Running in the background, it acts as the system's middleware. Meanwhile, the Main Server Software is multi-level software that handles processes such as retrieval of meter readings directly from the remote station, computation of bills and processing of payments for the said bills. The software is composed of a database and data collection, computation and analysis, SMS billing statements generation and payment processing modules.

The Main Server Software's Database is connected to all the modules of the software. This is where data in the system is stored and retrieved.  The Data Collection Module communicates data with the SMS Messaging Server. From there it

retrieves relevant SMS messages such as meter readings to be saved in the database. The computation and analysis, module retrieves data from the database, calculates and analyzes the overall consumption and relays the information to the billing statements generation module.



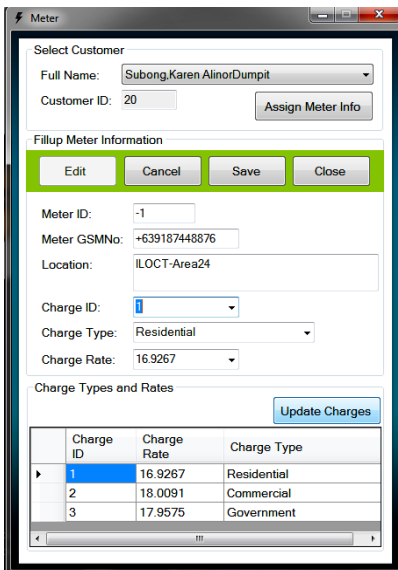**Fig. 4.** Input Window for Customer's Details for Registration
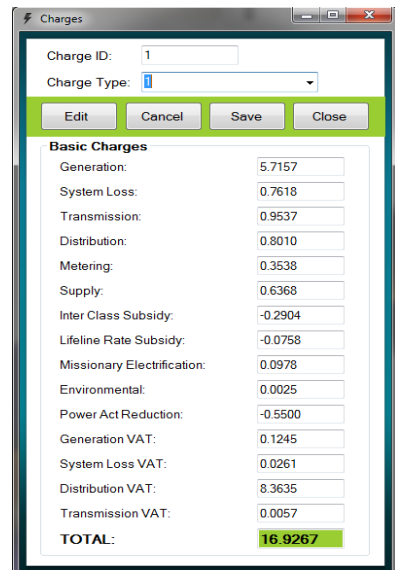


**Fig. 5.** Assigning meter details for each customer



**Fig. 6.** Updating charge rates

The SMS billing statements generation module generates detailed reports of customers monthly bill consisting of the current and previous kWh readings, total kWh used, charge rates, amount due and due date. Billing statements are sent to the consumer's cellular phone in SMS format. This is presented in Figure 7.
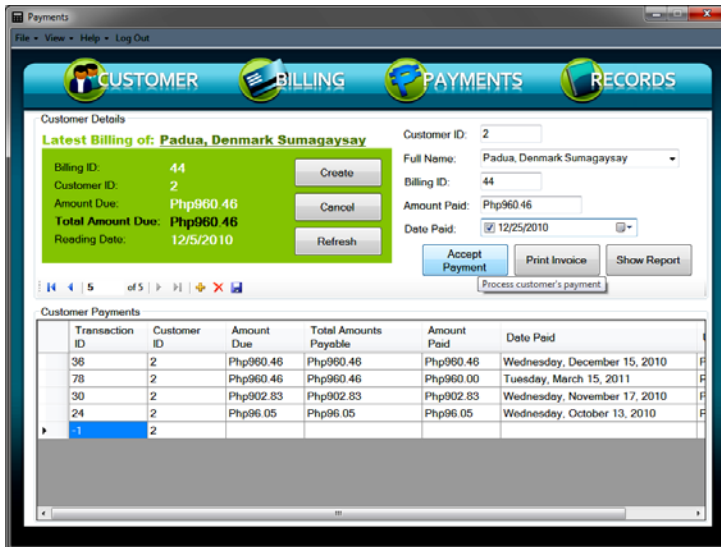


**Fig. 7.** Processing Customers' Payment

On the other hand, the payment processing module is responsible for processing the payments of the customer. It also includes the handling of unpaid due amounts and other functions related to payment system.



**Fig. 8.** Billing Information (SMS) Received by the Customer

The GSM network, when interfaced with an SMS gateway like ActiveXperts can be utilized as an effective data communications system. The ActiveXperts SMS gateway on the other hand, is good third-party software for this matter. It efficiently manages received data into databases and is capable of sending data via SMS. Figure 8 shows the SMS sent to the customer for its billing information.
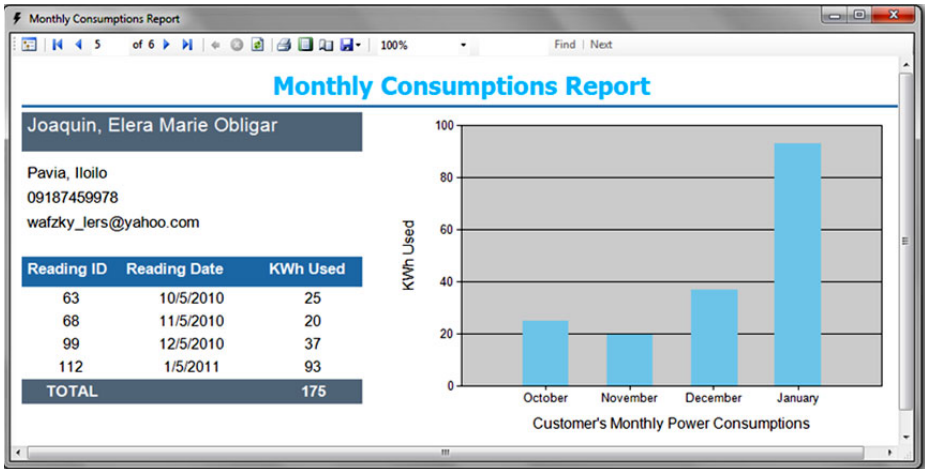


**Fig. 9.** Customer's Monthly Consumptions Report

On the other hand, Figure 9 shows the monthly power consumption of the customer. The system could also provide master list of the customers and as well as daily report of consumption and payment reports.

## 5      Conclusions and Recommendations

In this study, a user-friendly software application for the base station was created. We demonstrated the automation of the retrieval, storage and sending of data. In addition, the system's software was able to compute the data acquired from the remote site and generate billing statements for the customer.

A prototype digital meter that measures power consumption and sends data via SMS was successfully adopted and integrated into the system. Moreover, effective communication between the remote site and the base station was successfully established using the GSM network gateway.

To further improve the efficiency of the software system, the researchers recommend that functions such as bulk sending of SMS billing information to the customers, one click computation of all customers' monthly bills and receiving of inquiries from customers via SMS shall be included in the future study. Also the researchers recommend that energy consumers should monitor their power consumption by inquiring their own meter readings directly from the customized digital meter at any given time.

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