

Wireless ARM-Based Automatic Meter Reading & Control System (WAMRCS)

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Abstract—In this paper we discuss about Wireless ARM Based Automatic Meter Reading with control system (WAMRCS). This System is used with 32 bit ARM microprocessor for reading power consumption & communicates this data to the utility server for power data processing. GPRS networks are used for communication with utility server in two – way communication link. Power data is used for various purposes such as bill management, for measurement of static power parameters etc. Control systems contains relay circuit, used for disconnection power supply when consumer fails to pay electricity bill in due time.

Index Terms—Automatic Meter Reading, ARM Based System, GPRS, Relay Control.

I. INTRODUCTION

Problem associates with traditional meter reading have been increased day by day, due to various reasons such as rapid growth in population, tedious location, environmental conditions etc. But with new developments of microcontroller, there are many improvements in automating various industrial aspects for reducing manual efforts. In traditional meter reading system in which utility usages are written on paper by workers, there is lot of chances of human errors. These will cost more to the utility company. Also there are chances that of unavailability of consumers during utility worker's visit for meter reading. In such cases, billing process will be pending & utility workers again require to visit to consumer. Going to each & every consumer's house & generating the bills is very labourious task & require lot of time. It becomes very much difficult in natural calamities specially in rainy season. Moreover it is also difficult for utility workers to find out unauthorized connections or malpractices carried out by consumers manually. This all will result in loss of revenue generation for utility company.

There are another type of customers also, for which not only continuous electricity is matter but also about quality of power is also matter. In

practical meter reading system, traditional meters does not provide more information about the same. There should be provision for power supply unstable / outage occurs to utility consumer's information to utility company for clearing the fault as quick as possible.

Also the development in the field of wireless technology along with microcontroller leads to unwrap the solution to many problems. The wireless media made the exchange of information fast, secured & more accurate. These wireless media, along with microcontroller or microprocessor leads to digital implementation which causes rapid utilization of devices such as computers & telecommunication devices. Communication media like GPRS, Internet are easily available everywhere. GPRS is widely used due to its advantages such as always on-line, high speed transmission & charged fee according to the amount of data transmitted. After considering all this GPRS advantages, It is also can be used for sending power parameters on automatic system of reading digital meter.

Considering all above pro & cons of traditional & automatic metering system, this study proposes a wireless ARM- based automatic meter reading & control system (WAMRCS). It uses Current & Power Transformer to read current & Voltage parameters of incoming electrical signal. After this, signal conditioning unit along with ARM-based embedded system (AES) is used to compute the power parameters. These computed power parameters are then sent to Utility company server through wireless communication method such as GPRS. Also data or signal from utility company server is received through wireless communication module to ARM based embedded system. (AES).

II WAMRCS System Architecture

WAMRCS System Architecture is as shown in fig 1. As shown in figure, WAMRCS is sub-divided in to five sub-parts viz:-

- A. Signal Sampling Unit (SSU)
- B. Relay Control Unit (RCU)
- C. ARM – Based Embedded System (AES)
- D. Wireless Communication Module (WCM)
- E. Utility Control Center (UCC)

A Signal Sampling Unit (SSU) –

The main problem of measuring analog quantities such as voltage & current is solved by using Power transformer (PT) & Current Transformer (CT). The analog quantity of voltage as well as current on the primary side of transformer is proportionally transformed on the secondary via power Transformer (PT) & Current Transformer (CT). Burden resistor is used along with CT for setting the desired voltage at the CT's Secondary Side. Along with Power Transformer (PT), Voltage divider is used to drop the voltage to limits of ARM operating voltage range. Finally filter is used to avoid any emf in DC signal, before passing this to ADC of ARM Controller.

B Relay Control Unit (RCU) –

This Unit consists of Proactive relay, breaker control circuit & breaker. It is an interrupting device used for fault interruption & load switching.

Relay Control Unit is used to shutting off the electric power supply when the signal from AES because due date is over. Electricity will resume automatically with the help of protective relay wired in series with breaker control circuit, so the breaker could be controlled. Depending upon the information received from remote stations, ARM processor can control the relay module to shut off or resume the electric power supply. This relay is driven by ARM processor.

C ARM – Based Embedded System (AES)

This is heart of the system. Conventional power measure instruments is not able to give required information about power quality. So in order to calculated Root Mean Square value of voltage and current, power factor, real power, reactive power and apparent power, it us appropriate to use microprocessor to design digital reading meter.

There are various microprocessor based digital power meters are available in laboratory & in market. These are basically bulky in size & having limited capabilities. Compare with this, ARM-based system occupies small space. It also supports most popular communication protocols. As far as ARM based system is concern, it is widely used in variety of network equipments, such as mobile phone and PDA, and become popular and cheaper. It's also having on chip 10 bit ADC of successive approximation type. In this each analog input has a

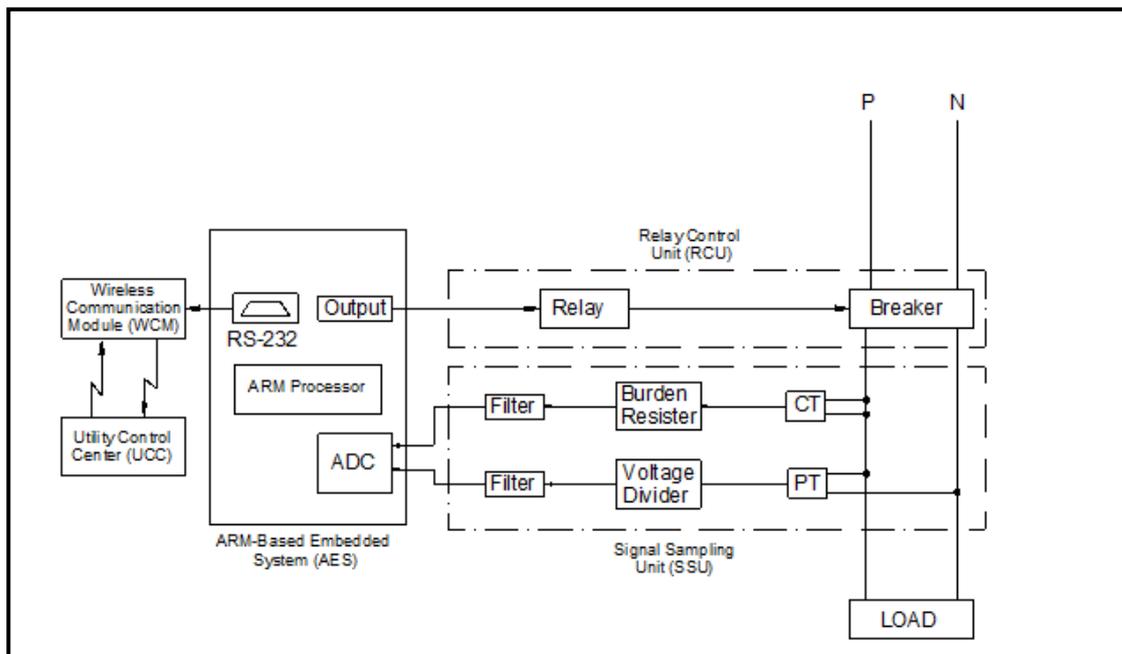


Figure 1 WAMRCS System Architecture

separate register to avoid interrupt handling & it is having global start command for both converter.

This study adopts LPC2148 ARM Processor for AES System. ARM based embedded system is having simple in operation compare to their counterparts. So software program development can be done in popular C Language.

Comparison between ARM & Microcontroller -

1. ARM executes almost all the instruction in only one cycle where as 8051 micro controller takes more than one cycles in almost all the instruction except register transfer.

Ex: Conditional jump takes 3 cycles for execution ex: DJNZ in 8051

2. ARM is RISC based architecture where as 8051 is a CISC but having less number of instructions as compared to ARM.

3. ARM is based on load store architecture i.e. data processing instruction can not access memory directly , data has to be stored in a register before processing where as 8051 can access memory directly.

4. ARM has conditional data processing instruction whereas 8051 does not.

D] Wireless Communication Module (WCM)

The Wireless Communication Module (WCM) in WAMRCS is the system is mainly composed of different subsystem such as - central monitoring station and GSM network. Central monitoring station is consist of GSM modem. The wireless remote communication between ARM Based Embedded System (AES) station and Utility Control Center (UCC) is done by the GSM network.

A GSM module assembles a GSM modem with standard communication interfaces like RS-232 (Serial Port), USB etc., so that it can be easily interfaced with a computer or a microcontroller based system. The power supply circuit is also built in such module that can be activated by using a suitable adapter.

The GSM Module used in project uses GSM network which offers GPRS data communications along with GSM services & mobile internet access. It also be integrated via standard RS-232 interfaces [16].

GSM Module in Wireless Communication Module (WCM) offers following features -

- Uses the extremely popular SIM 300 GSM module.

- Provides the industry standard serial RS232 interface.
- Provides serial TTL interface for easy and direct interface to microcontroller.
- Provides the industry standard serial RS232 interface.
- Provision for 3V lithium battery holder
- Can be used for GSM voice communications, data/Fax, SMS, GPRS and TCP/IP stack
- Can be controlled through standard AT Commands.

E] Utility Control Center (UCC)

Utility Control center (UCC) is the central sarvar used for information processing & data exchange between various AES systems through wireless communication module (WCM). UCC is located in Utility company. It is having Personal Computer (PC) used as a control sarvar along with required programs & storage media (generally Hard drive). UCC will read & collect power parameters form AES via communication network. UCC sarvar have following specification:-

- 2.4 GHz Intel Pentium III processor
- 512 Megabytes RAM
- 80 Gigabyte Hard Disk
- 15" LCD Monitor
- DVD-Rom Drive
- 100 Mbps. Network Connections
- Dot-matrix printer

For Simulation purpose, we uses a Visual Basic (VB) Graphical user Interface (GUI). VISUAL BASIC 6 is a high level programming language which evolved from the earlier DOS version called BASIC. Among many versions of Visual Basic that exist in the market, the most popular one and still widely used by many VB programmers is Visual Basic 6. With Visual Basic 6, you can create any program such as inventory management system , password cracker, investment calculator, slot machine, reversi, star war, tic tac toe and more.

In this Program, we created a Virtual server in VB showing all details of customer such as -

- Name of Customer
- Address of Customer
- Account Number
- Consumption Unit
- Last Date for Payment
- Billing status.

Utility Control Center (UCC) is connected with AES through GSM Module in WCM. It will receive the billing Units from ARM Based Embedded System. & UCC send the command signal to AES if Customer is fail to pay the bill in due date to cut off the power supply line to customer.

III Design of Software Architecture

The developing tool of the program design of central monitoring station is Visual Basic 6.0, and the software includes the controlling interface and initialization program of monitoring center, the program of accepting and sending short messages, data processing and preserving program. The most of important of those is the serial communication between the central monitoring center servers and GSM wireless communications module SIM900. Visual Basic 6.0 provides a serial communication control MSCComm which can facilitate the realization of serial communication.

The functions of AES software are measurements acquisition, relay control, tamper detection, AES setup, power parameters computation and database management. The AES software runs under the Real Time Operation system.

The software design tasks of the central monitoring station include sending instructions to remote monitoring stations (in the form of short message), accepting the monitoring data from the remote monitoring stations (in the form of short message), store and deal with database. Adopting VB to design the software of central monitoring station has many advantages. For example, it has a good man machine interface, it can provide serial communication control MSCComm which can facilitate realization of serial communication the programming method is very and the operation is simple, connecting to database and its management are very easy.

On the aspect of WAMRCS software, the embedded system uses RTX as operating system core. Developer can use c-language to program software and build it as executive file on personal computer beforehand. his executive file will be loaded into microprocessor of embedded system through RS-232 from PC and runs under RTX operating system.

Features of RTX Operating System:

- Royalty-free, deterministic RTOS with source code.
- Flexible Scheduling: round-robin, preemptive, and collaborative

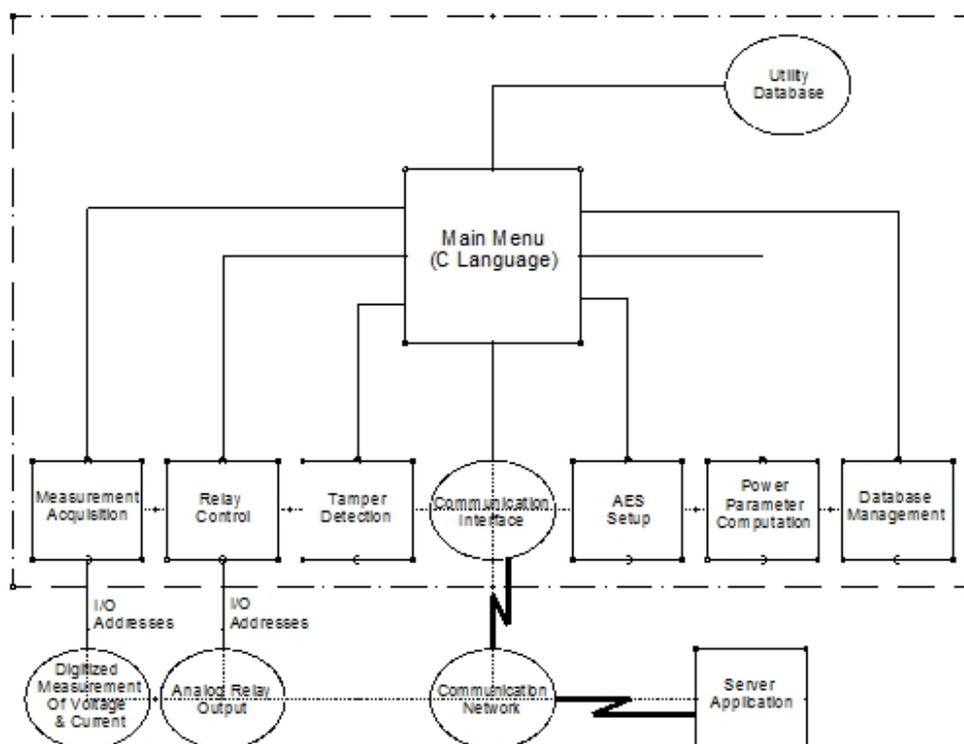


Figure 2: System Software Architecture

IV IMPLEMENTATION AND RESULT

The Proposed system is tested in place of conventional meter & achieved good results. Fig 3 to Fig 6 shows actual photographs of the proposed system. Here we consider if 100 watt load is ON for 10sec then 1 Unit is calculated for demo purpose. Same unit calculation is done for 40W load as , if 40W load is ON for 30 sec then 1 unit is calculated.

ARM-Based Embedded System (AES) is interfaced with GSM Module, Signal Conditioning unit & Relay Control Unit. For demonstration purpose, 100 Watt bulb is used as a load to examine our system. The bulb is connected to load & Signal conditioning unit, which is used to measure the average real power information. This test is performed and power consumption is calculated. During the test, voltage & currents parameters are read for specified time interval to generate the bill. Based on this reading , Power is also calculated & display on LCD in ARM - Based Embedded system (AES) . After due date, the ARM- Based Embedded System turned the off the bulb through relay control unit, which proves the accuracy of our system in terms of the power Calculation & remote controlling.

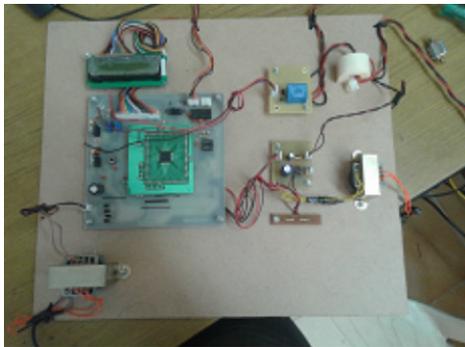


Figure 3:Wireless Automatic Meter Reading & Control System (WAMRCS) Setup.

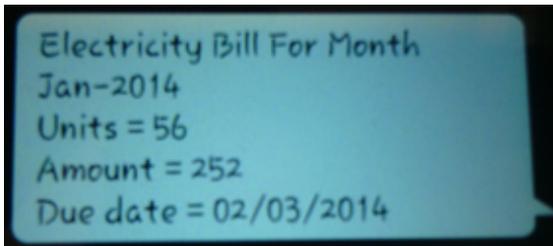


Figure 4: SMS generated by WAMRCS System showing Billing details.

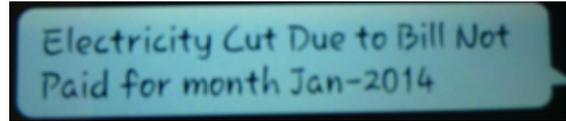


Figure 5: SMS generated by Utility Server showing Electricity cut information due bill not paid.

Table1: Unit Consumption for various Load.

Load	No.of Hours	Unit Consumed
		Proposed System
40 Watt	0.28	56
100Watt	0.28	168

For demo purpose we assume that for 100W load for 10 sec, 1 unit is consumed. From Table 1,we can say that ,if the load is disconnected immediately after the due date then there will not be any loss of energy consumption. But it s not possible through manual operating system This can be achieved by using to this proposed system which automatically disconnects the load when the user not paid the bill in the specified time.So by using proposed system , most of the problem associated with the conventional systems are eliminated.

V CONCLUSION

By using this embedded system along with GSM module, provide automation for electrical distribution system. Along with this , it provides better accuracy in meter reading , better control over distribution & management.

Same system can be expanded for multipurpose like water & natural gas. Also many users can share same system.

REFERENCES

- [1] Patrick, A., Newbury, J., and Gargan, S., "Two-way communications systems in the electricity supply industry," IEEE Trans. Power Delivery, Vol.13, pp. 53 - 58, Jan. 1998.
- [2] Miura, N., Sato, H., Narita, H., and Takaki, M., "Automatic meter-reading system by power line carrier communications," in Proc. C 1990 IEEE Trans Generation, Transmission and Distribution, Vol. 137 Issue: 1, pp. 25 - 31.
- [3] Donovan, D., "Cellular control channel communications for distribution automation applications," in Proc. 2001 IEEE/PES Transmission and Distribution Conference and Exposition, Vol.2 , pp. 982 -984.
- [4] Anderson, H.R., "Measured data transmission performance for AM broadcast-VHF radio distribution 2000 IEE 3G

Mobile Communication Technologies Conference, pp. 426-430.

- [5] Chakrabarti, S. and Mishra, A., "A network architecture for global wireless position location services," in Proc. 1999 IEEE Communications Conference, Vol.3, pp. 1779-1783.
- [6] Constantinos F. Grecas, Sotirios I. Maniatis, and Iakovos S. Venieris, "GIP: an infrastructure for mobile intranets deployment, Wireless Networks," Kluwer Academic Publishers, Vol.9, Issue 4, 2003, pp. 321-330.
- [7] Chih-hsien Kung and Devaney, M.J., "Multirate digital power metering," Instrumentation and Measurement Technology Conference, 1995, pp. 179-182.
- [8] C.P. Young and M.J. Devaney, "Digital power metering manifold," in Proc. 1997 IEEE Instrumentation and Measurement Technology Conference, Vol.2, pp. 1403-1406.
- [9] WISCORE Inc., <http://www.wiscore.com/>, NET-Start production information.
- [10] Siemens Inc., MC35 Hardware Interface Description, Version: 05.00, DocID: MC_35_HD_01_V05.00, 2002.
- [11] Arcturus Networks Inc., <http://www.muClinix.org>, Embedded Linux/Microcontroller Project.
- [12] Misra, R.B. and Patra, S., "Tamper detection using neuro-fuzzy logic [static energy meters]," in Proc. 1999 IEE Metering and Tariffs for Energy Supply Conference, pp. 101-108.
- [13] <http://www.tnb.com.my/residential/billing/penalties-and-charges.html>, access date 24/02/2012
- [14] <http://www.tnb.com.my/residential/billing/connection-disconnectionof-supply.html>, access date 24/02/2012