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Forest Fire Monitoring System

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ABSTRACT

Recent years have seen a considerable increase in the frequency of forest fires due to various factors that include climate changes, human activities which are essential for economic development.Uncontrolled human activities and abnormal natural conditions disturb the environmental conditions resulting in occurrence of forest fires frequently which lead to serious disasters, destroying a large portion of forest resources and destruction of human environment. Forests play a vital role in preserving the environment and natural human resources,which play a major role in maintaining ecological balance. Forest fires are catastrophic to the natural resources contained in the forests. It is hence imperative that forest fires are detected at the earliest. This paper describes the architecture of wireless sensor network and a scheme for data collection in real-time forest fire detection. Sensors have limited computational power and use low power batteries, which makes energy efficiency an extremely important factor for consideration.The performance of the approach of packet transmission at discrete time intervals vs continuous packet streaming is compared and is evaluated in terms of energy expenditure by simulation. The simulation results are good to encourage the environmentalists to adopt this technique in protection of forest.

Key words :ATMEGA 48 MICROCONTROLLER,GSM MODULE,SENSORS.

1.INTRODUCTION

Over the years wireless sensor networks have been proving that they make things simpler and more reliable and more importantly easy to implement and at comparatively lesser cost which have attracted many research efforts during the past few years and definitely, will keep attracting in the future years.Sensor networks , are mainly comprised of a large number of inexpensive and mall sensor nodes and few sinks.

These spatially distributed sensors monitor physical or environmental conditions like temperature , humidity, pressure and the collected data is passed onto a main controller. Sensor networks are used in many fields and have been deployed in a variety of applications ranging from monitoring a small room to large forests. The sensor networks are also used in many industrial and consumer applications in real time machine health monitoring, runway monitoring, coal mines, etc,. The importance of early detection of forest fires cannot be over emphasised: delays can lead to loss of acres of forest land and spread to nearby villages which may lead to loss of human life as well. Hence the prevention of these forest fires has become a global concern in forest fire prevention organizations and thus monitoring of forest fires is an important issue to consider. Presently, forest fire prevention methods largely consist of patrols, observation from watch towers and satellite monitoring. Although the methods like patrols, watch towers are easy and feasible, they are not very effective as they require many financial and material resources with trained labour force. Many problems with fire protection personnel abound carelessness of workers, absence from the post, inability for real-time monitoring and the limited area coverage lead to turning these methods inefficient. The scope of application of satellite detection systems is also restricted by many factors such as, the resolution of its saturated pixel .

2. RELATED WORKS

In 2009 **-** The detection of forest fire was done manually and using sensor networks. In 2014 – The detection of forest fire was done by using sensor networks, together with satellite monitoring and areal patroling.

In 2016 – the forest fire detection was carried out using wireless sensor networks.

3. METHODLOGY

PROBLEM STATEMENT:

Considerable research has been done in the detection of forest fires. In Zheping et. al., proposed a design for detection of forest fires using wireless sensor networks.

It adopts low-power IC, enhances stability, credibility, and reduces volume. In Breejan et. al., propose an autonomous forest fire detection principle based on temporal contrast differences with the natural background and spatial characteristics of the smoke plume. In an analysis has been carried out on the dependence that certain magnitudes related with the pixels where there is fire present. Energy efficiency has not been considered as a primary factor for the above works. As wireless sensor networks deployed in hostile territory like fire- hazardous area, with minimal means of recharging the sensors, every effort has to be made to prolong the lifetime of the network by an energy efficient design. Compared to the traditional methodologies, use of wireless sensor network makes the detection of forest fire is easier and make a quick assessment of a potential fire danger. This work proposes a simple but energy efficient wireless sensor network design for detection of forest fires. The aim is to detect and predict forest fire promptly and precisely in order to minimize the loss of forests, wild animals and people. Large number of sensor nodes are densely deployed in a forest environment to monitor and measure certain physical factors which contribute effectively in detection of forest fire like temperature, relative humidity, etc. The collected data is sent to the main controller of the monitoring center for analyzing. The analytical results will later be sent to forest department or any department which takes further actions to prevent the fire from spreading to other parts of the forest. In this paper it is proposed for the application of wireless sensor network technology as a monitoring system for forest fire. The organization of the paper is as follows: Firstly Describes the parameters that result in forest fire, network model for forest fire detection is presented in deals with processing of collected data efficiently, simulation results in Section V and conclude this paper. There are mainly three causes of forest fire, namely natural, intentional/deliberate and unintentional/accidental. Natural fires are those fires which cannot be averted as these occur naturally due to lightening, rolling of stones and rubbing of dry bamboos due to strong winds. Intentional/deliberate are those that are purposefully initiated for the better growth of fodder grass, and sometimes set by villagers to drive away the animals which destroy their crops. The unintentional/accidental fires are created due to the careless human activities like throwing of burning matchsticks or cigarettes. Availability of air, heat and fuel are the main parameters that initiate a fire in forest. The moisture content of the combustible material plays an important role in assessment and prediction of forest fire. The moisture content is related with relative humidity in the atmosphere, wind, temperature of the air and similar factors while relative humidity directly affects water evaporation. The physical properties of the combustible materials vary indirectly by air temperature. Hence, relative humidity and air temperature are regarded as the two major factors which affect the moisture content of the fuel.

3.2 FEASIBILITY STUDY

TECHNICAL:

When there is a whole range of desirable new high end features to the scene, the new features interact in cleverer ways.The Atmega48 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISCS architecture. By executing powerful instructions in a single clock cycle, the Atmega48 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed. High performance is its main feature. It operates with a voltage of 4.5-5.5.

ECONOMICAL*:*

The components like Atmega48, Max232 level converter, tarang module, UART costs low. From economical point of view the cost of purchasing software is low. Ultimately, the implementation of this project will reduce the expenditure of power supply board.

OPERATIONAL:

The module provides very user friendly interface and does not need extra training for usage to open or close at any time he needs. If in that room many people are staying finger prints of all can be used in that room.

HARDWARE REQUIREMENTS:

ATmega48 microcontroller

The microcontroller is at the core of every embedded module. Hence, great care must be exercised in choosing the right microcontroller without compromising on functionality. Keeping in view many factors that governed the correct implementation of our project the ATmega168 microcontroller from Atmel Corporation’s AVR microcontroller family was chosen. Few crucial reasons may be cited so as to justify our choice of this microcontroller. The first being, that all AVR microcontrollers are designed to deliver more performance at lesser power consumption. It is compatible with popular protocols like I2C and SPI. It also has advanced features like an on chip analog to digital converter, six pulse width modulation channels, and data retention is supported up to a hundred years at 25º C. Also compilers for the ATmega88 are available free of cost from the manufacturer. An added advantage is that the AVR series can be programmed using the AVRGCC (GNU C compiler) , thus making it an undisputed choice for even GNU/Linux based programmers.

The Atmega48 microcontroller has execution speeds of up to one MIPS per MHz of clock frequency. Elucidating the specifications of the CPU of the AVR, it is an 8 bit microcontroller with advanced RISC architecture. The CPU is designed for the stellar combination of parallelism and performance. Thus the CPU uses the Harvard architecture (separate memories and buses for program and data). The CPU also accommodates a 32 general purpose 8-bit registers.

Atmega provides the data handbook and application notes for the microcontroller in portable document format on their official website 'www.atmel.com'. As a first step, we will proceed now to study the microcontroller in brief detail, starting with the pin conFigureuration.

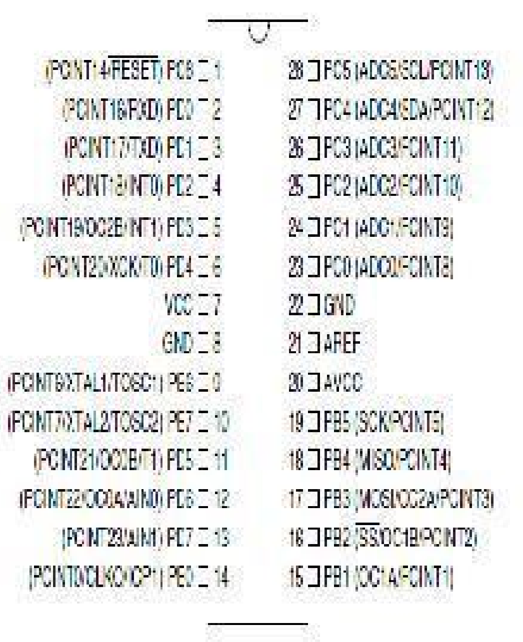


Figure: Pin Diagram of Atmega48 Microcontroller

PORTS:

The ports of the AVR have read-modify-write functionality when used as general digital I/O ports, as stated in the datasheet of the device. The ports are bi-directional I/O ports with optional internal pull-ups. Each port pin mainly has three register bits which are DDxn, PORTxn and PINxn. DDxn is the data direction bit and indicates input or output at a particular pin of any port.

If DDxn is set to one, the pin is used as output pin, else it is an input pin. If PORTxn is written to a logic one, and if DDxn is set to zero that particular pin's internal pull up resistor is activated. The DDxn is accessed at the DDRx register, the PORTxn is in the PORTx register and the PINxn is at the PINx register. Writing a logic one to PINxn will toggle PORTxn. The alternate functions of the port pins and the port registers are explained at the end as part of the datasheets. The pin value can be read at any time through the PINxn register bit, irrespective of the DDxn pin setting.

Analog to digital converter:

The Atmega48 is equipped with a successive approximation analog to digital converter with a resolution of 10 bits. All the input channels of the ADC are connected to a multiplexer. The ADC channel is selected by selecting the corresponding bits as defined in the ADMUX register of the microcontroller. The ADC output which is 10 bits long is stored in the ADCH and ADCL registers of the microcontroller. For eight bit precision, reading ADCH is sufficient. Further details of the ADC are provided with the datasheets.

UART:

A universal asynchronous receiver/transmitter (usually abbreviated **UART** and pronounced is a type of "asynchronous receiver/transmitter", a piece of computer hardware that translates data between parallel and serial forms. A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers. A dual UART or **DUART** combines two UARTs into a single chip. Many modern ICs now come with a UART that can also communicate synchronously; these devices are called **UARTs**.Serial transmission of digital information (bits) through a single wire or other medium is much more cost effective than parallel transmission through multiple wires. A UART is used to convert the transmitted information between its sequential and parallel form at each end of the link. Each UART contains a shift register which is the fundamental method of conversion between serial and parallel forms.The UART usually does not directly generate or receive the external signals used between different items of equipment. Typically, separate interface devices are used to convert the logic level signals of the UART to and from the external signaling levels. Communication may be "full duplex" (both send and receive at the same time) or "half duplex" (devices take turns transmitting and receiving).

Power Supply:

Power supply is used to energies the equipments such as microcontroller, relay, level converter, GSM and GPS module. The power supply is used to energies the whole module. The power supply can be in the form of wired or battery. In our project 12V battery is used as a power supply.

LM7805C Voltage Regulator:

A voltage regulator based on an active device (such as a bipolar junction transistor, field effect transistor or vacuum tube) operating in its "linear region" and passive devices like zener diodes operated in their breakdown region.

The regulating device is made to act like a variable resistor, continuously adjusting a voltage divider network to maintain a constant output voltage.

Figure: Voltage Regulators

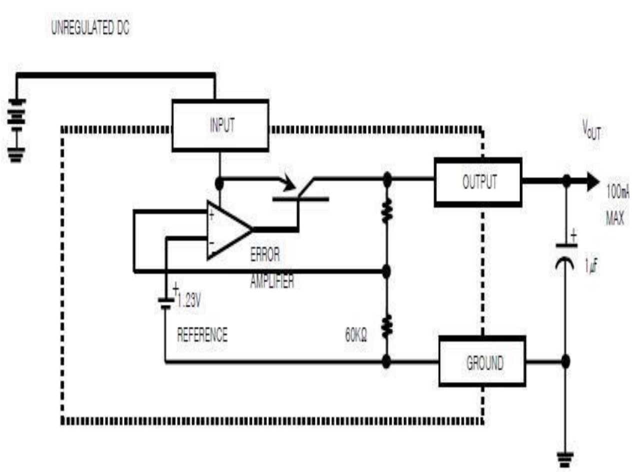


Figure: Circuit Diagram of Voltage Regulator

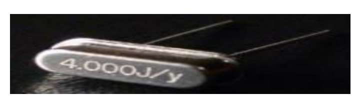
Crystal Oscillator - 4MHz :

A crystal oscillator is an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time, to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type ofpiezoelectric resonator used is the quartz crystal, so oscillator circuits designed around them were called"crystal oscillators".A crystal is a solid in which the constituent atoms, molecules, or ions are packed in a regularly ordered, repeating pattern extending in all three spatial dimensions.

Almost any object made of an elastic material could be used like a crystal, with appropriate transducers, since all objects have natural resonant frequencies of vibration. For example, steel is very elastic and has a high speed of sound. It was often used in mechanical filters before quartz. The resonant frequency depends on size, shape, elasticity, and the speed of sound in the material. High-frequency crystals are typically cut in the shape of a simple, rectangular plate. Low-frequency crystals, such as those used in digital watches, are typically cut in the shape of a tuning fork. For applications not needing very precise timing, a low-cost ceramic resonator is often used in place of a quartz crystal.

When a crystal of quartz is properly cut and mounted, it can be made to distort in an electric field by applying a voltage to an electrode near or on the crystal. This property is known as piezoelectricity.When the field is removed, the quartz will generate an electric field as it returns to its previous shape, and this can generate a voltage. The result is that a quartz crystal behaves like a circuit composed of an inductor, capacitor and resistor, with a precise resonant frequency.

Quartz has the further advantage that its elastic constants and its size change in such a way that the frequency dependence on temperature can be very low. The specific characteristics will depend on the mode of vibration and the angle at which the quartz is cut (relative to its crystallographic axes).[5] Therefore, the resonant frequency of the plate, which depends on its size, will not change much, either. This means that a quartz clock, filter or oscillator will remain accurate. For critical applications the quartz oscillator is mounted in a temperature-controlled container, called a crystal oven, and can also be mounted on shock absorbers to prevent perturbation by external mechanical vibrations.Quartz timing crystals are manufactured for frequencies from a few tens of kilohertz to tens of megahertz. More than two billion (2×109) crystals are manufactured annually. Most are small devices for consumer devices such as wristwatches, clocks, radios, computers, and cell phones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscopes.



Figureure 3.8: A Crystal Oscillator.

MAX232 and DB9 connector(Level Converter)

Since the RS232 is not compatible with today's microprocessor and microcontroller, we need a line driver to convert the RS232's signals to TTL voltage levels that will be acceptable to the microcontroller's TxD and RxD pins. One example of such a converter is MAX232 from Maxim Corp. The MAX232 converts the RS232 voltage levels to TTL voltage levels, and vice versa. One advantage of the MAX232 chip is that it uses a +5V power source, which is the same as the source voltage for the microcontroller, and Max 232, with no need for the dual power supplies that are common in many older systems.

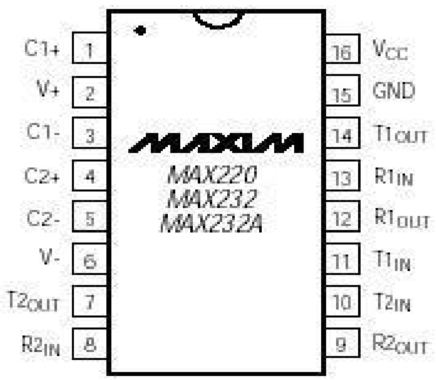


Figure: Pin diagram of MAX232

The MAX232 has two sets of line drivers for transferring and receiving data. The line drivers used for TxD are called T1 and T2, while the line drivers for RxD are designated as R1 and R2. In many applications only one of each is used. For example, T1 and R1 are used together to TxD and RxD of microcontroller, and the second set is left unused.

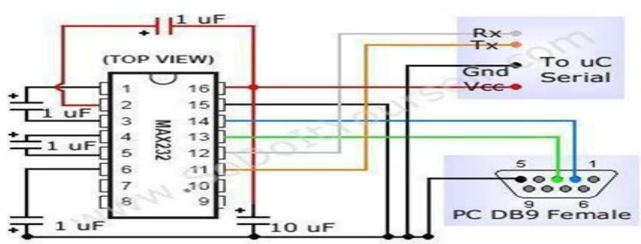


Figure: MAX232 and DB9 connector

Code Vision AVR Cross Compiler:

CodeVision AVR is a C cross-compiler Integrate Development Environment and Automatic Program Generator designed for the Atmel AVR family of microcontrollers. The program is designed to run under the Windows 95, 98, Me, NT 4, 2000 and XP operating systems.The C cross-compiler implements nearly all the elements of the ANSI C language, as allowed by the AVR architecture, with some features added to take advantage of specificity of the AVR architecture and the embedded system needs.The compiled COFF object files can be C source level debugged, with variable watching, using the Atmel AVR Studio debugger.The Integrated Development Environment (IDE) has built-in AVR Chip In-System Programmer software that enables to automatically transfer of the program to the microcontroller chip after successful compilation/assembly.The In-System Programmer software is designed to work in conjunction with the Atmel STK500/AVRISP/AVRProg (AVR910 application note), Kanda Systems STK200+/300, Dontronics DT006, Vogel Elektronik VTEC-ISP, Futurlec JRAVR and MicroTronics ATCPU/Mega2000 programmers/development boards.

AVR Studio Programmer

AVR Studio is an Integrated Development Environment (IDE) for writing and debugging AVR applications Windows 9x/ME/NT/2000/XP/VISTA environments. AVR Studio provides a project management tool, source file editor, simulator, assembler and front-end for C/C++, programming, emulation and on-chip debugging.AVR Studio supports the complete range of ATMEL AVR tools and each release will always contain the latest updates for both the tools and support of new AVR devices.AVR Studio 4 has a modular architecture which allows even more interaction with 3rd party software vendors. GUI plug-ins and other modules can be written and hooked to the system.

Embedded C

Embedded C is extensive and contains many advanced concepts. The range of modules covers a full introduction to C, real-time and embedded systems concepts through to the design and implementation of real time embedded or standalone systems based on real-time operating systems and their device drivers. Real time Linux (RTLinux) is used as an example of such a system. The modules include an introduction to the development of Linux device drivers. Embedded C covers all of the important features of the C language as well as a good grounding in the principles and practices of real-time systems development including the POSIX threads (pthreads) specification.The design of the modules is intended to provide an excellent working knowledge of the C language and its application to serious real time or embedded systems. Those wanting in-depth training specifically on RTLinux or Linux kernel internals should contact us to discuss their requirements; this set of modules is geared more towards providing the groundwork for approaching those domains rather than as in-depth training on a specific approach.Embedded C contains essential information for anyone developing embedded systems such as microcontrollers, real-time control systems, mobile device, PDAs and similar applications. This C course is based on many years experience of teaching C, extensive industrial programming experience and also participation in the ANSI X3J11 and BSI standards bodies that produced the standard for C. We focus on the needs of day-to-day users of the language with the emphasis being on practical use and delivery of reliable software.

TESTING

1. Integration Testing

Integration testing is done to verify if the package as a whole, after the integration of all the modules is working properly. This phase of testing is mainly concerned with finding out if the variables and data are sending correctly from one module to another.

In order to conduct the said test, the active program is compiled. This package has been tested for various inputs. It was found that the package performs its function to meet the requirements.

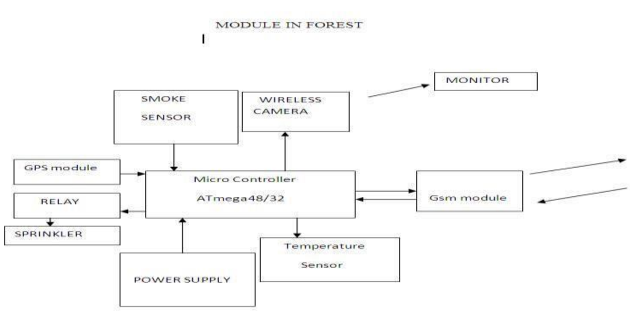
2. System Testing

System testing involves putting all the modules together and checking the entire software. It is useful in checking whether with the given input, the desired output is got as a result. System testing will be largely functional in nature.

3. Acceptance Testing

This is the final stage in the testing process. Before the system is accepted for the operational use it may reveal errors and omissions in the system requirements definitions because the real data exercises the system in different way from the test data.Acceptance testing may also reveal requirements problem where the systems performance is unacceptable.Testing here is focused on the external behavior of the system and the internal logic of the program is not emphasized. In this stage of testing the application was installed in the system.

BLOCK DIAGRAM



EXPERIMENTAL RESULTS

4. CONCLUSION

As the saying goes “Necessity is the mother of all inventions”, a need for software which would control process and devices was recognized. Accordingly a highly interactive user friendly module based embedded technology with microcontrollers was developed to solve the problem. The module which is developed will make the job of process easier. The user module has resulted in reducing work of human also makes more comfortable.The module is, therefore functioning as a very good tool. Incorporating the future enhancement as specified earlier would make the software a perfect tool, which would help the user.

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