



# FOOD GRAIN STORAGE MANAGEMENT SYSTEM USING NANO TECHNOLOGIES

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**Abstract**—Agriculture is the backbone of any nation's economy and there is a dependency between agricultural growth and economic prosperity. As India is an Agriculture country where 70% of the population depends on farming, the storage of grains plays a crucial role in national economy. Due to the seasonality of grain production, the storage of grain is the top priority task for restoring and reusing. In the process of grain storage, temperature and humidity are major environmental factors that can influence directly on the quality of the Grain. Hence, there is a necessity to monitor the vital parameters continuously during storage and communicate the status to the manger in real time which becomes challenging. The traditional methods are limited to simple manual temperature and humidity testing which are relatively backward since grain situation analysis are made without any effective means of processing and regulation hence there is a need for smart grain management system with automation which can also avoid hidden security risks. The Real-time monitoring of the grain storage system is designed based on ARDUINO and using GSM module as the lower level Control unit which improves the level of grains storage and reduces the grain losses during storage procedure and also reduces manpower and labor intensity. The Experimental results show that grain condition intelligent monitoring system designed in this paper has several good features such as real-time online detection, easy acquisition, and good site stability.

**Keywords**—Arduino; Forming; grain; monitoring; economy.

## 1. INTRODUCTION

In many countries Grains are the main source of food and many staple food products are prepared from them, so every human life depends on Grains food products for survival in one or the other way. Hence cultivation and storage of grains play a crucial role in the national economy and overall development of the society. Economies of developed and developing nations depend directly or indirectly on storage of cultivated grains since they are related to the several hundreds of millions of people. `

The aim of grain storage facility is mainly to provide safe storage condition and to maintain the quality of the stored product. Grain loss occurs by adverse environmental conditions and from

the activities of insects and microorganisms. Temperature and moisture content of the stored grain environment are the most important factors that can influence stored-product mold growth, insect activity and subsequent production of mycotoxins in a storage facility.

Maintaining optimum temperature, relative humidity and proper moisture content in the storage facility are the challenges faced in Grain acquisition. Seasonal and daily climate fluctuations influence quality of Grain to the greater extent results in mold growth, insect activities. The optimum temperature range for mold growth inside the depot is around 25-40°C, and temperatures above 35°C (Celsius) are ideal for insect growth and reproduction. Insect metabolic activity in dry commodities below 10% moisture content can result in heating up to 42°C (Mills 1989).

A major contributor to the spoilage of grain is the growth of a variety of mold species, including several that produce mycotoxins. Mycotoxins are natural chemicals produced by fungi that are detrimental to the health of grain.

Now we are still using our old methods to store various cultivated crops, traditional methods of grain condition monitoring and controlling are limited to simple manual temperature and humidity testing and grain situation analysis without any effective means of processing and regulation.

Usually, these are carried out by means of ventilation, drying and circulative fumigation which is relatively backward and results in wastage a lot of manpower and resources hence it not only brings great inconvenience to the grain storage management but also hidden security risks.

The advancement in technology allows us to develop real-time monitoring system of remote locations, which makes it easier to control and monitor conditions from any place at any time. The Real-time monitoring of the grain storage system is designed based on ARDUINO, which helps us to improve the level of grains storage and reduce the grain losses during storage procedure and also reduce manpower and labor intensity.

The objective is to design a granary monitoring system by combining Embedded and GSM technology. The GSM modems are used to complete acquisition and transmission of environment parameters over the network to achieve the system's remote control and using ARDUINO to achieve precise control of the Granary environment as system data controller. It greatly improves the flexibility and scalability of the warehouse management which sends available data to grain depot manager and each and every minute condition of grain will be monitored.

## **2. RELATED WORKS**

A. The Design of Granary Environmental Monitoring and Control System Based on ARM Controller and ZIGBEE:

An application developed in the monitoring system incorporates a host PC, information administration and remote monitoring system based on Lab Windows and ZigBee sensor system. Sensor system outlined considering temperature, humidity and Light are principle variables impacting condition of the Grain. ZigBee WSN's [2] has some significance in complex systems such as it offers low-power operation, robustness and high security and scalability.

The author likewise depicts framework of the design [4], hardware and software components, this paper additionally covers performance of the transmission separation of ZigBee remote hub in grain and the hub lifetime estimation. The system contains various observations regarding to

environment such as temperature, humidity and moisture along with other factors can be of importance. A normal way to compute these factors in storage environment meant individuals manually taking dimensions and inspecting them at different times.

**B. A Survey on Applications of Agent Technology in Industrial Process Control:**

This survey focuses exclusively on the technology applications in the automation of continuous industrial processes, as the differences in the technology adoption between the process automation and manufacturing are significant. A large part of the literature on the subject is reviewed.

The analysis of the literature is provided from several points of view, the main trends of research are described, including the shift of the researchers' interest from the agent-based supervisory control to the low-level agent-based control algorithms. The rapid population growth is seen as the major factor that results in increased demand for food. According to the FAO.

**C. Design of Monitor System for Grain Depots Based on Wireless Sensor Network:**

This scheme utilizes sensor nodes deployed in barns, which compose an autonomous network, to collect environmental data of grain storage and then transmit them to remote control center by means of wireless and multi-hop communication. Due to using small, low cost sensor nodes and wireless communication, several problems in traditional monitor system are solved.

These problems include large cable coverage, more opportunities of interference and lightning strike, high maintenance cost and so on. Consequently, the WSN-based system has good reliability, maintainability and cost effectiveness. The world's population is expected to increase by 50 percent between 2000 and 2050. In Turkey, for instance, it is expected to be 84.247.088 citizens in 2023 with a population growth rate of 9,8 percent per year.

**D. Environmental Monitoring in Grain:**

The techniques which have been developed have generic applicability, but in this work they are focused on the monitoring of grain storage. Determination of the environmental conditions in a grain silo is challenged by the dielectric properties of the grain and the multi-path nature of RF propagation in the silo. These challenges apply to both the inter node WSN communication and node positioning. The methods adopted to meet these challenges and significant results achieved are presented.

### **3. GRAIN SYSTEM DESCRIPTION AND WORKING PRINCIPLE**

The general model proposed for grain storage framework comprised of two parts, one is the host MOBILE which assembles Grain environment ie Sensor data, its procedure and forecast of grain circumstance, the other one lower level control terminal in the silo/depot with grain information obtaining. The principle reason for the framework is to get information from various sensors and transmits this information's over Wireless Network.

The sensors collect the information from the environment, the collected signals through the analog to digital conversions. These conversions are sent to ARDUINO unit. This ARDUINO unit is connected to temperature and humidity sensors and using GSM to achieve the system's remote control.

It greatly improves the flexibility and scalability of the warehouse management which sends available data to grain depot manager in time and filters invalid data on the spot. The architecture of proposed grain monitoring system is consisting of Hardware as well as Software components.

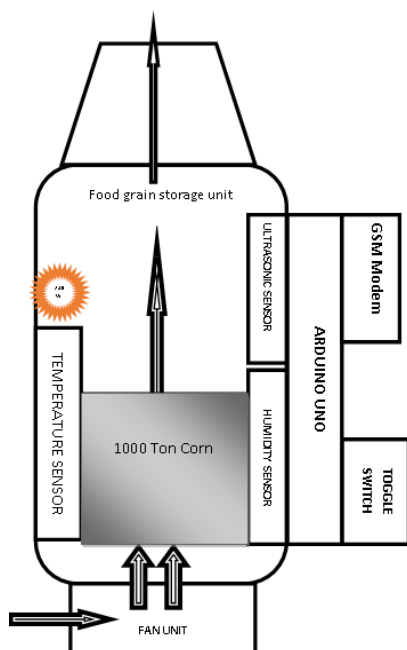


Fig 1: Grain Monitoring System Architecture

The hardware part include sensors, ARDUINO and GSM module are connected properly inside remote grain acquisition depots and controlling action can be performed using ARDUINO. Three environmental monitoring sensors are used they are a DHT11 humidity sensor, LM35 temperature sensor.

These two monitoring sensors are connected to ARDUINO micro-controller board. These sensors are analog in nature they sense signals and produce an output voltage proportional to corresponding signal measured. The output voltage is processed using controller and data acquisition model. The signals are amplified if signals are weak and digitized using Analog to Digital converters.

It Acquire the real-time data from granary process the signal and then given to the ARDUINO controller board in digital form. The ARDUINO controller sends the data received and processed from granary environment over the above model to mobile using GSM module.

#### E. Arduino

The Arduino Nano is a microcontroller board based on a removable, dual-inline-package (DIP) ATmega328 AVR microcontroller. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs). Programs can be loaded on to it from the easy-to-use Arduino computer program. The Arduino has an extensive support community, which makes it a very easy way to get started working with embedded electronics. The R3 is the third, and latest, revision of the Arduino Nano.

#### F. Units

- Temperature sensor

Temperature sensors LM35 is chosen since LM35 provides reliable accurate surrounding temperature directly in °C according output voltage. These sensors are analog in nature which senses surrounding temperature produces output voltage in mV proportional to surrounding

temperature, so it is easy to take accurate readings by connecting to development boards. It can measure temperature ranges from -55°C to 150 °C.

- Humidity sensor

DHT11 humidity sensor modules are chosen and they are configured with IC's circuitry to provide on chip signal conditioning. Absorption-based humidity sensors provide both Relative Humidity (%RH) and temperature outputs. On chip signal processing ensures Relative Humidity output versus linear voltage. The Sensor laser trimming offering +5%RH accuracy and attains 2%RH accuracy with calibration. Packages are chemical resistant and operating in range of -40 °C to 85 °C [-40°F to 185°F] to accommodate erratic environment.

- GSM Module

This GSM Modem SIM900 are simple to interface serial interface. It features with voice, SMS, and Data services. GPRS data related operations can be controlled with the help of AT tension commands from the PC and also from controllers. This module contains the highly popular SIM900 module inside it which holds SIM CARD meant for all its data, voice related operations. This module come with familiar widely used standard RS232 interface, so these modules can be easily interfaced to PC and controllers.

#### 4. IMPLEMENTATION

Implementation part of grain system includes Hardware implementation and software realization. Each implementation part is described in the lower section.

##### G. Firmware Implementation and Flowchart

The program source code is written in such a way that operations of the development board can be controlled. The PCB circuit design for the hardware used in the present work is done using Orcad design software. The software development kit Arduino IDE supports ATMEGA family controllers, with the help of this tool source code is written in C language and compiled to generate hex file. The hex code generated by the compiler is burned into ARDUINO development board using flash magic programmer. Flowchart for transmitting and receiving station grain monitoring system model is shown below.

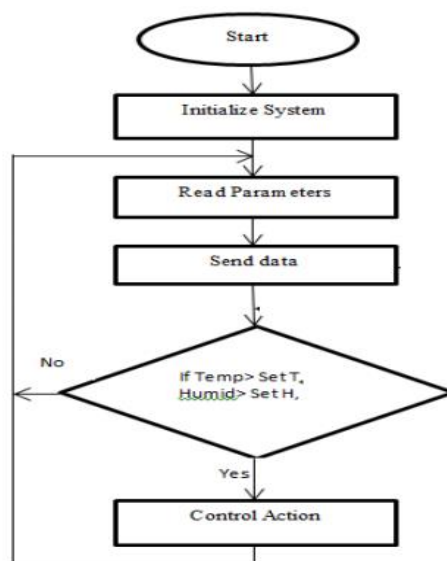


Fig 3: Flowchart for transmitting section of Grain storage system

##### H. Simulation Implementation

This design is an automatic environment monitoring system and control system of the granary combining Arduino and GSM (Virtual Terminal).

GSM can be used to complete acquisition and transmission of environment parameters and ARDUINO is used to achieve precise control of data controller and GSM to achieve the system's remote control, it greatly improves the flexibility and scalability of the warehouse management which sends available data to grain depot manager in time and filters invalid data on the spot. It can be saves a lot of manpower and material resources and improves labor productivity.

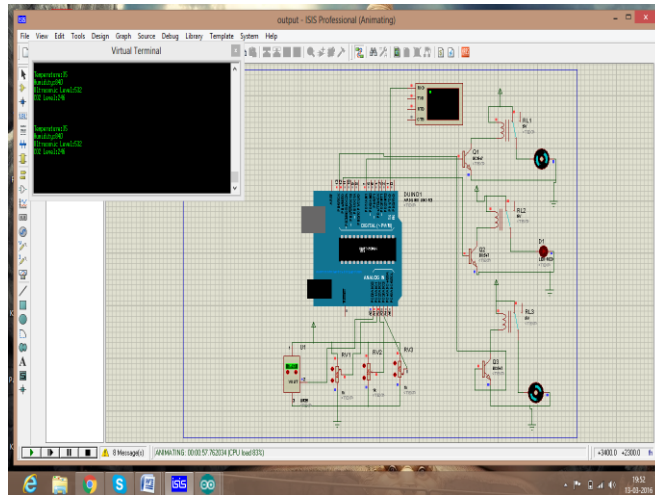


Fig: 4.1: Simulation result when values are normal

### I. Hardware Implementation

The framework depends on installed Arduino for the lower machine control unit. The grain condition Information, for example, temperature, and mugginess information is gathered and put away by Multi-sensor. On the off chance that the dampness and temperature sensor esteem is increment the further activity should be possible by Arduino.

On the off chance that the internal room and external room temperature is up typical or not equivalent Arduino naturally produce the flag to run the engine for open the window. At the point when the temperature is ordinary naturally it shut. In the event that the Humidity level is high naturally fan will turn. In the meantime relating in charge will get the data through GSM.



Fig: 4.3: Proposed system Hardware

Flip switch is utilized for actuate or deactivate the Theft security process. Ultrasonic sensor is utilized to create the reverberate motion for stop the generation or creatures (like feline, rodent, and so on) and reptile (like Central unshaven drago, Ground agama, and so forth). And furthermore it is utilized to distinguish the individual passage in the store. Here we are composed one concealed entryway for security reason. In the event that the individual passage to the store consequently the data is send to the comparing in control. The in charge can initiate the entryway by utilizing the GSM.

## 5. CONCLUSION

India produces about 259.32 million tonnes of food grain annually but the post production losses are also high. Major stock is stored at farmers' level (70%) and remaining at organizational level. The advancement in scientific design and development of low cost storage structures has been found effective as it has created interest and awareness among farmers and traders to preserve the food grains safely. The modified and improved structures provide safe and economical means of grain storage for long durations.

Need of the hour is to strengthen traditional means of storage with modern inputs and to provide cheaper storage structures such as low cost bins to farmers so as prevent enormous storage losses. With the chemical insecticides being phased out due to their residual effect on human health; the need for the hour is to maintain hygienic practice in the storage systems.

Maintenance of controlled atmospheres or hermetic storage environment for the control of insect growth is also very effective and is possible for bulk storage system. Precision monitoring system of insect population and application of control dose of insecticides are few such measures for ensuring grain safety and security. It is shown from the design implemented in the current work provides flexibility, scalability, portability and security/integrity of the data transmission over long networks with lower power consumption.

In existing system the storage of grains are monitored manually. There is no proper inspection of the storage grains at periodic levels. Due to this the grains may get damaged. There is automatic attribute control facility to maintain an optimized temperature. Hence there is a need to design an automated system which monitors & maintains the storage grains quality. Here chemical tablets are used for grain damage and it affects the human health.

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