ISSN : 2393-8188 (print)
2393-8196 (online)
www.milliyasrcollege.org.journal.php

GRANARY ENVIRONMENTAL MONITORING AND CONTROL SYSTEM BASED ON MSP430 AND ZIGBEE

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ABSTRACT

Grain storage is the very important component in the economy and the society. The quality and safety of grains related to the peoples. The temperature and humidity are the important parameter that can affect the grain quality. Therefore, these factors must be in accurate and real time monitoring by supervisory systems in large granaries. The automatic monitoring of the grain storage will help to improve the operation steps of grain storage; it reduces the grain loss and reduces labour intensity. This project helps us to monitor environment parameters like temperature, humidity, gas and light with the help of MSP430 and ZigBee wireless sensor network technology. Using ZigBee wireless sensor network to complete acquisition and transmission of environment parameters and using ARM9 to achieve control of the barn environment as system data controller and using GSM to achieve the system's remote control, this improves the flexibility and scalability of the warehouse management which sends available data to grain database manager in time and filters invalid data [1].

KEYWORDS— *Wireless sensor network, Mixed Signal Processor, Zigbee, Globalise System of Modulation, ARM*

1. INTRODUCTION

Grain storage is the important factor in day by day life for the human being. But there are some environmental factors which affects the grain storage. In the process of grain storage, temperature, gas like CO2, humidity, light intensity is the major ecological factors that can affect the grain quality. Therefore, the parameters like temperature, humidity, CO2, light intensity should be in accurate and real time monitoring. . The automatic monitoring of the grain storage will help to improve the operation steps of grain storage; it reduces the grain loss and reduces labour intensity.

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2. RELATED WORK

Liai Gao He proposed a system Traditional environmental monitoring system is usually achieved by wired network, making the system complex and costly [2]. There is problem of power supply however; to solve the problem of system power supply effectively is rarely reported. If battery power is used, the battery must be replaced after some particular period and a large number of used batteries will cause environmental pollution. Therefore, the problem of power supply must be solved to achieve a real sense of "wireless" transmission.

Aryo H.Primicanta, Mohd Yunus Nayan, and Moohammand Awan proposed a method on ZigBee-GSM based Automatic Meter Reading system. In this paper GSM modem technic is used to transmit fault messages to user via Zigbee. Computerized environmental control systems were found to be the most reliable solution in providing the ability to integrate the control of all systems involved in manipulating the growing environment, thus improving the crop development and reducing the production costs [3].

3. PROPOSED SYSTEM

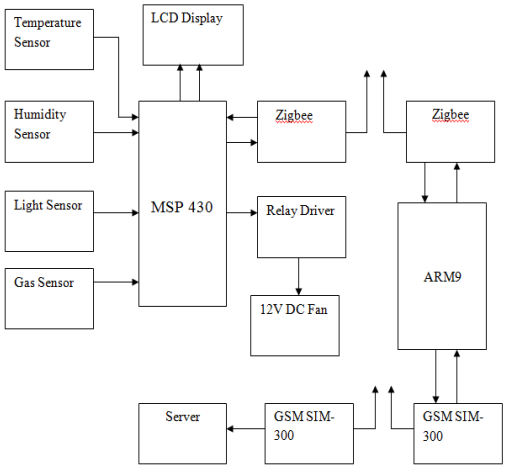

Fig.1 Proposed Granary environmental monitoring and Control system

The sensor which is given to the MSP430 acts as an input to the system. This sensor node gathered the environment information like temperature, gas, light intensity and humidity. The signals collected by the sensor given to the analog to digital converter which is inbuilt and which converts into voltage form and then sent to MSP430. The mixed Signal Processor 430 is connected to LCD which displays the environmental parameter values of temperature, humidity, CO2 and light intensity. 12volts dc fan is the controlling part of the system which is connected to MSP430 through the relay driver which controls the fan. The Zigbee communication module changes the data into data packets of Zigbee communication protocol which are transmitted to the coordinator node. The ARM master unit gathered the collected information data. The information collected by the ARM master is sent to warehouse data management system through the GSM network through serial Communication.

A. MSP430

The MSP430 16-bit microcontroller platform of ultra-low power RISC mixed-signal microprocessors from TI provides the ultimate solution for a wide range of low power and portable applications. TI provides robust design support for the MSP430 16-bit MCU including technical documents, training, tools, and software.

The Texas Instruments MSP430 family of ultralow power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low power modes is optimized to achieve extended battery life in portable measurement applications. The device features a powerful 16-bit RISC CPU, 16-bit registers, and constant generators that attribute to maximum code efficiency.

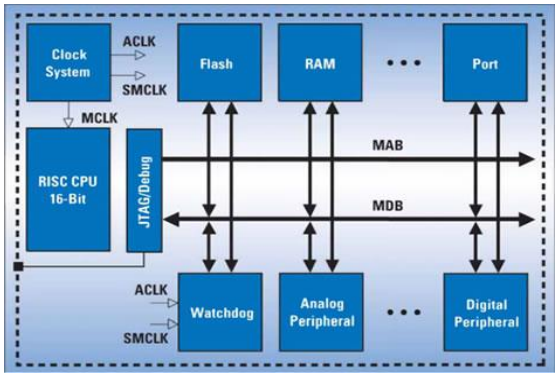

Fig.2 Architecture of MSP430

The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 6μs. The MSP430x15x/16x/161x series are microcontroller configurations with two built-in 16-bit timers, a fast 12-bit A/D converter, dual 12-bit D/A converter, one or two universal serial

synchronous/asynchronous communication interfaces, I2C, DMA, and 48 I/O pins. In addition, the MSP430 offers extended RAM addressing for memory-intensive applications and large C-stack requirements. Typical applications include sensor systems, industrial control applications, hand-held meters, etc.

Features

1) 16-Bit RISC Architecture, 125-ns Instruction Cycle Time

2) 12-Bit A/D Converter with Internal Reference, Sample-and-

Hold and Autoscan feature

3) Dual 12-Bit D/A converters With Synchronization

4) Bits: 4 bits (older devices) to 32 bits devices

5) Memory: Limited available memory, usually less than 1

M Byte

6) Input/output (I/O): Low to high (8-150) pin-out count.

B. Zigbee Overview

The name ZigBee is what engineers are trying to emulate with this protocol a bunch of separate and simple organisms that join together to tackle complex tasks. In the wireless environment, the signal strength which is sent by coordinators can be weakened as distance from it increases, causing communication with target nodes to become difficult and abuse of the wireless resources. Therefore, it is difficult to perform stable and reliable wireless communication with wide range nodes. It is not easy to use the wireless resources using location data because the coordinator cannot search the location of node. Also, the wireless link can occur to the signal attenuation by distance and the wireless signal fading by the transferring media.

1. *ZIGBEE NETWORK ARCHITECTURE*

In general, a complete ZigBee network contains 3 major parts: ZigBee Coordinator, ZigBee Router and End Device.

- **ZigBee coordinator (ZC):** The coordinator is the central unit of a ZigBee network. The generation of network beacon, controlling the formation of network topology and coordinating the communication and flow rate of the devices in the network.

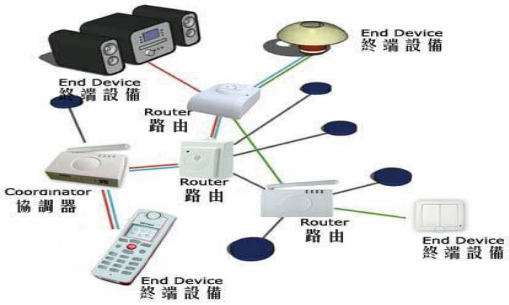

Fig.3 ZigBee Network Architecture

- **ZigBee Router (ZR)**: The transmission of data, coordination of flow rate of some devices in the network, sending and receiving commands and data, and permitting subsidiary device comes under the supervision of router. It also helps to extend the coverage of ZigBee network that's why it is also called as repeater.
- **End Device (ZED)**: End device present at the bottom of network topology, which supervise sending and receiving data and execute commands. Generally, there should not be hand over data to other devices [4].

2. *ZIGBEE STACK*

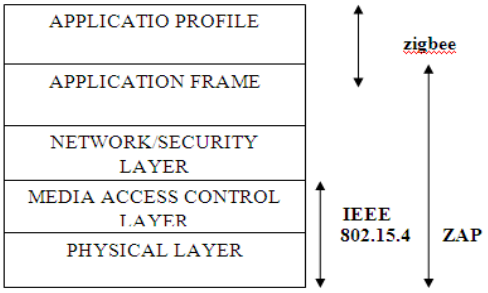

Fig. 4 ZigBee Stack

There are a multitude of standards that address mid to high data rates for voice, PC LANs, video, etc. However, up till now there hasn't been a wireless network standard that meets the unique needs of sensors and control devices. Sensors and controls don't need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large device

arrays. There are a multitude of proprietary wireless systems manufactured today to solve a multitude of problems that also don't require high data rates but do require low cost and very low current drain. These proprietary systems were designed because there were no standards that met their requirements. These legacy systems are creating significant interoperability problems with each other and with newer technologies.

3. *ZIGBEE APPLICATIONS*

• Home Control includes Security, Heating, Ventilation, and Air-Conditioning (HVAC), Lighting control, etc

• Personal health care includes Patient and fitness monitoring

• Industrial control includes Asset management, Process control, Energy management, Environmental monitoring

• Building automation includes Automatic Meter Reading (AMR), Security, HVAC, Lighting control, Access control, etc

• Environmental monitoring includes different environmental parameters monitoring such as temperature, humidity, illumination of light, etc. [5]

C. Relay Driver (ULN 2803)

Relays are components which allow a low-power circuit to switch a relatively high current on and off, or to control signals that must be electrically isolated from the controlling circuit itself. To make a relay operate, you have to pass a suitable pull-in and holding current (DC) through its energizing coil. And generally relay coils are designed to operate from a particular supply voltage. In each case the coil has a resistance which will draw the right pull-in and holding currents when it's connected to that supply voltage. So the basic idea is to choose a relay with a coil designed to operate from the supply voltage using for control circuit and with contacts capable of switching the current you want to control, and then provide a suitable relay driver. Circuit so that low-power circuitry can control the current through the relays coil. Typically this will be somewhere between 25mA and 70mA.

Often relay driver can be very simple, using little more than an NPN or PNP transistors to control the coil current. All your low-power circuitry has to do is provide enough base current to turn the transistor on and off. A NPN transistor Q1 is being used to control a relay (RLY1) with a 12V coil, operating from a +12V supply. Series base resistor R1 is used to set the base current for Q1, so that the transistor is driven into saturation (fully turned on) when the relay is to be energized. That way, the transistor will have minimal voltage drop, and hence dissipate very little power. As well as delivering most of the 12V to the relay coil.

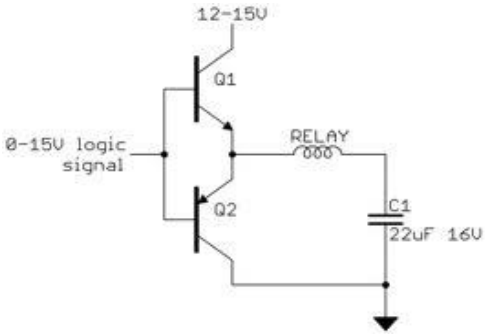

Fig.5 Relay Driver Circuit

D. ARM9

Advances RISC Machines now known as ARM was established as a joint venture between Acorn, Apple and VLSI between Acorn, Apple and VLSI in November 1990. ARM is the industry's leading provider of 16/32-bit embedded RISC microprocessor solutions. The company licenses its high-performance, low-cost, power-efficient RISC processors, peripherals, and system-chip designs to leading international electronics companies ARM provides comprehensive support required in developing a complete system. The mini2440 is a practical low-cost ARM9 Single Board Computer with a very high performance/cost ratio. With the Samsung S3C2440 microprocessor and the use of professional layout and quality peripheral chips, it is very robust. The Mini2440 uses a four-layer board design with gold immersion processing, and has high quality equal-length bus routing in timing critical areas. The production environment and quality control are the same as those of modern high-speed motherboards. A non-unified cache, so that instruction fetches do not evict data and vice versa. On the other hand it should upload the data to the ARM master unit through the serial port. The ARM master unit gathered the collected information data. The information collected by the ARM master is sent to warehouse data

management system through the GSM network through serial Communication.

Feature

- Decreased heat production and lower overheating risk.
- Clock frequency improvements. Shifting from a three-stage pipeline to a five-stage one lets the clock speed be approximately doubled, on the same silicon fabrication process.
- Cycle count improvements.
- Faster loads and stores.
- Exposing pipeline interlocks, enabling compiler optimizations to reduce blockage between stages.

E. SENSOR

1. *HUMIDITY SENSOR (SY-SH-220)*

To measure humidity, amount of water molecules dissolved in the air of environments, a smart humidity sensor module SY-HS-220 is opted for the system under design. The humidity sensor is of capacitive type, comprising on chip signal conditioner. However, it is mounted on the PCB, which also consists of other stages employed to make sensor rather smarter. The PCB consists of CMOS timers to pulse the sensor to provide output voltage. Moreover, it also consists of oscillator, AC amplifier, frequency to voltage converter and precision rectifiers.

Incorporation of such stages on the board significantly helps to enhance the performance of the sensor. Moreover, it also helps to provide impediment to the noise. The humidity sensor used in this system is highly precise and reliable. It provides DC voltage depending upon humidity of the surrounding in RH%. This work with +5 Volt power supply and the typical current consumption is less than 3 mA. The operating humidity range is 30% RH to 90% RH. The standard DC output voltage provided at 250C is 1980 mV. The accuracy is ± 5% RH at 250C. It provides three pins recognized one pin provides the DC output voltage, whereas the middle pin is ground. The VCC of +5V is applied at third pin. The humidity dependent voltage is obtained and subjected for further processing.

2. *LIGHT SENSOR*

A light dependant resistor also known as a LDR, photoresistor, photoconductor or photocell, is a resistor whose resistance increases or decreases depending on the amount of light intensity. LDRs (Light Dependant Resistors) are a very useful tool in a light/dark circuits. LDRs can have a variety of resistance and functions. The light dependent resistor is used to detect the light intensity. This sensor will give a variable output voltage with respect to the light intensity variations in a greenhouse. It has two cadmium sulphide (cds) photoconductive cells with spectral responses. The cell resistance falls with increasing light intensity and it can detect the minimum light intensity i.e. moonlight 0.1 lux.

3. *GAS SENSOR*

This sensor is used to sense the concentration of CO2 in a greenhouse. This sensor is also used as gas sensor to detect the smoke if occurs in greenhouse. Standard measuring circuit of MQ-7 sensitive components consists of 2 parts. One is heating circuit having time control function the high voltage and the low voltage work circularly. The second is the signal output circuit; it can accurately respond changes of surface resistance of the sensor. The CO2 concentration detection range is 200ppm to 10,000ppm.The concentration of CO2 can be expressed in terms of PPM or in percentage.

4. TEMPERATURE SENSOR

One of the most common and lowest cost methods of temperature measurement can be achieved with a thermistor. In its simplest form, a thermistor is a temperature-dependent resistor with the resistance changing as the temperature varies. In an ideal world, this response would be linear; however, this is not the case. For most practical uses, this non-linearity must be corrected. This can easily be achieved by using the analog-to-digital converter (ADC) of an MSP430 microcontroller to measure the resistance and linearize the result by a look-up table, linear interpolation or other, more complex mathematical methods.

Thermistors are available as both surface mounts and through-hole PCB-mounted components, making them a good, low-cost option for PCB level, or enclosed housing

temperature monitoring. For many industrial or automotive uses, thermistors are available enclosed in housing for easy mounting, or as a completed temperature probe. The MSP application report SLAA129 (Implementing an ultra-low-power thermostat with slope A/D conversion) describes a method of using a thermistor to create an ultra-low-power thermostat using a low-cost, but high-precision comparator-based slope-conversion method. Extending this implementation to use one of the MSP430 microcontroller's integrated ADCs with linear interpolation based on multiple calibration points or a lookup table is easily possible and can result in higher accuracy.

4. CONCLUSIONS

This paper focused on safety of wireless grain with the help of MSP430 and based on Zigbee technology. We address a new granary system based on sensor networks to reduce man power and safety of grain from the environmental parameter. The proposed system is flexible and easy to implement sensor network having low cost, low power more reliable. A Granary environmental parameter monitoring and control system can provide both significant cost savings in a home environment, as well as a great level of flexibility and control on the environmental.

ACKNOWLEDGMENT

The authors would like to thanks all the colleagues from the network and members of department of electronics and telecommunication Deogiri Institute of engineering and Management Studies, Aurangabad for their continue support and feedback.

This work focused on the environmental parameter monitoring and controlling which is very important for the grain safety through automation with wireless sensors.

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