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Design and Implementation of an Intelligent Automatic Meter Reading System Using Wireless Technology

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Abstract: *In this system an intelligent energy meter is installed in every household unit. The meter is communicating with GSM module which facilitates bidirectional communication between the two ends using the existing GSM. Server can easily control energy meter by sending a command using SMS. The bidirectional GSM communication using SMS ensures the effectiveness of these measures. Actions against dishonest consumers can also be taken.*

Keywords: *GSM, SMS, Energy Meter.*

1. INTRODUCTION

Electricity theft has emerged as a serious problem in power sectors especially in the developing countries. A huge amount of revenue is lost due to electricity theft. In some countries this is so severe that governments are incurring losses instead of revenue. In some cases government has to provide subsidies to the power sector to maintain a reasonable price of electricity. The financial loss results in shortage of funds for investments to expand the existing power capacity and as a result governments are failing to satisfy the ever increasing demand of electricity. In some cases this problem has become so extreme that the affected power systems are near bankrupt. Electricity theft includes tampering meters to show a low meter reading, stealing electricity bypassing a meter, billing irregularities and unpaid bills. Billing irregularities comprise inaccurate meter reading taken by bribed service man an intentional fixing of the bill by office staffs in exchange of illicit payments from the consumer. Different non technical and technical methods were proposed in the past to detect electricity pilfering. Non technical methods may include inspection of the customers with suspicious load profile. Although periodic inspection can substantially reduce theft, such measure requires large manpower and huge labour. Such effort also fails in most cases due to the dishonesty of the staffs. Some of the technical ways to detect pilferage are use of central observer meter at secondary terminals of distribution transformer, harmonic generator, genetic support vector machines, extreme learning machine, and power line impedance technique. However, these technical approaches can be effectively implemented only if proper communication is ensured between the central control station and the appropriate test points.

2. PROPOSED SYSTEM

In the proposed system the power utility maintains a server and each consumer are provided an energy meter. The server and meters use GSM module respectively to communicate with each other using the GSM network. The energy meter consists of a Microcontroller (ARM7), GSM module, current transformers, potential transformers, LCD display and a relay. The Microcontroller calculates the energy consumption by counting the output of current and potential transformers on an interrupt basis. The Microcontroller uses AT command set to communicate with the GSM module (mobile phone). The Embedded C programming language and the Keil uvision4 software have been used to program the Microcontroller. As the user consumes energy, the corresponding units are updated to consumed units are displayed using LCD. After regular time intervals the server sends a command to the user

meter system, enquiring about the consumed energy. After receiving the command the system will read the EEPROM units reading and will send the consumed energy along with the details of the user. In the mean time of the bill generation, if the user did not respond to pay the bill, then immediately the server send a command to meter system to disconnect the load. Instead of sending a person, to disconnect the load. If the user pays the amount of the bill then server then sends a command to connect the load. By this the human power is less used.

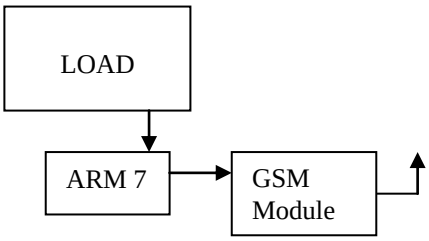

Fig1. *Over view of the proposed System*

In the above figure load is designed by a bulb setup for showing the consumption of the electricity. The calculation of the power is done using ARM7 based LPC2148 microcontroller. GSM module is for communication purpose

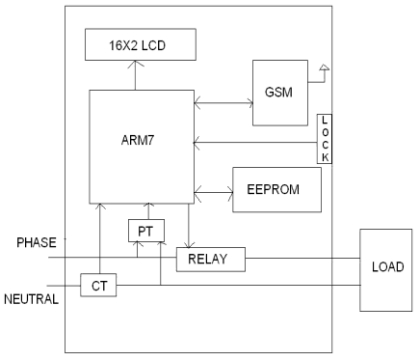

Fig2. *Block Diagram*

For the designing of the proposed system we are using LPC2148 microcontroller for controlling the whole system by programming it. Potential Transformer (PT) is used to calculate the voltage. Current Transformer is used to calculate the power consumed by the load. Relay is used to "CONNECT" or "DISCONNECT" the load. EEPROM is used to store the consumed units. LCD is used to display the units to the user.

3. THEFT CONTROL MEASURE

3.1. Protection Against Tampering

Consumers or professional ones may try to open the energy meter and tamper it to show low or no energy consumptions. To get rid of this problem, one switch is used at opening side of the proposed energy meter. Output of switch is connected to external interrupt pin of the Microcontroller. In normal conditions, the switch will be closed and the Microcontroller will detect 5V at its external interrupt pin. If consumer tries to open the energy meter the switch will be opened and the Microcontroller will detect 0V at its external interrupt pin. If this occurs, the Microcontroller immediately notifies the server and disconnects the load from the supply.

4. HARDWARE IMPLEMENTATION

4.1. History of ARM

ARM stands for Advanced RISC machine. The first processor in ARM family was developed at Acorn Computers Ltd between October 1983 and April 1985. Acorn Computers was a British computer company established in Cambridge, England, in 1978. The company worked for Reduced Instruction Set Computer (RISC) processor design. The company produced a variety of computers which were very popular in the United Kingdom. These included the Acorn Electron, the BBC Micro

and the Acorn Archimedes. Particularly BBC Micro computer dominated the UK educational computer market during the 1980s and early 1990s. The ARM7TDMI core is a 32-bit embedded RISC processor delivered as a hard macro cell optimized to provide the best combination of performance, power and area characteristics.

4.2. ARM7TDMI Features

- 32-bit ARM instruction set for maximum performance and flexibility
- 16-bit Thumb instruction set for increased code density
- Unified bus interface, 32-bit data bus carries both instructions and data
- Three-stage pipeline
- 32-bit ALU
- Very small die size and low power consumption
- Fully static operation
- Coprocessor interface

4.3. LPC2148 Microcontroller

LPC2148 microcontrollers are based on a 32 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support that combines the microcontroller with embedded high speed flash memory of 512kb. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces the code by more than 30% with minimal performance penalty.

- 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8 to 40 kb of on-chip static RAM and 32 to 512 kb of on-chip flash program memory.
- 128 bit wide interface/accelerator enables high speed 60 MHz operation.

4.4. Liquid Crystal Display

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

4.5. Relay

A relay is an electrically controllable switch widely used in industrial controls, automobiles and appliances. The relay allows the isolation of two separate sections of a system with two different voltage sources i.e., a small amount of voltage/current on one side can handle a large amount of voltage/current on the other side but there is no chance that these two voltages mix up. When current flows through the coil, a magnetic field are created around the coil i.e., the coil is energized. This causes the armature to be attracted to the coil. The armature's contact acts like a switch and closes or opens the circuit. When the coil is not energized, a spring pulls the armature to its normal state of open or closed. There are all types of relays for all kinds of applications.

4.6. GSM

Global System for Mobile Communications GSM is a digital wireless network standard designed by standardization committees from major European telecommunications operators and manufacturers.

The GSM standard provides a common set of compatible services and capabilities to all mobile users across Europe and several million customers worldwide. Designed for global market, SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz. SIM300 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.With a tiny configuration of 40mm x 33mm x 2.85mm, SIM300 can fit almost all the space requirements in our applications, such as smart phone, PDA

phone and other mobile devices. In this hardware SIM300 is only interfaced with RS232, Regulated power Supply 4.0V SIM Tray Antenna with LED indications

The power line current is measured by passing it through a current transformer, output of which is a current proportional to the line current, the turns ratio being the constant of proportionality. A precision resistor converts the output current into equivalent alternating voltage. The voltage across resistor passes through precision rectifier, ripple eliminator and voltage divider stages before being finally fed to the inbuilt ADC peripheral of the Microcontroller. Current transformer, for current measurement, is an efficient measurement technique compared to shunt resistor (which changes the line voltage at higher line current), thus having higher linearity and virtually zero burden current.

The microcontroller used is the LPC2148, featuring a 10 bit ADC, which enables measurement of minute changes in line voltage and current. Power consumption is computed, every second, using the measured values of voltage and current. Summing power consumption over a given period of time gives energy used by the consumer.

The on chip Timer interrupts the controller every second. This is extremely important since if this time duration it self has error then the measurement would be erroneous as it is calculated at an interval of every 1 second. The system utilizes two voltage levels, one of ±9 V for the signal conditioning circuitry and other of 3.3 V for the microcontroller. Both voltage levels are provided using a single power supply board. The system consumes a maximum of 3 VA or on monthly basis approximately 2 units which is lower than currently available metering systems.

5. HARDWARE & RESULTS

As per the proposed system the results are obtained. Fig 3 is the hardware setup for the proposed system.

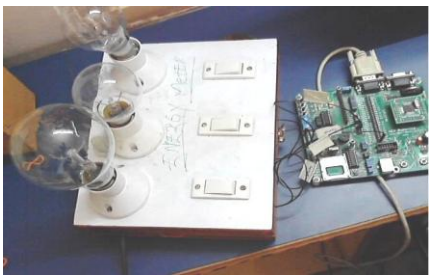

Fig3. *Prototype of the Proposed System*

Fig4. *Internal Connections of CT & PT*

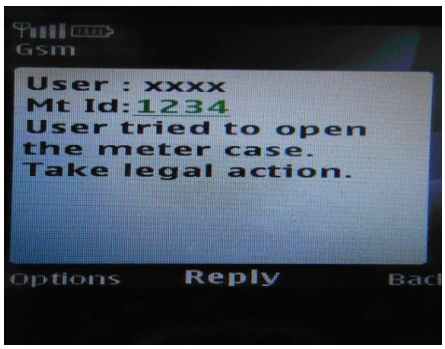

Fig5. *Message Received When User Tried to Open the Meter Case*

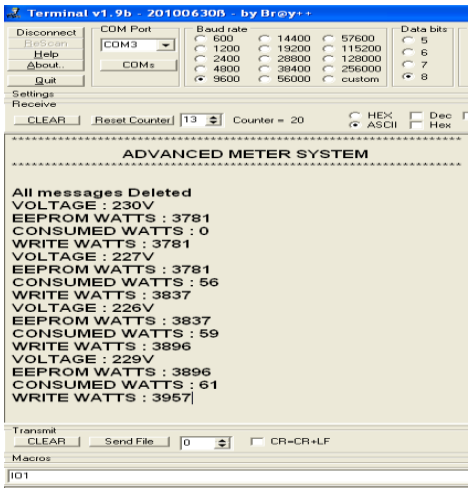

Fig6. *Terminal Screen shot*

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