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Machine To Machine Communication Based Smart Metering System

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***Abstract*—Machine-to-machine (M2M) communications provides real-time monitoring and control without the need for human intervention. A smart electric metering system using Machine to machine communication has been discussed here. The presented solution collects data from electricity meters and provides data presentation to end user in graph form and the data collected can further be used to generate electricity usage bills.**

***Keywords*—M2M - Machine-to-machine, smart meter, GPRS.**

I. Introduction

M2M uses a device to capture an event, which is sent through the network to an application that translates captured event into meaningful information. The goal of M2M services is to automate decision and communication processes.

Smart metering infrastructure offers the possibility for additional energy related services such as demand side management and realization of virtual power plants. The future of smart metering will depend heavily on the policy and decisiveness of the governmental bodies involved. Energy savings and an increased security of supply will be main drivers and believe in smart metering as a means to reach these goals is indispensable.

II. RELATED WORK

The existing electricity metering system is costly and dumb as compared to smart meters, a meter reader comes by once a month and reads off the number, reading them manually very time consuming. In many cases the meter's reading is photographed using a camera with a tele-lens. The digital photo is then inspected at a central location, by a person who enters the number into a computer. In some areas, the meter reader must walk to each meter, which takes a lot of staff time.

A smart meter is a logical successor of the mechanical electricity meter, just as the pick-up, the dial phone and the typewriter are replaced with digital, more intelligent alternatives.

Smart meters transmit energy usage information to utilities via communication networks to help monitor electricity delivery and track power consumption. They allow the customers to track their own energy use on the Internet and/or with third-party computer programs.

Planning for proper data interfaces of the Smart Meter System and the utility legacy systems is imperative. An interface connects the smart meter to home appliances or a home display.

The electricity meter communicates by means of a modem. An important characteristic is the communication infrastructure used by the smart meter for this communication. Amongst the possibilities are Power Line Carrier (PLC, using the existing electricity grid); a wireless modem (GSM of GPRS) or an existing permanent internet connection (ADSL).

The two-way nature of Smart Meter Systems can allow forming Smart grid and enabling sending commands to operate grid infrastructure devices, such as distribution switches, to provide a more reliable energy delivery system in turn implementing Distributed automation.

An advanced metering infrastructure offers more than just reading and controlling smart meters. It can be seen as a dedicated gateway to the customer's home, offering additional energy related services. It can be used both for demand response (stimulate the customer to change his energy behavior) and demand side management (direct control of household appliances such as the washing machine or the air conditioner). In relation to local generation of electricity (micro-CHP), it offers the possibility to realize a virtual power plant.

III. PROPOSED SYSTEM

M2M uses a device (such as sensor or meter) to capture an event (such as temperature, inventory level, etc.), which is relayed through a network (wireless, wired or hybrid) to an application that translates the captured event into meaningful information.

The proposed system is hardware and software combined. The proposed system Hardware is composed of Sensor unit microcontroller board, GPRS modem & Monitoring unit.

In order to provide the remote monitoring of energy consumption i.e. to communicate the energy consumption of one machine to another machine, the proposed metering system is based on web server technology which uses GPRS Modem for the wireless data transmission between the microcontroller based embedded device and monitoring Unit.

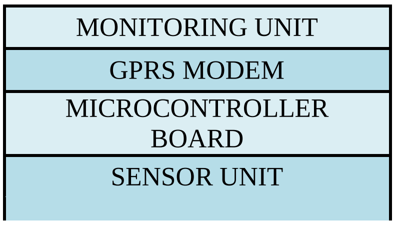

Fig. 1. Layered Diagram Representation

The system will be low powered and secured as it does not require continuous kind of monitoring. The system will provide updated information regarding energy consumption whenever requests come from authenticated user.
It comprises of Wattmeter (sensor unit) as the system needs to measure energy consumption. The consumption of bulb is being sensed by the wattmeter and send to ARM7 (microcontroller board) in form of digital pulses. The controller will then send the received data to GPRS modem through Universal Asynchronous Receiver/Transmitter (UART) interface.
The data would be stored onto a database over the internet required for web Server to plot and display the consumption.

IV. SYSTEM ARCHITECTURE

The architecture of proposed system can be seen in Fig. 2.

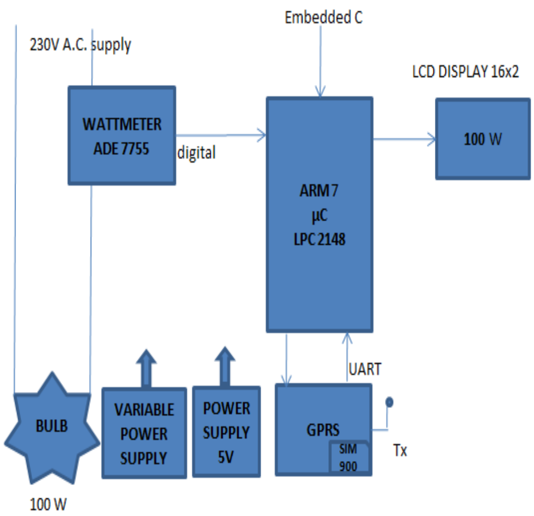

Fig. 2. Smart Meter System Architecture

As shown in Fig. 3. The frequency output CF is connected to an MCU counter or port, which counts the number of pulses in a given integration time that is determined by MCU internal timer.

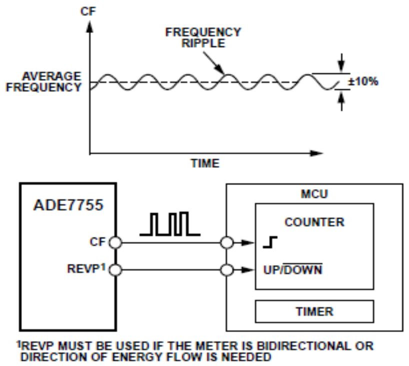

Fig. 3. Interfacing ADE to MCU

The easiest way to interface the ADE7755 to a microcontroller is to use the CF high frequency output with the output frequency scaling set to 2048 × F1, F2. This is done by setting SCF = 0 and S0 = S1 = 1. With full-scale ac signals on the analog inputs, the output frequency on CF is approximately 5.5 kHz. The average power proportional to the average frequency is given by:

Average Frequency == Average Active Power = Counter/timer

The energy consumed during an integration period is given by:
Energy = Average power x Time = Counter/timer

For the purpose of calibration, this integration time can be 10 seconds to 20 seconds to accumulate enough pulses to ensure correct averaging of the frequency. In normal operation, the integration time can be reduced to 1 second or 2 seconds depending, for example, on the required update rate of a display. With shorter integration times on the MCU, the amount of energy in each update may still have some small amount of ripple, even under steady load conditions. However, over a minute or more, the measured energy has no ripple.
The GPRS modem will play most important role of communicating data between the smart device & system.
The Modem can be directly interface with 5V microcontrollers like PIC, AVR, 8051 Derivatives, Arduino3 and 3V3 Microcontrollers like ARM, ARM Cortex XX etc. As per Fig. 4. Only 2 connections are required to use the modem. Connect RX pin of the modem to the TX pin of the microcontroller and TX pin of the modem to Microcontroller's RX pin. The connected power supply (4.2v to 12v dc) should be capable of handling current up to 1A. The modem automatically sets to the baud rate of the first command sent by the host system as it gets turned ON.

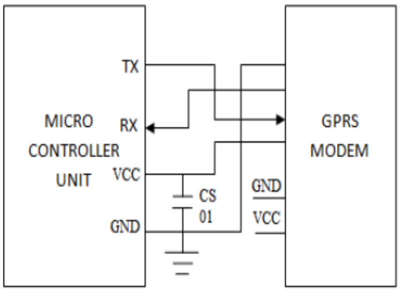

Fig. 4. GPRS Modem interfacing with MCU

In order to know the connection status of GPRS with the monitoring Module (Fig. 5.) of household appliance of each client, the VB graphical interface of connection status was designed for this thesis. Users can set related settings of USB communication port such as number of communication port, data transmission baud rate, transmitting data size and number of stop bits.

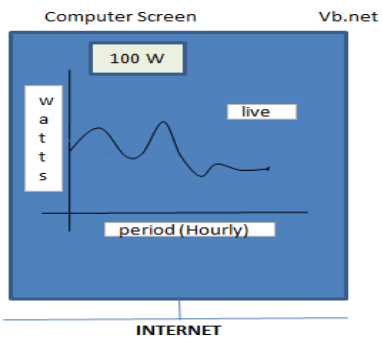

Fig. 5. Monitoring Module

In household appliance node labeled area of GPRS, the interface allows user to know status of power consumption.

This makes possible to see how much energy is being used at different times of the day, week, month or year, which could help cut the energy usage and bills by adjusting their behavior.

It also implements analysis for the energy consumption by household appliances to draft out bill at end of set cycle period (Monthly).

V. Conclusion

Smart metering generally involves the installation of an intelligent meter at residential customers and a regular reading, processing and feedback of Consumption data to the customer.

By Realization of above proposed System one can monitor household energy consumption as well receive accurate billing for the Energy Usage. It can give insight into areas where the consumption should be controlled and thus serve Energy conservation.

Many advantages are attributed to smart metering, including lower metering cost, energy savings for residential customers, more reliability of supply, variable pricing schemes to attract new customers and easier detection of fraud.

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