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Energy Saver and Wireless Billing Using Smart Energy Meter

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I. INTRODUCTION

Now the low voltage and load shedding are two major problems that we are facing in our daily life. Most of the people waste energy by using large amount of unnecessary devices especially in peak time. Kerala State Electricity Board (KSEB) reduce energy consumption for saving energy through load shedding. This is not an effective solution. Because it will affect large number of users who use low energy within their limit of usage.

This paper is to design and develop an energy meter that measures the amount of electrical energies supplied to residence, business, machine or to a locality under a substation or transformer and reduce the power consumption by providing an initial warning and automatic connection closing when an over load is occur. This paper differs from an ordinary energy meter, it includes some additional facilities

- Warning and automatic fusing and defusing facility during excess load.
- Wireless billing.
- Wireless disconnection and reconnection processes.

So there are three intentions implemented in this system. First one is, providing a warning mechanism during over load on the electrical circuit using GSM based messaging system and automatic connection closing. When the power consumption is exceeding the limit, the system send a warning message to the contact number of registered user and also display in LCD screen and on an alarm. After sending the message to user, a timer starts and after a particular interval the system again measures the load and the system closes the electrical circuit if the over load is not reduced.

The second part is the wireless billing using GSM technology. By implementing this meter we can avoid spot billing system. The wireless transmission allows the transfer of meter readings to the billing station at the electricity board. The billing station calculate the bill using information of units received from energy meter at the client side and send the bill to the customer mobile number. And also print the bill for bill collector. This reduces the man power.

Third part is wireless disconnection and reconnection processes. Admin / Engineer at electricity board can cut the connection wirelessly by sending an SMS if a customer did not pay his bill with in date.

The meter is highly user friendly in the sense that the power used is monitored and the information about bill is informed through GSM. The LCD module also displays the unit corresponding to the power used. Thus the user is constantly informed of his power usage.

The advantages of this paper are:

1. Minimize the energy consumption.
2. This meter is free from inherent defects of ordinary ferry wheel energy meters used currently, such as low accuracy, low reliability, lack of user friendliness & safety, etc.This meter is static in that it does not depend on moving parts such as rotating ferry wheels (used in induction type meters) for its operation. All the advantages of static meters are present in this meter also.
3. This system also provides wireless billing to a remote place.

The system contains two parts:

II. ENERGY METER AT THE CLIENT SIDE

This section transmits the amount of energy consumed in units. For this, read the load and give as input of the controller. Here we use a PIC 16F877A Microcontroller to count the pulses and after a specific preset number of pulses it increments the unit. MAX232 is used as an interface between PIC and the GSM module. This is to ensure that the data is transmitted serially to the GSM. The unit value is transmitted through GSM. An LCD module interfaced with the PIC connected to the meter for display units consumed and the current load. Energy meter automatically cut off the supply and send warnings when the usage exceeds the limit.

III. BILLING STATION

This section deals with the processing of data received from different consumers. It sends a request to the module installed at consumer's end. When the required information is transmitted back, the billing device generates and sends the bill to the customer Mobile number and also prints the bill. We can change the tariff for each month / time.

This work can develop in embedded systems. PIC 16F877A can be used as the controller. The GSM transmission is used to establish connection between client and server. The paper "Smart Energy Meter" has a great role in reducing the wastage of electricity in future.

SYSTEM ENVIRONMENT

System environment specifies the hardware and software configuration of the new system. Regardless of how the requirement phase proceeds, it ultimately ends with the software requirement specification. A good SRS should establish the basis for agreement between the customers and suppliers on what the software specified in the SRS will assist the potential users to determine if the software specified meets their needs or how the software must be modified to meet their needs.

HARDWARE ENVIRONMENT FOR DEVELOPMENT

System:

Processor	:	Pentium Dual Core or above
Memory	:	2 GB RAM
Hard Disk	:	80 GB or above
Keyboard	:	Windows Compatible
Mouse	:	Windows Compatible
Monitor	:	SVGA Monitor

Other tools

PIC Programmer
Soldering tools
Multimeter

Hardware components used in embedded system:

- Microcontroller (PIC 16F877A)
- GSM Modem
- IC RS232
- LCD Module (16 X 2)
- Thermal printer
- Transformer
- Relay
- Buzzer
- LEDs

The LCD display also possesses 64 bytes of Character-Generator (CG) RAM. This memory is used for characters defined by the user. Data in CG RAM is represented as an 8-bit character bit-map. Each character takes up 8 bytes of CG RAM, so the total number of characters, which the user can define, is eight. In order to read in the character bit-map to the LCD display, we must first set the CG RAM address to starting point (usually 0), and then write data to the display.

THERMAL PRINTER

Thermal printing (or direct thermal printing) is a digital printing process which produces a printed image by selectively heating the coated thermal paper, when the paper passes over the thermal print head.
Thermal printing is notable for being the only form of printing which involves no ink or toner.
A thermal printer comprises these key components:

- Thermal head: generates heat; prints on paper
- Platen: a rubber roller that feeds paper
- Spring: applies pressure to the thermal head, causing it to contact the thermo sensitive paper
- Controller boards: for controlling the mechanism

BUZZER

It is used for beep an alarm during overload.

RELAY

Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults. Relay is used for ON / OFF the supply.

SOFTWARE ENVIRONMENT

Operating System	:	Windows XP/Windows Vista or
7Programing Language	:	Embedded C
IDE	:	MP LAB
Programmer	:	PICKIT 2
CAD Software	:	Orcad 9

Embedded C

In the fast growing market of embedded systems there is an increasing need to write application programs in a high-level language such as C. Basically there are two reasons for this trend: programs for embedded systems become more complex (and hence are difficult to maintain in assembly language), and processor models for embedded systems have a decreasing lifespan (which implies more frequent re-adapting of applications to new instruction sets). The code re-usability achieved by C-level programming is considered to be a major step forward in addressing these issues. Embedded processors are often used to analyze analogue signals and process these signals by applying filtering algorithms to the data received. Typical applications can be found in all wireless devices. The common data type used in filtering algorithms is the fixed-point data type, and in order to achieve the necessary speed, embedded processors are often equipped with special hardware for fixed-point data. The C language does not provide support for fixed-point arithmetic operations, currently leaving programmers with no option but to handcraft most of their algorithms in assembly language. This Technical Report specifies a fixed-point data type for C, definable in a range of precision and saturation options. Optimizing C compilers can generate highly efficient code for fixed-point

IV. SYSTEM ANALYSIS EXISTING SYSTEM

At present, most of the houses have the traditional mechanical watt hour meters and the billing system is not automated. At the end of each month a person from the Electricity Board, one for each area, goes to every house in that area and takes the meter reading manually. These meter readings are used for electricity bill calculation and doing spot billing. The consumer is acquainted with the printed bill containing details about the number of units consumed, cost per unit, total amount to be paid and the last date to pay the bill without fine. Customer goes to electricity department for paying this bill amount.
Each customer can use large amount of electricity which exceeds the limit suggested by electricity board.

Problems with the Existing System

Existing manual system requires the electricity board to incur the additional cost of paying salary for a set of employees destined to take the meter reading. In addition the travelling allowances for these employees are also to be incurred by the board. On the long run these costs turn around to a very large amount.

Disconnecting and reconnecting processes are laborious tasks in today's system. The concerned persons should visit the location personally and do the process manually. This also adds to the loss of money and wastage of time.

Each customer can use large amount of electricity which exceeds the limit suggested by electricity board. The electricity board implement load shedding for reduce the energy consume in peak time which will affect all the customers even he not use small amount of energy with in his limit.

V. PROPOSED SYSTEM

The proposed system, Smart Energy Meter, is a fully automated electricity billing system. With this it is possible to measure and monitor the electricity consumed by consumers in a locality and transmit the units consumed to the power station and issuing the bill of consumed power automatically. Using this system the Electricity Board can access all data regarding the consumed power in each home and in each station. This system is to help consumers a direct contact with the electricity board.

This system provides freedom to electricity department to take action against lenient customers who have outstanding dues, otherwise electricity board can disconnect the power of customer .Companies can re connect the power after deposition of dues. Time saving, fast accessing of meter reading and eliminating manual errors are the main benefit of the system.

Smart Energy meter-reading system helps the customer and electricity department to access the accurate and updated data from the power meter. This System can send energy consumption in hourly, monthly as per request. This data is sent to billing station wirelessly.
System can also implement load shedding to the only users whose energy consume is exceeds the limit.

Features of the Proposed System

- Wireless Meter Reading is done.
- Bill details are sent to consumer's mobile phone.
- Disconnection and reconnection processes can be done very easily by SMS.
- The entire system is under the control and monitoring of the electricity board and so the board can be liberated of the additional costs associated with spot billing.

FEASIBILITY STUDY

A feasibility study is conducted to identify the best system that meets all the requirements. This includes an identification description, an evaluation of the proposed system and the selection of the best system for job. If a paper is seen to be feasible from the results of the study, the next logical step is to proceed with it. The research and information uncovered in the feasibility study will support the detailed planning and reduce the research time. Feasibility Studies can be undertaken by any type of paper or team and they are a critical part of the Project Life Cycle.

A Paper Feasibility Study is an exercise that involves documenting each of the potential solutions to a particular problem. The purpose of a Feasibility Study is to identify the likelihood of one or more solutions meeting the stated requirements. During the Feasibility Study, a variety of 'assessment' methods are undertaken. The outcome of the Feasibility Study is a confirmed solution for implementation.
The key factors to be considered during feasibility study are:

Commercial Feasibility

It is used to determine the single and multi-dimensional market forces that affect the system. This is done by evaluating the market; the users and the demand. There is no efficient system that can provide a secure and safe backup. So bringing in a system that meets the requirements will produce high demand.

Commercially our proposed system is highly feasible as it offers a very convenient and efficient method for automating the existing manual task. It liberates the Electricity board of its additional cost and wastage of time and labour. Our system can easily be leveraged with the existing hardware.

Economic Feasibility

Economic analysis is the most frequently used method for evaluating the effectiveness of a candidate system. More commonly known as cost/benefit analysis, the procedure is to determine the benefits and savings that are expected from a candidate system and compare them with costs. If benefits outweigh costs, then the decision is made to design and implement the system.

Though the initial cost incurred for this system is high, on the long run the money wasted by the board on the manual system surpasses this cost. Further, large scale production of the hardware can also reduce the cost incurred in its production.

Technical Feasibility

It is used to determine the requirements of technologies for the current system. In the technical feasibility the system analyst look between the requirements of the paper. It is concerned with specifying external equipment that will successfully satisfy the user view of requirements. Thus in technical analysis, the analyst has to consider how far the existing hardware and software can be utilized in the proposed system.

Embedded C used for programming the PIC is a highly stable and efficient language. So the proposed system satisfies technical feasibility.

Behavioral Feasibility

People are inherently resistant to change and computers have known to facilitate change. An estimate should be made of how strong the reaction the user staff is likely to have towards the development of the computerized system. It is a common knowledge that retraining and changes in employee job status. Therefore it is understandable that the introduction of a candidate system requires special efforts to educate, sell and train of staff on the ways of conducting business. A behavioral feasibility study is conducted among the top staffs using direct interviews and questionnaire. All the users have knowledge about the system and have a good reaction towards the system

VI. LIST OF ACTORS AND THEIR ROLES

1. Electricity Board Engineer (Admin):

Is the user who can install and activate the system, determine the energy consumption limits. He can also change the boundary value, customer contact number through which the customer is informed and billing rate.

2. Electricity Billing Staff:

Billing staff also get the copy of all bills and he also inform Electricity board engineer (Admin) about the details of payment.

3. Customer:

Customers get warning alerts and information of bill through Mobile Phone.

BUSINESS RULES:

- Electricity Board Administrator set the energy limit based on customer's requirement mentioned in the application at the time of getting connection.
- Only EB Administrator can change the energy limit based on customer's request.
- Customer cannot change the energy limit and OFF the system.
- Power supply for energy meter should from main directly.
- The energy meter should have a battery backup.
- System should be in Mobile Network covered area.
- System must have a SIM with message facility for wireless messages and billing.
- The final bill is based on the settings in EB billing system.
- Consumer can make the payment offline.
- One billing system at a electricity office handles only limited customers of same type at that region.

USE CASES:

1. **Install system**
   Electricity Board Administrator set the energy limits for a customer, customer number and install the system in both customer side and billing station.
2. **Get overload warning**
   If the load is exceed the registered limit customer get overload warning through SMS and alarm.
3. **Change tariff**
   Billing staff can change the default tariff at the billing satation.
4. **Request bill**
   The billing staff can request the bill at the billing station. The devices at billing station send a request to energy meter and receive data from Energy meter and calculate the bill as per the tariff.
5. **View Bill**
   The billing staff can view the bill and get a print. And the customer also get bill in his mobile phone.
6. **Connection management**
   Administrator can disconnect and reconnect the connection based on the payment details from bill collector by message.

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