IOT Based Energy Meter Billing And Monitoring System

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Abstract- *The system is fully Internet of Things (IOT) based and highly desirable in field of energy. In this system consumer can do power management by knowing energy usage time to time. The customer needs to pay the bill on schedule, if couldn't, the electric power connectivity can be turned off autonomously from the distant host. The abstract explains the modelling and working of different units of the system and also discussed the basic components and their functions such that IOT and its working, microcontroller(ARM7-LPC2138) and its architecture, USB to TTL Converter and its features, GSM system, Relay and LCD display and its interfacing with microcontroller.*

I. INTRODUCTION

The world is changing towards automatic wireless technologies, which prefer not only reducing human efforts but is helping in making systems automatic and efficient. A system is said to be intelligent when it can decide what to do without any instruction and can work automatically. An Electric or Energy meter measures the total electrical energy in units used by the appliances which consume electrical energy from the main power supply.

Electromechanical and Electronic meter are two types of meter Available in the market to measure the unit consumption. Electromechanical meters are commonly used in village areas, where the uses of modern technology are not as high as it is in cities. Electromechanical meters have become out of date nowadays. Electronic meters replace electromechanical meters. This meter consists of LCD to display the reading. Calibration Led is used on the meter which shows the units consumed. Manpower is required to read the meter and note down the reading.

The reading on the meter is increasing which is used to generate the electricity bill. An IOT Based Smart Electricity Meter and billing System does the same task without human efforts. IOT Based SEM system is controlled using Arm LPC2148, which is a microcontroller board.

The purpose behind choosing this board is its efficiency and memory. It is more efficient in terms of memory . The data obtained is then sent to the cloud through the internet. Data obtained can be easily sent wirelessly over long distance without any noise disturbance using the internet. As the data is directly sent to the cloud there is no occurrence of range and distance problem and is highly accurate and efficient because of no human interference. Other wireless technologies such as GSM. have limited range thus cannot be used over very long distances effectively.

This project envisages the use internet and the concept of IOT by which the base station, as well as users, remain updated with the current consumed units, changing the present problems faced by the electricity board and the user.

EXISTING SYSTEM:

This system we have to existing the usage power by energy meter. Commonly we have a tendency to don't knowledge power we have a tendency to are victimization the daily and the way abundant value it's up to month ending. Energy meter we have to developed to homes and how much power usages to calculate the watts same as every month ending to see how much power usages in our homes to calculate watts and to electricity bill.

PROPOSED SYSTEM:

These projected system is to observe the usage power by victimization the energy meter. commonly we have a tendency to don't knowledge power we have a tendency to are victimization the daily and the way abundant value it's up to month ending. However during this project we can we will we are able to knowledge power we have a tendency to are victimization daily or each hour.

Therefore we are able to cut back the usage of power by turn out the hundreds utilized in the homes or trade. during this project the energy meter sends the information for each day or all hour by victimization the RTC, therefore we

are able to management the usage of the ability by turn out masses during this project user will management masses with mobile through the Wi-Fi communications and internet based mostly things. Here we are able to observe the daily usage of the ability and value by victimization the RTC, if the electricity load was high we have a tendency to turn out the spare masses within the home and that we will management any load with the web of things and that we will operate remotely.

Embedded Systems:

An embedded system is a computer system designed to perform one or a few dedicated functions often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer (PC), is designed to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today.

Embedded systems are controlled by one or more main processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task, which may require very powerful processors. For example, air traffic control systems may usefully be viewed as embedded, even though they involve mainframe computers and dedicated regional and national networks between airports and radar sites. (Each radar probably includes one or more embedded systems of its own.)

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Physically embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. In general, "embedded system" is not a strictly definable term, as most systems have some element of extensibility or programmability.For example, handheld computers share some elements with embedded systems such as the operating systems and microprocessors which power them, but they allow different applications to be loaded and peripherals to be connected.

Moreover, even systems which don't expose programmability as a primary feature generally need to support software updates.

On a continuum from "general purpose" to "embedded", large application systems will have subcomponents at most points even if the system as a whole is "designed to perform one or a few dedicated functions", and is thus appropriate to call "embedded". A modern example of embedded system is shown in figure

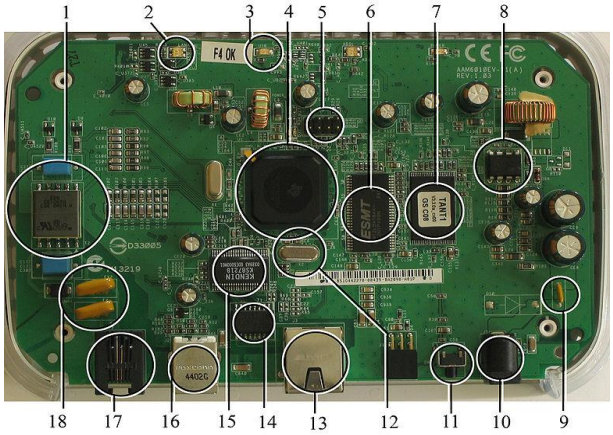


Fig 1.1 :A modern example of embedded system

Labelled parts include microprocessor (4), RAM (6), flash memory (7).Embedded systems programming is not like normal PC programming. In many ways, programming for an embedded system is like programming PC 15 years ago. The hardware for the system is usually chosen to make the device as cheap as possible. Spending an extra dollar a unit in order to make things easier to program can cost millions. Hiring a programmer for an extra month is cheap in comparison.

History:

In the earliest years of computers in the 1930–40s, computers were sometimes dedicated to a single task, but were far too large and expensive for most kinds of tasks performed by embedded computers of today. Over time however, the traditional electromechanical sequencers, via solid state devices, to the use of computer technology.

One of the first recognizably modern embedded systems was the Apollo Guidance Computer, developed by Charles Stark Draper at the MIT Instrumentation Laboratory. At the project's inception, the Apollo guidance computer was considered the riskiest item in the Apollo project as it employed the then newly developed monolithic integrated circuits to reduce the size and weight.

An early mass-produced embedded system was the Automatics D-17 guidance computer for the Minuteman missile, released in 1961. It was built from transistor logic and had a hard disk for main memory.

When the Minuteman II went into production in 1966, the D-17 was replaced with a new computer that was the first high-volume use of integrated circuits.

Tools:

Embedded development makes up a small fraction of total programming. There's also a large number of embedded architectures, unlike the PC world where 1 instruction set rules, and the Unix world where there's only 3 or 4 major ones. This means that the tools are more expensive. It also means that they're lowering featured, and less developed. On a major embedded project, at some point you will almost always find a compiler bug of some sort.

Debugging tools are another issue. Since you can't always run general programs on your embedded processor, you can't always run a debugger on it. This makes fixing your program difficult. Special hardware such as JTAG ports can overcome this issue in part.

Resources:

To save costs, embedded systems frequently have the cheapest processors that can do the job. This means your programs need to be written as efficiently as possible. When dealing with large data sets, issues like memory cache misses that never matter in PC programming can hurt you.

Luckily, this won't happen too often- use reasonably efficient algorithms to start, and optimize only when necessary. Of course, normal profilers won't work well, due to the same reason debuggers don't work well.

Memory is also an issue. For the same cost savings reasons, embedded systems usually have the least memory they can get away with.

That means their algorithms must be memory efficient (unlike in PC programs, you will frequently sacrifice processor time for memory, rather than the reverse). It also means you can't afford to leak memory. Embedded applications generally use deterministic memory techniques and avoid the default "new" and "malloc" functions, so that leaks can be found and eliminated more easily.

Other resources programmers expect may not even exist. For example, most embedded processors do not have hardware FPUs (Floating-Point Processing Unit). These resources either need to be emulated in software, or avoided altogether.

Explanation of Embedded Systems:

Software Architecture:

There are several different types of software architecture in common use.

Simple Control Loop:

In this design, the software simply has a loop. The loop calls subroutines, each of which manages a part of the hardware or software.

Interrupt Controlled System:-

Some embedded systems are predominantly interrupt controlled. This means that tasks performed by the system are triggered by different kinds of events.

An interrupt could be generated for example by a timer in a predefined frequency, or by a serial port controller receiving a byte. These kinds of systems are used if event handlers need low latency and the event handlers are short and simple.

Usually these kinds of systems run a simple task in a main loop also, but this task is not very sensitive to unexpected delays. Sometimes the interrupt handler will add longer tasks to a queue structure. Later, after the interrupt handler has finished, these tasks are executed by the main loop. This method brings the system close to a multitasking kernel with discrete processes.

Cooperative Multitasking:

A non-preemptive multitasking system is very similar to the simple control loop scheme, except that the loop is hidden in an API. The programmer defines a series of tasks, and each task gets its own environment to “run” in. When a task is idle, it calls an idle routine, usually called “pause”, “wait”, “yield”, “nop” (stands for no operation), etc.The advantages and disadvantages are very similar to the control loop, except that adding new software is easier, by simply writing a new task, or adding to the queue-interpreter.

Primitive Multitasking:

In this type of system, a low-level piece of code switches between tasks or threads based on a timer (connected to an interrupt). This is the level at which the system is generally considered to have an "operating system" kernel. Depending on how much functionality is required, it introduces more or less of the complexities of managing multiple tasks running conceptually in parallel.

As any code can potentially damage the data of another task (except in larger systems using an MMU) programs must be carefully designed and tested, and access to shared data must be controlled by some synchronization strategy, such as message queues, semaphores or a non-blocking synchronization scheme.

Because of these complexities, it is common for organizations to buy a real-time operating system, allowing the application programmers to concentrate on device functionality rather than operating system services, at least for large systems.

Smaller systems often cannot afford the overhead associated with a generic real time system, due to limitations regarding memory size, performance, and/or battery life.

Microkernels And Exokernels:

A microkernel is a logical step up from a real-time OS. The usual arrangement is that the operating system kernel allocates memory and switches the CPU to different threads of execution. User mode processes implement major functions such as file systems, network interfaces, etc.

In general, microkernels succeed when the task switching and intertask communication is fast, and fail when they are slow. Exokernels communicate efficiently by normal subroutine calls. The hardware and all the software in the system are available to, and extensible by application programmers. Based on performance, functionality, requirement the embedded systems are divided into three categories:

Stand Alone Embedded System:

These systems takes the input in the form of electrical signals from transducers or commands from human beings such as pressing of a button etc.., process them and produces desired output. This entire process of taking input, processing it and giving output is done in standalone mode. Such embedded systems comes under stand alone embedded systems

Eg: microwave oven, air conditioner etc.

Real-time embedded systems:

Embedded systems which are used to perform a specific task or operation in a specific time period those systems are called as real-time embedded systems. There are two types of real-time embedded systems.

Hard Real-time embedded systems:

These embedded systems follow an absolute dead line time period i.e.., if the tasking is not done in a particular time period then there is a cause of damage to the entire equipment.

Eg: consider a system in which we have to open a valve within 30 milliseconds. If this valve is not opened in 30 ms this may cause damage to the entire equipment. So in such cases we use embedded systems for doing automatic operations.

Soft Real Time embedded systems:

These embedded systems follow a relative dead line time period i.e.., if the task is not done in a particular time that will not cause damage to the equipment.

Eg: Consider a TV remote control system ,if the remote control takes a few milliseconds delay it will not cause damage either to the TV or to the remote control. These systems which will not cause damage when they are not operated at considerable time period those systems comes under soft real-time embedded systems.

Network communication embedded systems:

A wide range network interfacing communication is provided by using embedded systems.

Consider a web camera that is connected to the computer with internet can be used to spread communication like sending pictures, images, videos etc.., to another computer with internet connection throughout anywhere in the world.

Whenever a person comes near the door, it captures the image of a person and sends to the desktop of your computer which is connected to internet. This gives an alerting message with image on to the desktop of your computer, and then you can open the door lock just by clicking the mouse. Fig: 2.2 show the network communications in embedded systems.

Fig 1.2: Network communication embedded systems

Microcontrollers classification:

The microcontrollers are characterized according to bus-width, coaching set, and reminiscence structure. For an equivalent circle of relatives, there are also bureaucracy with distinctive assets. The categories of microcontroller is proven in determine, they may be characterized with the aid of their bits, memory layout, reminiscence/devices and practise set. Let's talk in quick regarding it.

Classification based on Bits

The bits in microcontroller are classified into 8-bits, 16-bits and 32-bits microcontroller.

8- Bit Microcontroller-

In 8-bit microcontroller the inner bus is 8-bit. When in-house bus MCU is 8-bit bus then the ALU carries out the logic & arithmetic operations on a computer memory unit at an order. It is 8-bit micro-controller. The examples of 8-bit microcontrollers are 8051, PIC and Motorola families.

16 bit Microcontroller:

A sixteen bit Microcontroller consists of a sixteen bit bus and therefore the ALU performs arithmetic and logic operations on the sixteen bit quantity. It provides bigger preciseness and performance as compared to eight bit MCU.

For example eight bit microcontrollers will solely use eight bits, leading to a final vary of 0×00 – 0xFF (0-255) for each cycle.

In distinction, 16 bit microcontrollers with its 16 bit knowledge range encompasses a vary of 0×0000 – 0xFFFF (0-65535) for each cycle.

An extended timer most extreme value will probably influence be helpful in bound applications and circuits. It will mechanically care for 2 sixteen bit numbers. Some samples of 16-bit microcontroller square measure 16-bit MCUs square measure extended 8051XA, PIC2x, Intel 8096 and Motorola MC68HC12 families.

32-bit microcontroller:

It uses the 32-bit directions to perform the arithmetic and logic operations. When in-house bus for the information transmittal operates in MCU is 32 buses then the ALU carries out logic and arithmetic functions on quantity words of 32 bits at the orders. The MCU is 32-bit micro-controller. These provide higher accuracy and performance as compared to the 16-bit MCUs.

These square measure utilized in mechanically controlled devices as well as implantable medical devices, engine management systems, workplace machines, appliances and different forms of embedded systems. Some examples are Atmel 251/intel family, PIC3x.

3.4 Classification based on Memory Devices:

The memory devices are categories into 2 kinds, they are

Embedded memory microcontroller:

Its encompasses a microcontroller unit that has all the purposeful blocks accessible on a chip is named an embedded microcontroller. It's hardware and package embedded into one unit. Very few or no further peripheral unit or system exists for process throughout the management or creating use of the peripheral and for instance, 8051 having I/O ports, serial communication, counters , timers and interrupts on the chip is an embedded microcontroller.

External Memory Microcontroller:

Its encompasses a microcontroller unit that has not all the purposeful blocks accessible on a chip, it's referred to as an external memory microcontroller. Its memory externally connected to the hardware.8031 microcontroller includes of a program memory that is interfaced externally to that.

Classification based on Instruction Set:

CISC: CISC could be a complex Instruction Set computer. It permits the coder to use one instruction in place of the many less complicated directions.

RISC: The reduced instruction set computing is stands for Reduced Instruction set Computer; this sort of instruction sets

reduces the look of chip for trade standards. It permits every instruction to control on any register or use any addressing mode and synchronic access of program and knowledge.

CISC: Mov AX, 4
RISC: Mov AX, 0
Mov BX, 2
Mov BX, 4
ADD BX, AX Mov
CX, 2
Begin
ADD AX, BX
Loop Begin

From on top of example, reduced instruction set computing systems shorten execution time by reducing the clock cycles per instruction and CISC systems shorten execution time by reducing the quantity of directions per program. The reduced instruction set computing provides an improved execution than the CISC.

Classification based on Memory design:

Memory design of microcontroller are 2 kinds, they're namely:

Harvard Memory design Microcontroller:

During this form of design, the microcontroller has totally different memory for program directions and knowledge. It consists of 2 separate buses for directions and knowledge.

Von Neumann Memory design Microcontroller:

During this form of design, the microcontroller has same memory for program directions and knowledge. It incorporates only one bus to hold each directions and knowledge.

Microcontrollers are digital integrated chips that contain the processor in addition because the memory embedded on an equivalent chip. They're largely utilized in embedded systems. Microcontrollers disagree from microprocessors in their design in addition as their functioning.

Totally different microcontrollers will be classified supported the quantity of instruction bits, memory design, and instruction set design and memory devices.

ARM 7 LPC2148:

The raise 16/32-bit ARM7TDMI-S microcontroller coaching board is specifically Designed to assist students to master the desired skills within the space of embedded systems. The kit is designed in such means that each one the potential options of the microcontroller are going to be simply used by the scholars.

The kit supports in system programming (ISP) that is finished through Serial port raise Board has new and advance choices which can provide user the freedom of implementing complicated logic utilized in the planning of Embedded Systems. The event Experience on the raise Board can pose a chance to stand out within the field of Embedded Systems.

Interrupt controller:

The Vectored Interrupt Controller (VIC) accepts all the interrupt request inputs and categorizes them as quick Interrupt Request (FIQ), vectored Interrupt Request (IRQ), and non-vectored IRQ as outlined via programmable settings. The programmable venture theme means that priorities of interrupts from the various peripherals can be dynamically allocated and changed. Brief interrupt request (FIQ) has the very great priority. If quite one request is allotted to FIQ, the VIC combines the requests to provide the FIQ sign to the ARM processor.

The fastest achievable FIQ latency is finished as soon as just one request is classified as FIQ; due to then the FIQ subprogram would not ought to department into the interrupt subprogram but will run from the interrupt vector vicinity.

If pretty one request is allocated to the FIQ class, the FIQ subprogram can browse a word from the VIC that identifies that FIQ supply(s) is (are) soliciting for AN interrupt. Vectored IRQs have the middle priority.

Sixteen of the interrupt requests will be allocated to the present elegance. Any of the interrupt requests will be allocated to any of the 16 vectored IRQ slots, among that slot zero has the very great precedence and slot fifteen has very cheap. Non-vectored IRQs have very reasonably-priced priority. The VIC combines the requests from all the vectored and non-vectored IRQs to offer the IRQ sign to the ARM processor.

The IRQ subprogram will begin with the aid of studying a sign up from the VIC and leaping there. If any of the vectored IRQs square measure unfinished, the VIC presents the cope with of the highest-precedence asking for IRQs subprogram, otherwise it affords the cope with of a

default recurring it truly is shared by means of all the non-vectored IRQs.

The default habitual will browse some other VIC check in to check what IRQs rectangular measure energetic.Each laptop peripheral has one interrupt line related to the Vectored Interrupt Controller but may have many internal interrupt flags. Individual interrupt flags might also represent quite one interrupt supply.

Fast widespread reason parallel I/O (GPIO):

Device pins that don't appear to be connected to a selected peripheral perform square measure controlled via the GPIO registers. Pins is also dynamically organized as inputs or outputs. Separate registers allow setting or clearing any sort of outputs at the identical time. The well worth of the output sign in is also browse back, moreover because the present day state of the port pins. LPC2141/42/forty four/forty six/forty eight introduces extended GPIO features over preceding LPC2000 gadgets:

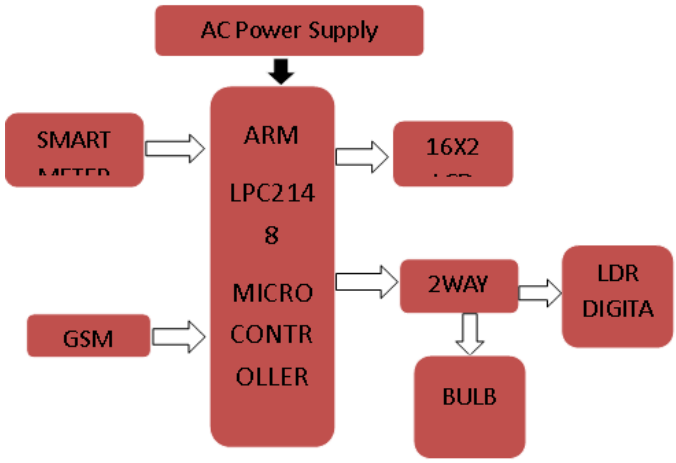
- GPIO registers square degree settled to the ARM native bus for the fastest conceivable I/O temporal arrangement.
- Mask registers permit treating units of port bits as a gaggle, going opportunity bits unchanged.
- All GPIO registers square degree pc reminiscence unit to be had.
- Entire port worth will be written in a single coaching.
- Bit-stage set and clear registers allow one instruction set or far from any sort of bits in one port.
- Direction management of man or woman bits.
- Separate control of output set and clear.
- All I/O default to inputs when reset.

Advantages Of using a Microcontroller Over Microprocessor:

A clothier can use a Microcontroller to

- Gather enter from severa sensors
- Process this input into a collection of actions
- Use the output mechanisms at the Microcontroller to try and do one component useful
- RAM and storage square measure intrinsic inside the megahertz

BLOCK DIAGRAM:



HARDWARE COMPONENTS:

- Micro controller LPC2148
- Smart Meter.
- LCD
- 2 Way Relay Module
- GSM 800A
- Light
- Ldr digital circuit module

Power Supply:

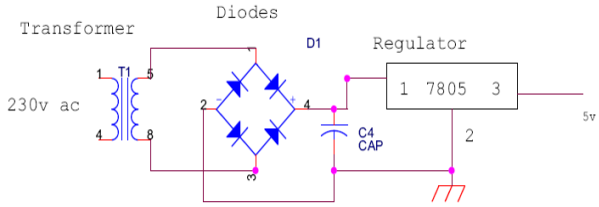


Figure Power Supply

Power provides unit consists of following units:

i) Step down Transformer (Electrical device).
ii) Rectifier unit
iii) Input filter
iv) Regulator unit
v) Output filter

Step-down Transformer (Electrical device):

The Step down electrical device is employed to step down the maximum offer voltage from 230V AC to lower price. This 230 AC voltage can not be used immediately, so it is stepped down. The electric tool consists of primary and

secondary coils. To cut back or step down the voltage, the electrical device is meant to include much less style of turns in its secondary center.

The output from the secondary winding is moreover AC undulation. So the conversion from AC to DC is critical. This conversion is achieved via mistreatment the Rectifier Circuit/Unit. Step down transformers will step down incoming voltage that permits you to possess the proper voltage input for your electrical wants. For instance.

If our instrumentality has been given for input voltage of twelve volts, and therefore the main power provide is 230 volts, we are going to want a step down electrical device that decreases the incoming electrical Voltage to be compatible together with your twelve volt instrumentality.

Advantages Disadvantages and Applications

Advantages:

1) It is used for real time monitoring of energy consumption.
2) We can save the electrical energy.
3) Monitoring day to day activity usage of electricity from anywhere in the world

Disadvantages:

1) It is very difficult to implement in commercial appliances
2) It is very expensive

Applications:

It is used for real time monitoring and consumptions of all electrical appliances

II. FUTURE SCOPE

The system provides only monitoring the sensor values but we can't control the devices with respective sensors. In future scope we can do both i.e. Monitoring as well as controlling the appliances. By implementing this concept we can use in several appliances like agriculture, Health monitoring etc.

III. CONCLUSION

It's using home application connecting relay/ac bulb the same time we are connecting GSM module and we write the code in such manner to WIFI communicate with the microcontroller and perform the specific task. The GSM module is interfaced with micro controller which is used to measure the corresponding data and WIFI monitor the information through web site. The system can also view the data from a mobile phone, hardware connation successfully.

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