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Design and Implementation of an Intelligent System to Prevent Grain Loss Due to Storage

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Abstract: **For people's livelihood, Grains are very important resources. But, its production is seasonal, that's why we need to store them. For this purpose grain storage depots are there in our Country, which are being run by the Government. Objective of these depots is provide the grains to the people whenever it is needed. Environmental parameters affect the quality of grains like temperature, humidity, light. If proper Environment is not provided then the Grains may get spoil, which may cause a heavy loss to the Country's economy as the bulk amount of grains will get wasted without being used. For overcoming this problem, here we are designing a system which will monitor as well as control the environmental parameters. This system will be an automatic system that will prevent the grain loss by automatically controlling the environment of Granary.**

Keywords: **ZigBee, Granary, ARM, ATmega.**

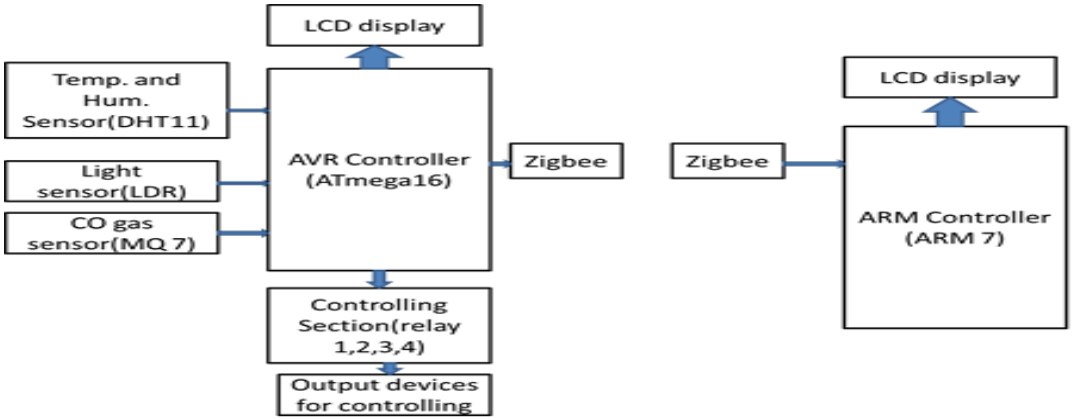
1. INTRODUCTION

To prevent the Grain loss, a system is needed that can monitor and as well as control those parameters that affects the grain quality. Here, we are going to design and implement the system for this purpose.

This system is a combination of embedded system and ZigBee Wireless Sensor Network technology. It uses ZigBee technology for communication between transmitter and receiver. The system allows for a user to input the desired conditions regarding the surrounding atmosphere`s temperature requirements. In this system, every time, the environmental parameters are compared with the desired parameters and when the environment parameters crosses its desired range the system will activate its dedicated relay and the corresponding device for controlling that particular parameter will get activate. This automatic system will improve the operation levels of grain storage, reduce the grain losses during stored procedure and reduce labor intensity.

This system's objectives are: to gather the environmental information of Granary and control them according to the conditions favorable for Grains, to transmit the Granary Environmental parameters to the receiver end through wireless sensor network using ZigBee and to display the current environmental parameters at both ends (source, destination).

2. HARDWARE DESIGN



This system consists of two sections, that is Transmitter and Receiver section. In transmitter part, AVR Controller (ATmega16) is used and this controller is connected to the sensors. The sensor node is responsible for collection of environmental information (such as temperature and humidity, CO, Light). The signals collected by the sensor through the analog to digital conversions are sent to MCU processing. The microcontroller is connected to LCD to display the values. In controlling part, dedicated output devices can be connected to the controller through the dedicated relays. Here, four relays are connected. For example, Heater, Cooler, bulbs, etc. can be used for controlling the environmental parameters. The ZigBee communication module changes the data into data packets of ZigBee communication protocol which are transmitted to the coordinator node.

In Receiver section, the coordinator node, after receiving the data packets from the sensor node performs handshake communication by sending a confirmation language source to the sensor node to complete a full ZigBee wireless communication process. 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 and displays it on the LCD, connected to it.

The AVR controller after gathering the collected information data, using the weighted algorithm to make judgments for the environmental information, such as starting the fan, cooler, bulbs and so on. So, environment of grain storage is achieved intelligent control.

HARDWARE REQUIREMENTS:

Hardware requirement standards are based on the current technology available combined with the current needs of end-users. The minimum hardware specification for our project purpose as follows:

After careful analysis the system has been identified to have the following hardware:

1) ARM7 TDMI LPC2148

2) AVR microcontroller ATmega16

3) Temperature and Humidity Sensor (DHT11) 4) Light Sensor (LDR)

5) CO gas Sensor (MQ7)

6) ZigBee Communication Device (XBEE2-4214A)

7) Serial data Communication using RS232

8) 16x2 LCD display unit.

The LPC2148 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-SCPU. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement. We are using this in receiver side (management depots) so that many granary environment may be monitored parallel, if needed.

The ATmega16 is a high performance, low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. It have built-in ADC, to which sensors are connected.

DHT11 is a temperature & humidity sensor with a calibrated digital signal output. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement. Its measurement range: For humidity, 20-90%RH and for temperature, 0-50 ℃.

LDR is light sensor. Normally, the resistance of an LDR is very high, but when they are illuminated with light resistance drops dramatically.

MQ 7 is CO gas sensor. When the grain starts spoiling, CO gas emits from it. So, this sensor is basically used to detect it and proper action may take place.

Zigbee is 802.15.4 compatible RF module for wireless communication in 2.4 GHz ISM band. It provides reliable communication. Its range is from 10m to 1000m.

For transmitter circuit designing, Proteus software ISIS module is used and for its layout ARES module is used. In receiver side, ARM7 development board is used.

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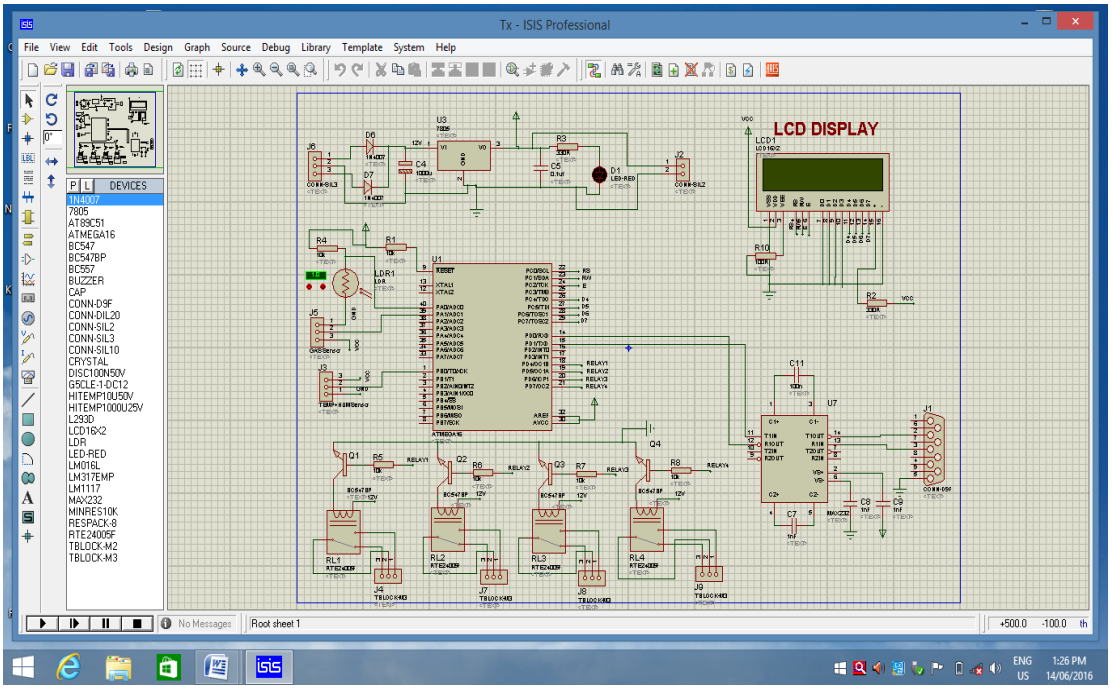

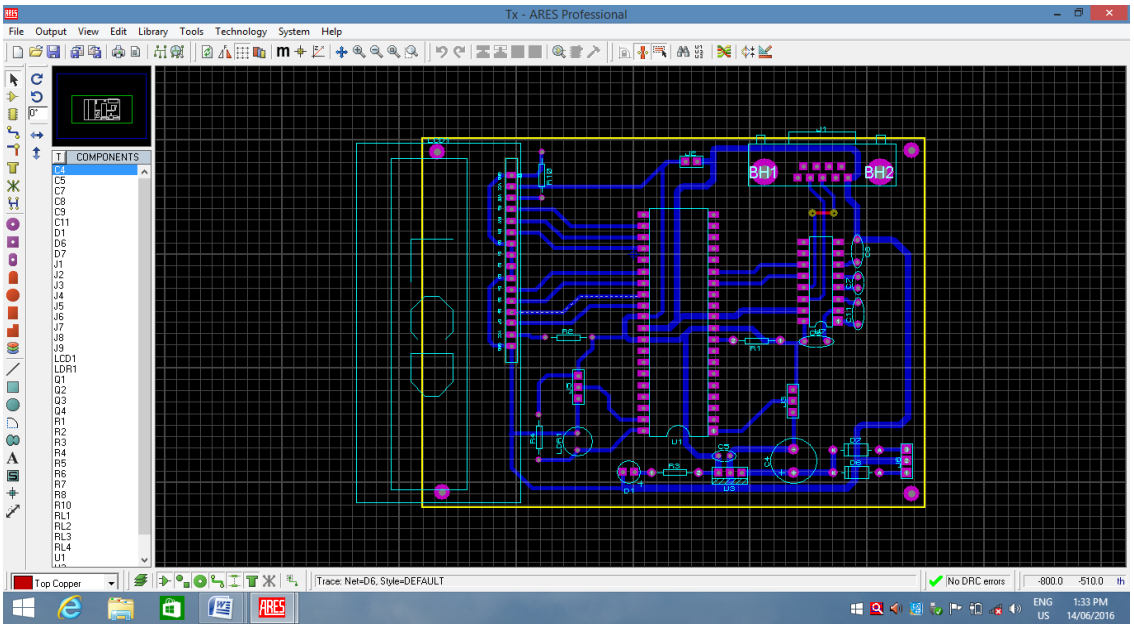

3. SOFTWARE DESIGN

After deciding and knowing about the Hardware which we need in our System, now it's the time to know about the Software which will be used in this system for programming the controllers and for burning the Program into the controller chip.

Code Vision- For AVR (ATmega16) programming

Keil µVision- For ARM (ARM7) programming

Flash Magic- For burning the receiver program into ARM7

ProgISP- For burning the transmitter program into ATmega16

Keil compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. µVision4 is an IDE (Integrated Development Environment) that helps to write, compile, and debug embedded programs.

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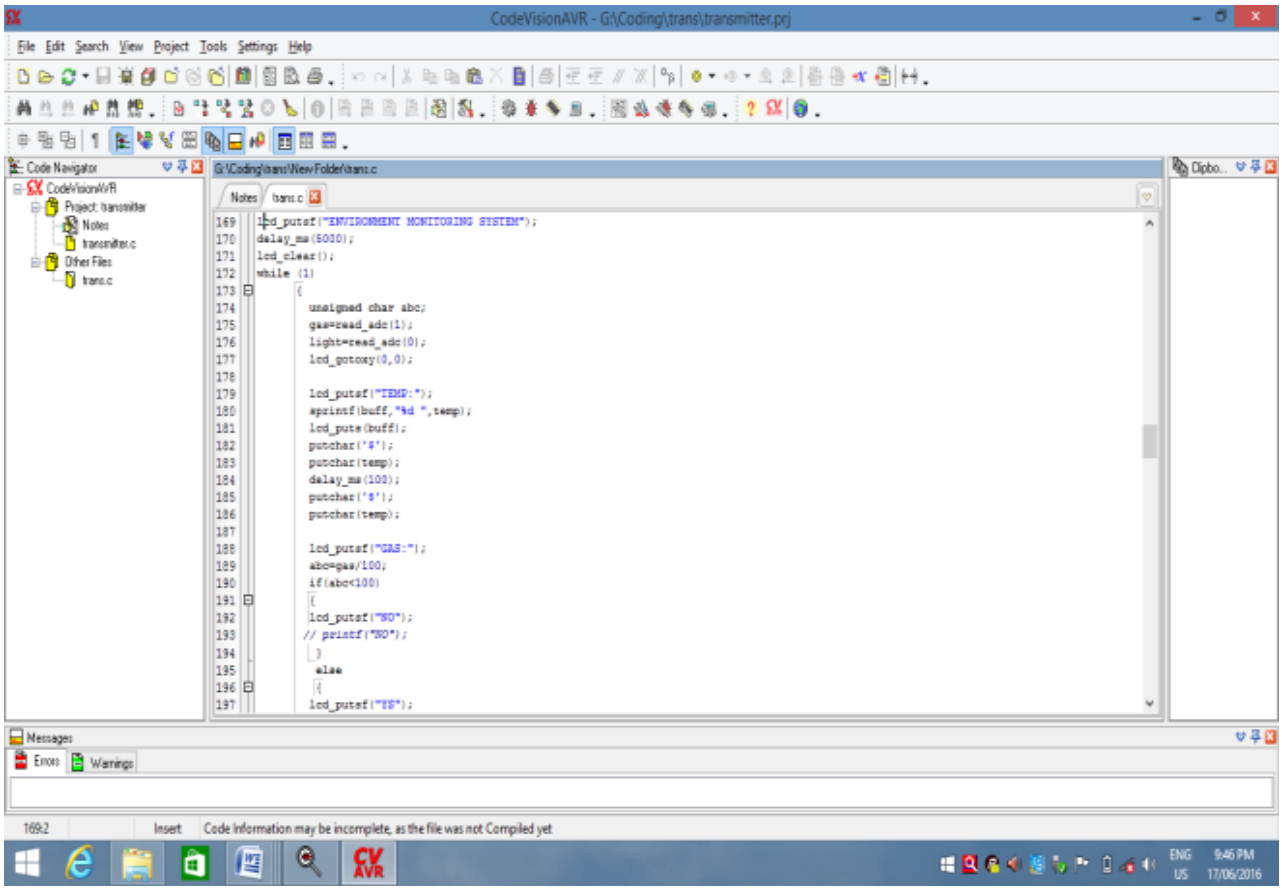
Code Vision AVR is a C cross-compiler, Integrated Development Environment and Automatic Program Generator designed for the Atmel AVR family of microcontrollers. The C cross-compiler implements all the elements of the ANSI C language, as allowed by the AVR architecture, with some features added to take advantage of specificity of the AVR architecture and the embedded system needs.

The code in embedded C, for transmitter side was compiled in Code vision software as shown:



Similarly, receiver code was also compiled in Keil uVision software.

Flash Magic is Windows software from the Embedded Systems Academy that allows easy access to all the ISP features provided by the devices. The method to download Hex File into Flash Memory of MCU is as shown:

Interface RS232 Cable between RS232 Serial Port of PC and Board UART-0 (CN3).

Supply power into board; in this case, we can see red LED1 is in status ON.

Set jumper BR4 (INT1) in ON state.

Run Program Flash Magic. Start setting the initial values into program as desired, so we configure values into program as follows:

Select COM port, set the baud rate to 9600

Set Device to be LPC2148

Set Interface to be None ISP

Set crystal oscillator with frequency corresponding with the value internal Board. In this case, it is 12MHz.

Press ISP LOAD Switch (S1) and RESET Switch (S2) on Board “ARM7 LPC2148 Development Board” to reset MCU to run in Boot Loader. ProgISP: This is used to burn the transmitter program into the ATmega16 chip. The following steps were followed:

Connect the USB cable to the Program burner.

Open and run ProgISP. It will display the window.

Select chip ATmega16.

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Then load Flash and select hex file of program.

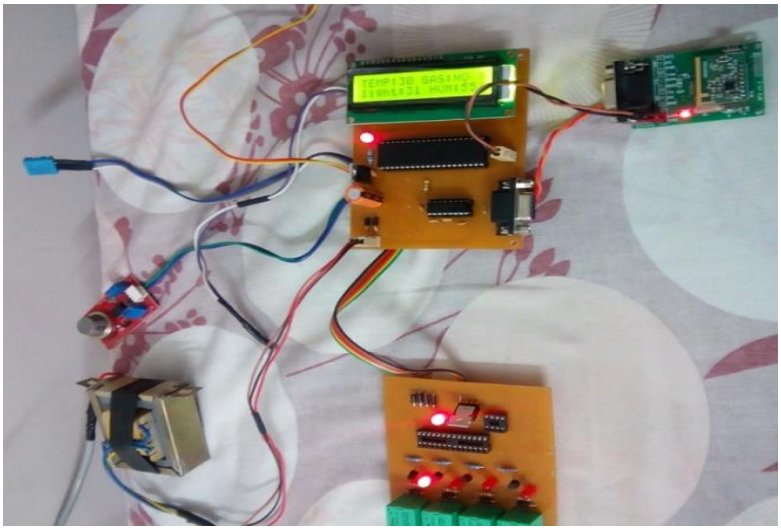
Set program fuse enable and set fuse as 0xD9E1 and press the Auto button.

Language Used:

For programming the controllers, Embedded C language has been used.

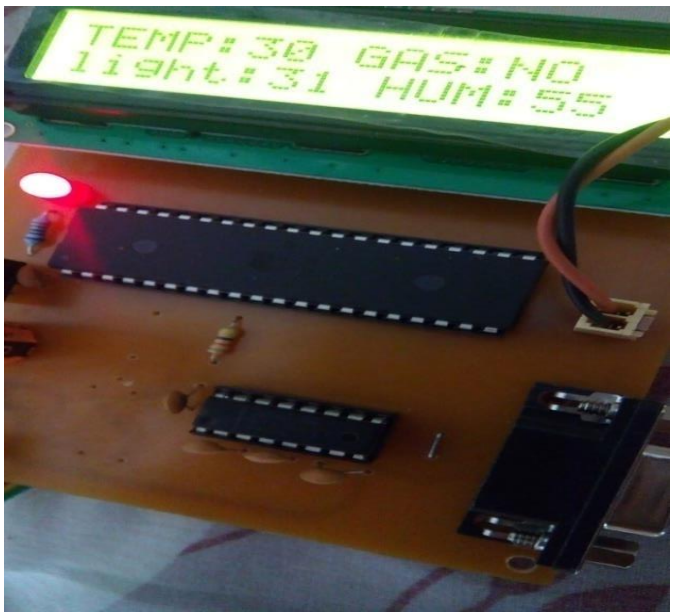
4. RESULTS

The implementation of an intelligent system to prevent Grain is done successfully. The communication is properly done without any interference between different modules in the design. Design is done to meet all the specifications and requirements. Software tools like keil uvision simulator, code vision, flashmagic, progISP to dump the source code into the microcontroller, have been used to develop the software code before realizing the hardware.



This is the transmitter section which is showing the ATmega16 Controller connected to the Sensors (DHT11, MQ7, LDR), LCD, Zigbee and the Relays (Controlling section). Here, the LCD is reading the following values:

Temperature: 30, Gas: NO, Light:33, Humidity: 55. Here, since humidity parameter has crossed its set value, that is why the relay dedicated for Humidity was activated as shown.



Receiver Section: Here, in this section the environmental parameters which was transmitted were accurately collected and displayed on the LCD.

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5. CONCLUSION

Using the above mentioned hardware and software, the environmental monitoring and controlling system has been made which was tested and it gave the results as desired. The parameters like temperature, humidity, light and CO has been sensed accurately and controlled as well, as required.

In this way, the system which is made, is fully automatic which does not need any human resources and hence, it is able to remove the labor. Finally, this system can be used in the Granary to prevent the loss of grains and our Country's economy. This system reduces the energy consumption significantly. The system designed is very simple, easy to use, also it is easy to install.

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