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Smart Water Monitoring System Using Wireless Sensor Network at Home/Office

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Abstract—

Project is used to find exact home information and to provide instant across the home. This involves some sensors, LCD display, GSM and ARM processor. All the sensors will give analog output but our processor will accept only the digital data. So we have to connect all the sensors to the ADC channel pins which are inbuilt to the processor.LCD will be on home display purpose. GSM module will contains a Subscriber Identity Module (SIM) user can communicate with this SIM Number. When the particular command activated or given by the user, immediately the corresponding sensor will activates and reads the present reading and immediately sends results to the same user mobile and displays in the LCD panel in the home. Immediately user will take the necessary action if required. Here we are using total seven sensors to monitor the home condition. Those are Temperature, Humidity, Soil moisture, Leaf sensor, PH sensor, Level sensor, Phase sensor. All these devices are connected to the ARM processor. GSM is used for communication purpose, with the help of AT (attention) Commands we can communicate with the components. For soil module and level sensing applications we are using motors. One motor is used to store water and another is for releasing the stored water into the soil.

1. INTRODUCTION

Water is a limited resource and is essential for agriculture, industry and for creatures existence on earth including human beings. Lots of people don't realize the true importance of drinking enough water every day. More water is wasted by many uncontrolled ways. This problem is quietly related to poor water allocation, inefficient use, and lack of adequate and integrated water management. Therefore, efficient use and water monitoring are potential constraint for home or office water management system. Every living thing on earth needs water to survive. Human bodies are made up of more than 60 percent water. We use clean water to drink, grow crops for food, operate factories, and for swimming, surfing, fishing and sailing. Water is vitally important to every aspect of our lives. By using water monitoring system, we avoid the water wastage, power consumption. Water monitoring day was established in 2003 by America's clean water foundation as a global educational outreach program that aims to build public awareness and involvement in protecting water resources around the world. World water monitoring day is celebrated on September 18. Tank Water Level Monitoring, is used to avoid overflowing and intimate level of water in the tank.

Water controlling system implementation makes potential significance in home applications. The existing automated method of level detection is described and that can be used to make a device on/off. Moreover, the common method of level control for home appliance is simply to start the feed pump at a low level and allow it to run until a higher water level is reached in the water tank. This is not properly supported for adequate controlling system. Besides this, liquid level control systems are widely used for monitoring of liquid levels, reservoirs, silos, and dams etc.

EMBEDDED SYSTEMS:

An embedded system is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few predefined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, benefiting from economies of scale.

Embedded System is a combination of hardware and software used to achieve a single specific task. An embedded system is a microcontroller-based, software driven, reliable, real-time control system, autonomous, or human or network interactive, operating on diverse physical variables and in diverse environments and sold into a competitive and cost conscious market. An embedded system is not a computer system that is used primarily for processing, not a software system on PC or UNIX, not a traditional business or scientific application. High-end embedded & lower end embedded systems. High end embedded system Generally 32, 64 Bit Controllers used with OS. Examples Personal Digital Assistant and Mobile phones etc. Lower end embedded systems Generally 8, 16 Bit Controllers used with an minimal operating systems and hardware layout designed for the specific purpose. Examples Small controllers and devices in our everyday life like Washing Machine, Microwave Ovens, where they are embedded in.

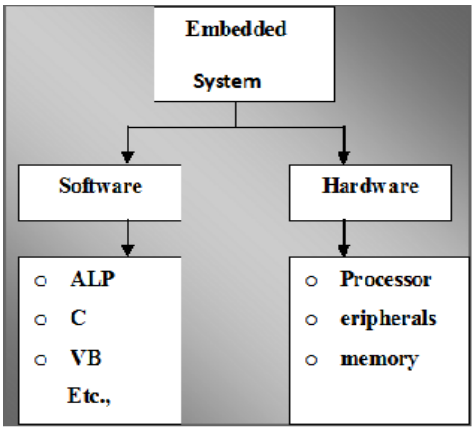

Fig1.1: Block diagram of Embedded System

Software deals with the languages like ALP, C, and VB etc., and Hardware deals with Processors, Peripherals, and Memory.

Memory: It is used to store data or address.

Peripherals: These are the external devices connected

Processor: It is an IC which is used to perform some task

1.1The Embedded System Design Cycle

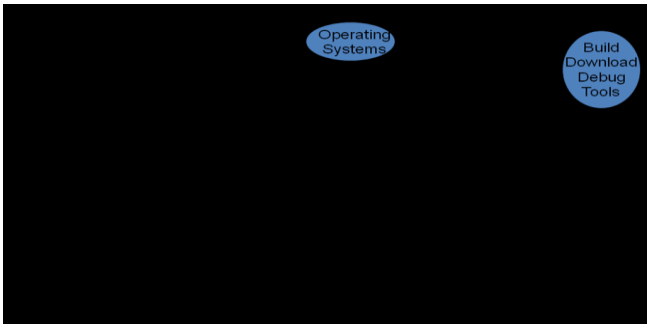

Fig. 1.2: Embedded System Design Calls

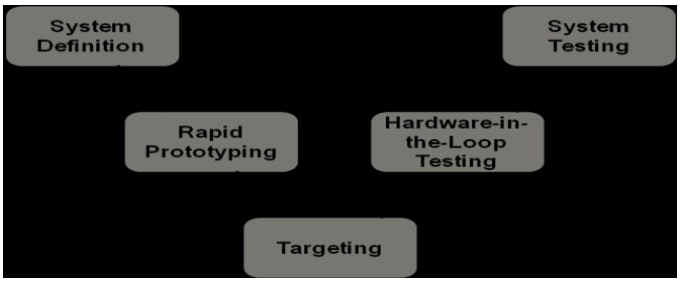

Fig.1.3: V Diagram

In this place we need to discuss the role of simulation software, real time systems and data acquisition in dynamic test applications. Traditional testing is referred to as "static" testing where functionality of components is tested by providing known inputs and measuring outputs. Today there is more pressure to get products to market faster and reduce design cycle times. This has led to a need for "dynamic" testing where components are tested while in use with the entire system either real or simulated. Because of cost and safety concerns, simulating the rest of the system with real time hardware is preferred to testing components in the actual real system.

The diagram shown in 1.3 is the "V Diagram" that is often used to describe the development cycle. Originally developed to encapsulate the design process of software applications, many different versions of this diagram can be found to describe different product design cycles. Here we have shown one example of such a diagram representing the design cycle of embedded control applications common to automotive, aerospace and defense application.

1.2. Characteristics of Embedded System

1. An embedded system is any computer system hidden inside a product other than a computer.
2. There will encounter a number of difficulties when writing embedded system software in addition to those we encounter when we write applications

a. **Throughput**: Our system may need to handle a lot of data in a short period of time.

b. **Response :** Our system may need to react to events quickly

c. **Testability:** Setting up equipment to test embedded software can be difficult

d. **Debug-ability:** Without a screen or a keyboard, finding out what the software is doing wrong (other than not working) is a troublesome problem

e. **Reliability:** Embedded systems must be able to handle any situation without human intervention

f. **Memory space:** Memory is limited on embedded systems, and you must make the software and the data fit into whatever memory exists

g. **Program installation:** You will need special tools to get your software into embedded systems

h. **Power consumption:** Portable systems must run on battery power, and the software in these systems must conserve power

i. **Processor hogs:** Computing that requires large amounts of CPU time can complicate the response problem

j. **Cost:** Reducing the cost of the

hardware is a concern in many embedded system projects; software often operates on hardware that is barely adequate for the job.

3. Embedded systems have a microprocessor/microcontroller and a memory. Some have a serial port or a network connection. They usually do not have keyboards, screens.

1.3. Applications of Embedded System

1. Manufacturing and process control
2. Construction industry
3. Transport
4. Domestic service
5. Communications
6. Office systems and mobile equipment
7. Banking, finance and commercial
8. Medical diagnostics, monitoring and life support
9. Testing, monitoring and diagnostic systems

2.1 ARM based LPC2148

2.1.1 Introduction

The LPC2148 microcontrollers are based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. 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 code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2141/2/4/6/8 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. A blend of serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTS, SPI, SSP to I2Cs and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive externalinterrupt pins make these microcontrollers particularly suitable for industrial control andmedical systems.

2.1.2 Features

• 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.

• In-System/In-Application Programming (ISP/IAP) via on-chip boot-loader software. Single flash sector or full chip erase in 400 ms and programming of 256 bytes in 1 ms.

• Embedded ICE RT and Embedded Trace interfaces offer real-time debugging with the on-chip Real Monitor software and high speed tracing of instruction execution.

• USB 2.0 Full Speed compliant Device Controller with 2 kB of endpoint RAM. In addition, the LPC2146/8 provides 8 kB of on-chip RAM accessible to USB by DMA.

• One or two (LPC2141/2 vs. LPC2144/6/8) 10-bit A/D converters provide a total of 6/14 analog inputs, with conversion times as low as 2.44 µs per channel.

• Single 10-bit D/A converter provide variable analog output.

• Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog.

• Low power real-time clock with independent power and dedicated 32 kHz clock input.

• Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 Kbit/s), SPI and SSP with buffering and variable data length capabilities.

• Vectored interrupt controller with configurable priorities and vector addresses.

• Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package.

• Up to nine edge or level sensitive external interrupt pins available.

• 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 µs.

• On-chip integrated oscillator operates with an external crystal in range from 1 MHz to 30 MHz and with an external oscillator up to 50 MHz

• Power saving modes include idle and Power-down.

• Individual enable/disable of peripheral functions as well as peripheral clock scaling for Additional power optimization.

• Processor wake-up from Power-down mode via external interrupt, USB, Brown-Out Detect (BOD) or Real-Time Clock (RTC).

• Single power supply chip with Power-On Reset (POR) and BOD circuits:

CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O Pads.

2.1.3 Applications

• Industrial control

• Medical systems

• Access control

• Point-of-sale

• Communication gateway

• Embedded soft modem

• General purpose applications

Device information

2.1.4 Architectural overview

The LPC2148 consists of an ARM7TDMI-S CPU with emulation support, the ARM7 Local Bus for interface to on-chip memory controllers, the AMBA *Advanced High-performance Bus* (AHB) for interface to the interrupt controller, and the *VLSI Peripheral Bus* (VPB, a compatible superset of ARM's AMBA Advanced Peripheral Bus) for connection to on-chip peripheral functions. The LPC2148 configures the ARM7TDMI-S processor in little-endian byte order. AHB peripherals are allocated a 2 megabyte range of addresses at the very top of the 4 gigabyte ARM memory space. Each AHB peripheral is allocated a 16 kB address space within the AHB address space. LPC2148 peripheral functions (other than the interrupt controller) are connected to the VPB bus. The AHB to VPB bridge interfaces theVPB bus to the AHB bus. VPB peripherals are also allocated a 2 megabyte range of addresses, beginning at the 3.5 gigabyte address point. Each VPB peripheral is allocated a 16 kB address space within the VPB address space. The connection of on-chip peripherals to device pins is controlled by a Pin Connect Block (see chapter "Pin Connect Block" on page 75). This must be configured by software to fitSpecific application requirements for the use of peripheral functions and pins.

ARM7TDMI-S processor

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on *Reduced Instruction Set Computer* (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core.

Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7TDMI-S processor also employs a unique architectural strategy known as THUMB, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. The key idea behind THUMB is that of a super-reduced instruction set. Essentially, the ARM7TDMI-S processor has two instruction sets:

- The standard 32-bit ARM instruction set.
- A 16-bit THUMB instruction set.

The THUMB set's 16-bit instruction length allows it to approach twice the density of standard ARM code while retaining most of the ARM's performance advantage over a traditional 16-bit processor using 16-bit registers. This is possible because THUMB code operates on the same 32-bit register set as ARM code.

THUMB code is able to provide up to 65% of the code size of ARM, and 160% of the performance of an equivalent ARM processor connected to a 16-bit memory system. The ARM7TDMI-S processor is described in detail in the ARM7TDMI-S Datasheet that can be found on official ARM website.

On-chip Flash memory system

The LPC2141/2/4/6/8 incorporates a 32 kB, 64 kB, 128 kB, 256 kB, and 512 kB Flash memory system respectively. This memory may be used for both code and data storage. Programming of the Flash memory may be accomplished in several ways: over the serial built-in JTAG interface, using In System Programming (ISP) and UART0, or by means of In Application Programming (IAP) capabilities. The application program, using the IAP functions, may also erase and/or program the Flash while the application is running, allowing a great degree of flexibility for data storage home firmware upgrades, etc. When the LPC2148 on-chip boot loader is used, 32 kB, 64 kB, 128 kB, 256 kB, and 500 kB of Flash memory is available for user code. The LPC2148 Flash memory provides minimum of 100,000 erase/write cycles and 20 years of data-retention.

1.8 On-chip Static RAM (SRAM)

On-chip Static RAM (SRAM) may be used for code and/or data storage. The on-chip SRAM may be accessed as 8-bits, 16-bits, and 32-bits. The LPC2148 provide 8/16/32 kB of static RAM respectively. The LPC2148 SRAM is designed to be accessed as a byte-addressed memory.

GSM MODEM

Definitions

The words, "Mobile Station" (MS) or "Mobile Equipment" (ME) are used for mobile terminals Supporting GSM services.

A call from a GSM mobile station to the PSTN is called a "mobile originated call" (MOC) or "Outgoing call", and a call from a fixed network to a GSM mobile station is called a "mobile

Terminated call" (MTC) or "incoming call".

What is GSM?

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services.

What does GSM offer?

GSM supports voice calls and data transfer speeds of up to 9.6 kbit/s, together with the transmission of SMS (Short Message Service).

GSM operates in the 900MHz and 1.8GHz bands in Europe and the 1.9GHz and 850MHz bands in the US. The 850MHz band is also used for GSM and 3G in Australia, Canada and many South American countries. By having harmonised spectrum across most of the globe, GSM's international roaming capability allows users to access the same services when travelling abroad as at home. This gives consumers seamless and same number connectivity in more than 218 countries.

Terrestrial GSM networks now cover more than 80% of the world's population. GSM satellite roaming has also extended service access to areas where terrestrial coverage is not available.

HISTORY

In 1980's the analog cellular telephone systems were growing rapidly all throughout Europe, France and Germany. Each country defined its own protocols and frequencies to work on. For example UK used the Total Access Communication System (TACS), USA used the AMPS technology and Germany used the C-netz technology. None of these systems were interoperable and also they were analog in nature. In 1982 the Conference of European Posts and Telegraphs (CEPT) formed a study group called the GROUPE SPECIAL MOBILE (GSM) The main area this focused on was to get the cellular system working throughout the world, and ISDN compatibility with the ability to incorporate any future enhancements. In 1989 the GSM transferred the work to the European Telecommunications Standards Institute (ETSI.) the ETS defined all the standards used in GSM.

3. BASICS OF WORKING AND SPECIFICATIONS OF GSM –

The GSM architecture is nothing but a network of computers. The system has to partition available frequency and assign only that part of the frequency spectrum to any base transreceiver station and also has to reuse the scarce frequency as often as possible.

GSM uses TDMA and FDMA together.

Graphically this can be shown below –

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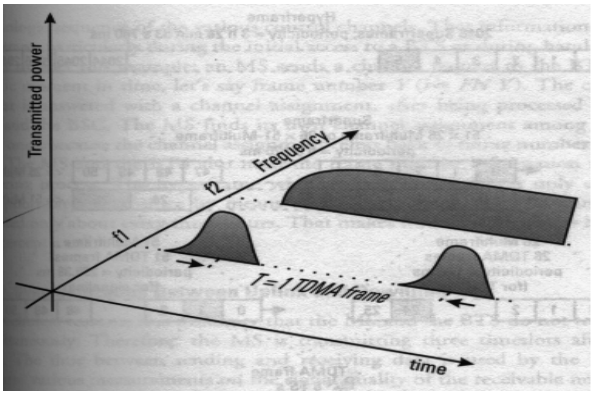

Fig 1. Representation of a GSM signal using TDMA & FDMA with respect to the transmitted power.

Some of the **technical specifications** of GSM was originally defined for the 900 Mhz range but after some time even the 1800 Mhz range was used for cellular technology. The 1800 MHz range has its architecture and specifications almost same to that of the 900 Mhz GSM technology but building the Mobile exchanges is easier and the high frequency Synergy effects add to the advantages of the 1800 Mhz range.

4. ARCITECTURE AND BUILDIGN BLOCKS –

GSM is mainly built on 3 building blocks. (Ref Fig. 2)

GSM Radio Network – This is concerned with the signaling of the system. Hand-overs occur in the radio network. Each BTS is allocated a set of frequency channels.

GSM Mobile switching Network – This network is concerned with the storage of data required for routing and service provision.GSM Operation and Maintenance – The task carried out by it include Administration and commercial operation , Security management, Network configuration, operation, performance management and maintenance tasks.

Fig.2 The basic blocks of the whole GSM system

SIGNALLING SCHEMES AND CIPHERING CODES USED –

GSM is digital but voice is inherently analog. So the analog signal has to be converted and then transmitted. The coding scheme used by GSM is RPE-LTP (Rectangular pulse Excitation – Long Term Prediction)

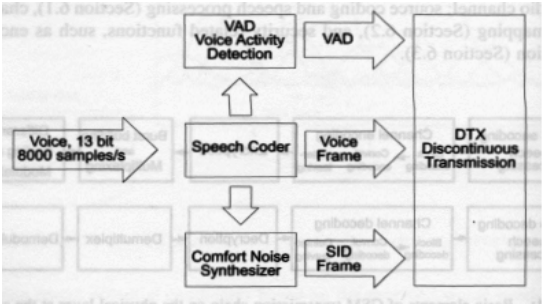

Fig.3 Transmitter for the voice signal

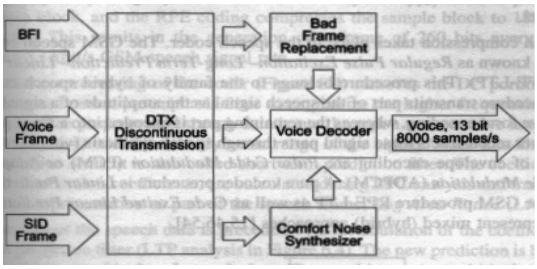

Fig.4 Receiver for the Voice signal

The voice signal is sampled at 8000 bits/sec and is quantized to get a 13 bit resolution corresponding to a bit rate of 104 kbits/sec. This signal is given to a speech coder (codec) that compresses this speech into a source-coded speech signal of 260 bit blocks at a bit rate of 13 kbit/sec. The codec achieves a compression ratio of 1:8. The coder also has a Voice activity detector (VAD) and comfort noise synthesizer. The VAD decides whether the current speech frame contains speech or pause, this is turn is used to decide whether to turn on or off the transmitter under the control of the Discontinuous Transmission (DTX). This transmission takes advantage of the fact that during a phone conversation both the parties rarely speak at the same time. Thus the DTX helps in reducing the power consumption and prolonging battery life. The missing speech frames are replaced by synthetic background noise generated by the comfort noise synthesize in a Silence Descriptor (SID) frame. Suppose a loss off speech frame occurs due to noisy transmission and it cannot be corrected by the channel coding protection mechanism then the decoder flags such frames with a bad frame indicator (BFI) In such a case the speech frame is discarded and using a technique called error concealment which calculates the next frame based on the previous frame.

CIPHERING CODES

MS Authentication algorithm's –

These algorithms are stored in the SIM and the operator can decide which one it prefers using.

A3/8

The A3 generates the SRES response to the MSC's random challenge, RAND which the MSC has received from the HLR. The A3 algorithm gets the RAND from the MSC and the secret key Ki from the SIM as input and generated a 32- bit output, the SRES response. The A8 has a 64 bit Kc output.

A5/1 (Over the Air Voice Privacy Algorithm)

The A5 algorithm is the stream cipher used to encrypt over the air transmissions. The stream cipher is initialized for every frame sent with the session key Kc and the no. of frames being decrypted / encrypted. The same Kc key is used throughout the call but different 22-bit frame is used.

TWO MAIN INTERFACES

The two main interfaces are the AIR and the ABIS interface. The figure shows the signaling between them.

AIR INTERFACE – signaling between MS and BTS

ABIS INTERFACE – signaling between BTS and BSC

.

5 Conclusion

As this project is based on ARM and zigbee technology is used to transmit data this can be of great use in the home of medicine and nelp the doctor to akeen eye on the patient health. System is Potable and easy to use,Modern technologies have developed that promotes comfortable and better life which is disease free and Prevention is better than cure

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