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# Web Based Monitoring System for Nuclear Plant

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## ABSTRACT

***This paper presents the wireless sensor network and Monitoring of Atmosphere at nuclear Power Plant is the main agenda in this Project by using Wireless Sensor Network (WSN). Zigbee and Ethernet are the Wired Communication Protocols used in this Project. Different types of Sensors like temperature sensor, nuclear fluid level sensor and fire sensor which sense the atmosphere changes and convert these changes into different voltage levels. These voltages from each sensor are given to microcontroller for analog to digital conversion. If the conversion is completed it will send the data through zigbee. In receiving side zigbee module is connected to a Ethernet which is used for updating the values in to web server database. The system consists of several distributed monitoring stations that communicate wirelessly with a backend server using machine-to-machine communication. Each station is equipped with different type of sensors as well as data logging and wireless communication capabilities. The backend server collects real time data from the stations and converts it into information delivered to users through web server. Data can be collected and performance analysis and assessment are performed.***

## Introduction:

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 pre-defined 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 systems often reside in machines that are expected to run continuously for years without errors and in some cases recover by them if an error occurs. Therefore the software is usually developed and tested more carefully than that for personal computers, and unreliable mechanical moving parts such as disk drives, switches or buttons are avoided. Recovery from errors may be achieved with techniques such as a watchdog timer that resets the computer unless the software periodically notifies the watchdog.

## PROJECT DESIGN

The implementation of the project design can be divided in two parts.

1. Hardware implementation
2. Firmware implementation

Hardware implementation deals in drawing the schematic on the plane paper according to the application, testing the schematic design over the breadboard using the various IC's to find if the design meets the objective, carrying out the PCB layout of the schematic tested on breadboard, finally preparing the board and testing the designed hardware.

The firmware part deals in programming the microcontroller so that it can control the operation of the IC's used in the implementation. In the present work, we have used the Or cad design software for PCB circuit design, the KEIL software development tool to write and compile the source code, which has been written in the C language. The Flash magic programmer has been used to write this compile code

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into the microcontroller. The firmware implementation is explained in the next chapter.

The project design and principle are explained in this chapter using the block diagram and circuit diagram. The block diagram discusses about the required components of the design and working condition is explained using circuit diagram and system wiring diagram.

The above Hardware implementation in this we are using LPC2148 micro controller this is ARM7TDMI microcontroller. And Iam using different sensors and below fallows.

## Block Diagram

### TRANSMITTER:

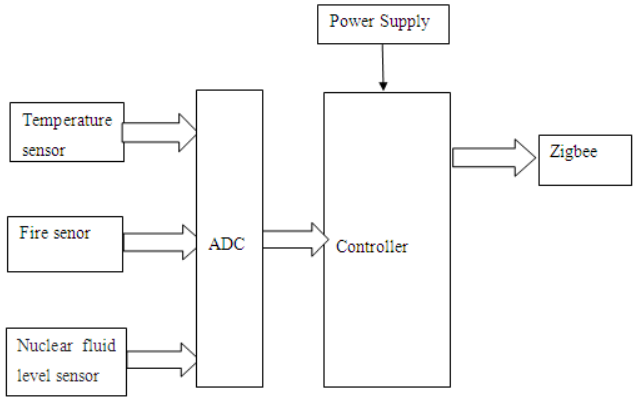


Figure 1 Transmission block diagram

### RECEIVER:

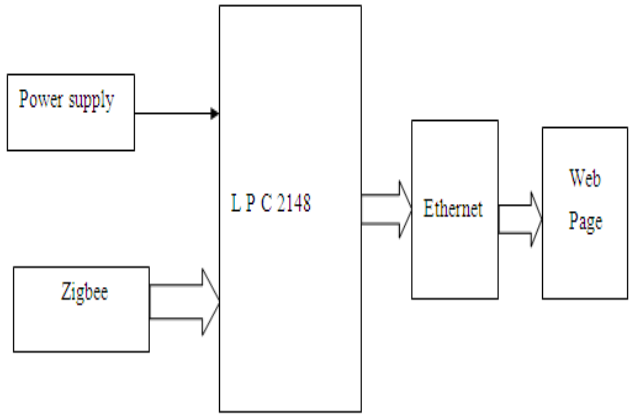


Figure 2 Receiver block diagram

## HARDWARE TOOLS

### POWER SUPPLY

The input to the circuit is applied from the regulated power supply. The A.C input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating D.C voltage. So in order to get a pure D.C voltage, the output voltage from the rectifier is fed to a filter to remove any A.C components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.

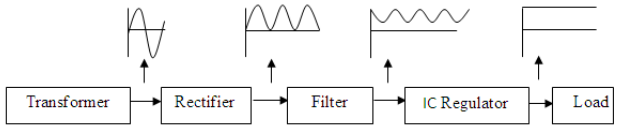


Figure3 Components of power supply

The block diagram of Components of power supply is shown in the figure and those are explained as:

### Transformer

Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly.

### Rectifier

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.

### Filter

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant.

### Voltage regulator

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical

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regulator designed to automatically maintain a constant voltage level.

## TEMPERATURE SENSOR - THE LM35

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ºC).

The LM35 - An Integrated Circuit Temperature Sensor

- Use of LM35s To Measure Temperature
  - You can measure temperature more accurately than a using a thermistor.
  - The sensor circuitry is sealed and not subject to oxidation, etc.
  - The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.
- LM35 Look Like

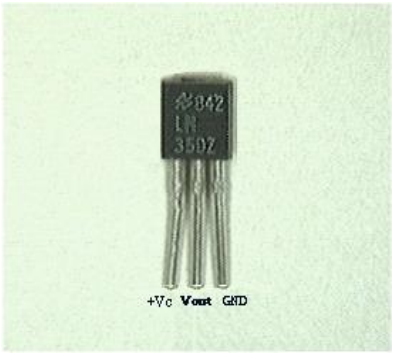


Figure 4 LM35 Temperature Sensor

- Working of LM35

o It has an output voltage that is proportional to the Celsius temperature.
o The scale factor is .01V/ºC
o The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 ºC at room temperature and +/- 0.8 ºC over a range of 0 ºC to +100 ºC.
o Another important characteristic of the LM35DZ is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 ºC temperature rise in still air.

- Use An LM35 (Electrical Connections)

o Here is a commonly used circuit. For connections refer to the picture above.
o In this circuit, parameter values commonly used are:

- $V_c$ = 4 to 30v
- 5v or 12 v are typical values used.
- $R_a = V_c / 10^{-6}$
- Actually, it can range from 80 K**W** to 600 K**W** , but most just use 80 KW.

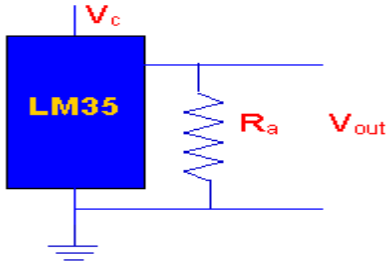


Figure 5 LM35 Electrical Connections

o Here is a photo of the LM 35 wired on a circuit board.
- The white wire in the photo goes to the power supply.
- Both the resistor and the black wire go to ground.
- The output voltage is measured from the middle pin to ground

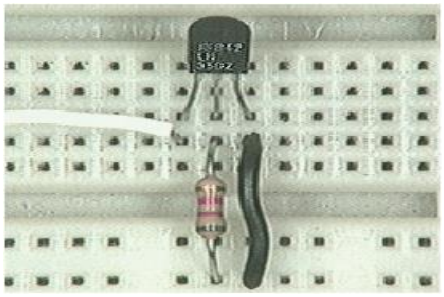

Figure 6. LM 35 wired on a circuit board

- What Can You Expect When You Use An LM35

o You will need to use a voltmeter to sense Vout.
o The output voltage is converted to temperature by a simple conversion factor.
o The sensor has a sensitivity of 10mV / ºC.
o Use a conversion factor that is the reciprocal, that is 100 ºC/V.
o The general equation used to convert output voltage to temperature is:
- Temperature ( ºC) = Vout * (100 ºC/V)
- So if Vout is 1V , then, Temperature = 100 ºC
- The output voltage varies linearly with temperature.

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In order to calculate the Celsius reading from the analog value, we use the following formula to calculate the temperature in Celsius:

$$\text{temp C} = \frac{5.0*val*100}{1024}$$

Where
Val = is the value send to the computer by the serial port
tempC= is the calculated temperature value (in Celsius)
5 is the reference we are using
1024 is the resolution of the 10 bit internal ADC

## FIRE SENSOR

A **Fire detector** is a device that detects Fire. Commercial, industrial, and mass residential devices issue a signal to a fire alarm system, while household detectors, known as Fire alarms, generally issue a local audible or visual alarm from the detector itself.

Internally fire sensor contains Darlington transistor pair. Here fire sensor gives digital output i.e. vcc or ground. Fire sensor gives logic high when the light or fire fall on it, otherwise it gives ground voltage.

In the diagram current flowing from collector to the emitter in the case of fire occurring. so due to this we are getting voltage drop across the RL resistor.

Figure 7 Fire Sensor

## CONTRAST CONTROL (Potentiometer)

To have a clear view of the characters on the LCD, contrast should be adjusted. To adjust the contrast, the voltage should be varied. For this, a preset is used which can behave like a variable voltage device. As the voltage of this preset is varied, the contrast of the LCD can be adjusted. Variable resistors used as potentiometers have all three terminals connected.

This arrangement is normally used to vary voltage, for example to set the switching point of a circuit with a sensor, or control the volume (loudness) in an amplifier circuit. If the terminals at the ends of the track are connected across the power supply, then the wiper terminal will provide a voltage which can be varied from zero up to the maximum of the supply.

## ARM Processor

ARM is the industry's leading provider of 32 bit embedded microprocessors. Offering a wide range of processors based on a common architecture that deliver high performance, industry leading power efficiency and reduced system cost. ARM is a 32-bit RISC instruction set architecture developed by ARM Holdings. It was named the Advanced RISC Machine and before that, the Acorn RISC Machine. The ARM architecture is the most widely used 32-bit instruction set architecture in numbers produced. Originally conceived by Acorn Computers for use in its personal computers, the first ARM-based products were the Acorn Archimedes range introduced in 1987.

The ARM architecture includes the following RISC features:

1) Load/store architecture.
2) No support for misaligned memory accesses.
3) An orthogonal instruction set.
4) Uniform 16 × 32-bit register file.
5) Fixed instruction width of 32 bits to ease decoding and pipelining, at the cost of decreased code density.
6) Mostly single-cycle execution.

ARM Advantages:

- It has less code density
- It offers low power consumption
- It operates at high speed
- It offers debug support

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- It has less System cost
- Interfacing of co-processors can be done easily
- Industry standard

**The ARM7 family comprises**

❖ ARM7TDMI: An integer core with three-stage pipeline delivering high performance together with very low power consumption on a small die size. This outstanding combination makes the ARM7TDMI processor the most widely shipped 32-bit embedded RISC processor in the world

Key features are:

- Hard macro cell
- Portable down to 65nm
- Performance up to 133 MHz
- Thumb and ARM instruction sets
- Three-stage pipeline
- Unified bus architecture
- Low power, fully static design
- Small die size
- Coprocessor interface
- Embedded ICE-RT debug logic
- Embedded Trace Microcell™ (ETM™) interface

❖ ARM7TDMI-S: A synthesizable version of the ARM7TDMI core, ideal for modern design flows where portability and flexibility are key. The ARM7TDMI-S core is the synthesizable version of the ARM7TDMI but with the improved testability and flexibility that synthesis offers. Scan flip-flops for automatic production testing and customer-specific boundary scan can easily be added. Optimized for flexibility, the ARM7TDMI-S core cuts time-to-market by reducing development time while allowing for increased design flexibility.

❖ ARM7EJ-S: An enhanced, synthesizable core with architecture and instruction set extensions to support DSP operations and accelerated execution of Java™ applications using ARM Jazelle DBX technology The ARM7EJ-S core provides all the benefits of the ARM7TDMI core low power consumption, small size and the Thumb instruction set while also incorporating ARM's Jazelle DBX technology and DSP extensions, offering up to 133 MHz on a typical 0.13µm process.

The DSP instruction extensions allow systems that may conventionally have been designed using a microcontroller and DSP to be implemented in a single core solution, removing multi-core complexity. The Jazelle DBX extensions enable hardware acceleration in the execution of Java applications while retaining compatibility with existing ARM and Thumb code.

❖ ARM720T: An integer core with memory management unit and 8KB unified cache for open platform applications such as Windows CE, Linux, Palm OS and Symbian OS.

The ARM720T hard Macro cell is a high-performance processor for systems requiring full virtual memory management and protected execution spaces. It is compatible with leading operating systems such as Linux, Palm OS, Symbian OS and Windows CE. It combines the ARM7TDMI core with:

- 8K unified cache
- Memory Management Unit (MMU)
- Write buffer
- AMBA AHB bus interface

The ARM720T core retains the coprocessor and ETM interfaces for system expansion and real- time debug capabilities

**ARM{x}{y}{z}{T}{D}{M}{I}{E}{J}{F}{-S}**

X—family
Y—memory management/protection unit
Z—cache
T—Thumb 16-bit decoder
D—JTAG debug
M—fast multiplier
I—Interrupt
E—enhanced instructions (assumes TDMI)
J—Jazelle
F—vector floating-point unit
S—synthesizable version

All ARM7 family processors share a range of common features:

- High performance: up to 133 MHz on 0.13µm
- Low power consumption
- Small die size

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- High code density
- Real-time debug facilities
- Coprocessor interface

## About the ARM7TDMI core

The ARM7TDMI core is a member of the ARM family of general-purpose 32-bit microprocessors. The ARM family offers high performance for very low power consumption, and small size. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles. The RISC instruction set and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs. This simplicity gives:

- A high instruction throughput
- An excellent real-time interrupt response
- A small, cost-effective, processor macro cell.

The instruction pipeline: The ARM7TDMI core uses a pipeline to increase the speed of the flow of instructions to the processor. A three-stage pipeline is used, so instructions are executed in three stages:

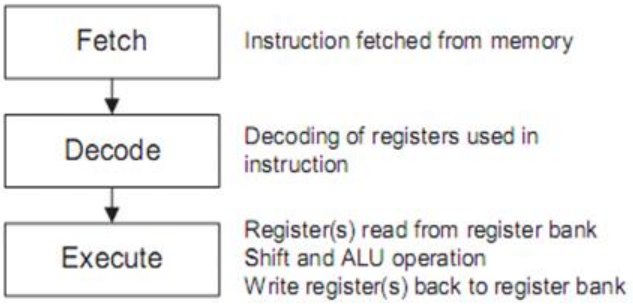


Figure: 8. ARM Instruction pipeline

Memory access: The ARM7TDMI core has a Von Neumann architecture, with a single 32-bit data bus carrying both instructions and data. Only load, store, and swap instructions can access data from memory.

Data can be:

- 8-bit (bytes)
- 16-bit (half words)
- 32-bit (words).

Memory interface: The Embedded ICE-RT logic provides integrated on-chip debug support for the ARM7TDMI core. The Embedded ICE-RT logic contains a Debug Communications Channel (DCC), used to pass information between the target and the host debugger. The Embedded ICE-RT logic is controlled through the Joint Test Action Group (JTAG) test access port.

## RESULTS AND DISCUSSIONS

Assemble the circuit on the PCB .After assembling the circuit on the PCB, check it for proper connections before switching on the power supply. This project consists of controller, and ZIGBEE all the units are working independently and in collaboration with each other as well

In total complete system (including all the hardware components and software routines) is working as per initial specifications and requirements of our project .Because of creative nature of the design, some features could not be fine tuned and are not working properly. As the users work with the systems ,they develop various new ideas for the development and enhancements of the project

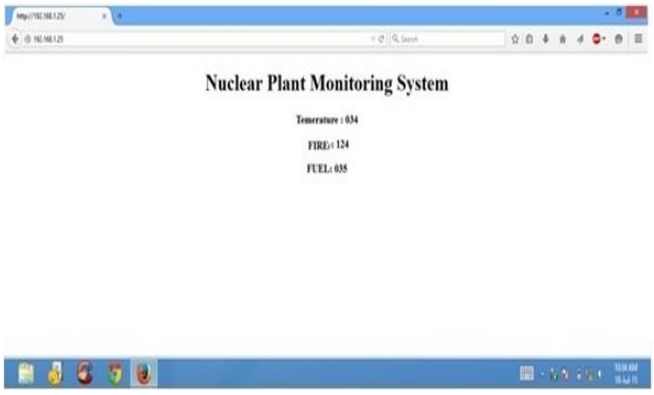


Figure 9. Web Papge Display Output

## CONCLUSION

In this project we have designed a prototype of an embedded wireless sensor network based on LPC 2148 microcontroller and XBEE [zigbee protocol] for connectivity, The temperature, fire, fluid level were considered as essential for monitoring of atmosphere at nuclear power plant any changes in the atmosphere the sensors are capturing the levels of temperature ,fire, fluid. Then this information passes through zigbee to Ethernet connected to the web server in the computer.

Development of light waited gateway using microprocessor which support low power zigbee to Ethernet on a single chip solution will reduce the

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complex design of wireless sensor and true power of internet for emerging application at low cost system with efficient protocol stack to control the entire system.

## FUTURE SCOPE

In this project we have presented an approach of using the Wireless technology for Web page display, from web page and explained the application for the purpose of device. The Zigbee has been implemented successfully with temperature, fire, fluid level and Ethernet outputs have been verified. As part of further research, Remote Terminal System (RTU), database, historical database and other system together can also be developed in the overall enterprise information system or for the automation of energy management system and monitoring. There is future scope for monitoring from smart phones and apps. To receive the updates and alerts on to smart phones or to designated mobile numbers.

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