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Review on Low Cost Wireless Sensor Network for Grain Storage Monitoring System

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Abstract: *Agriculture industry faces different losses both before and during harvest of grains due to lack of technology usage. In fact the greatest and considerable amount of food is wasted during storage of grains. Hence, there is a need to improve the storage facilities of grains to maintain its quality and quantity efficiently in order to reduce food as well as financial loss. An efficient storage system can ensure the grain's quality by controlling and monitoring environment related factors, such as temperature, light, humidity, pests and hygiene. The technique will measure the level of grains inside silos through efficient level sensors and monitor the environment in silos through environmental sensors and then recorded parameters will be sent periodically to the main computing device and will be displayed automatically on the display. In this paper we propose a smart solution for efficient monitoring of grain storage in order to reduce food wastage.*

Keywords: *Grain Storage, Wireless Sensor, Monitoring System*

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I. Introduction

Recent research interests in studying food wastage have taken priority in various countries for improving food security and the sustainability of food systems. The problem of food wastage is approached in two main perspectives, namely that due to environmental conditions and the other associated with consumption factors. Food wastage takes place throughout various stages of the food supply chain, right from farm production, during processing, packing, transportation, at wholesale market, retailers, and consumption. Hence, different measurements and lack of standards in data collection make it difficult to estimate and compare the food wastage among various countries. While it is difficult to arrive at an accurate estimate, reports indicate that food wastage globally amounts to about one-third of the food produced. It is estimated that about US$1 trillion is lost globally towards food wastage. In many low-income and developing countries, poor storage conditions and lack of appropriate storage facilities contribute considerably towards food wastage. In developing countries like China, high food wastage takes place in farm households where more than 50 percent of grain is stored, and studies indicate this is about the same level as the food wastage in developed countries. Although globally the agriculture industry faces different losses both before and during harvest of grains, the greatest and considerable wastage occurs during storage. For a sustainable development of agriculture with reduced financial loss, there is a need to improve the storage facilities of grains to maintain its quality and quantity efficiently.

A good storage system using information technologies can ensure the grain's quality by controlling and monitoring impending factors, like temperature, light, humidity, pests and hygiene. Hence, in this paper we focus on developing a smart solution as an intervention for food wastage, in particular for efficient monitoring of grain storage. Traditional storage structures for grains were mainly adopted as protection from pests for a very short period and hence were not constructed of good quality. Recent development of more affordable storage solutions such as hermetic storage technology can avoid wastage due to pests as their airtight containers absorb oxygen progressively resulting in non-survival of pests. Another factor to preserve the quality of grains is the adoption of appropriate temperature control conditions. Even with traditional systems adopting different air-tight bulk bins for grain storage, grain damage occurred due to excessive temperature, humidity and pressure of air through the grain heap. In countries with humid and tropical climate, the lack of drying technology is the main reason for grain damage. The two-stage grain drying technology reduces the grain moisture content to a safe storage level. Therefore, there is a need to develop an intelligent, automatic and real-time measuring and controlling system for efficient grain storage. Hence, by adopting smart solutions that optimize a combination of such storage conditions intelligently would help in measuring and monitoring the quality of the grains and preserving them for longer periods in their storage. Such systems are important also due to scarcity of labour, cost efficiency, and high productivity. In this paper, a smart automatic monitoring and controlling system is proposed by leveraging the potentials of CPSs. The system is will make use of sensing of the temperature, humidity and other affecting factors in the storage bin in order to reduce grain wastage during storage, provide a reliable, cost-effective and efficient grain quality monitoring system during grain storage, and finally provide a solution applicable to similar problems such as controlling the pest during grain storage with required extensions.

II. Literature Review

In this work, we have implemented a hierarchical air quality monitoring system based on IOT technology. By deployment of the front-end sensor nodes, routing nodes and sink nodes in the campus of Beijing University of Technology, together with the back-end database and data processing system, this monitoring system can accurately acquires air quality data from different spots within a relatively long distance. Further, we did power optimization of the whole hardware system through sleep mode and working mode switching. The acquired data showed that still the automobile emission is the biggest factor which contributes to the air pollution in Beijing City. Beijing in China is facing a serious air pollution problem which severely impacts the daily life quality. How to monitor the air quality in real-time with a big coverage of Beijing city, and automatically process the big data is now becoming a hot research topic. Air quality sensors, such as CO, SO2, NO, NO2 and PM2.5 sensors, can accurately detect the level of air pollution which may contain different kinds of tiny particles. By using Internet of Things (IOT) technology, information can be transferred from IOT sensor nodes to the information processing center through different wireless/wired networks. This paper aims to build a prototype system by hierarchically deploying terminal sensor nodes inside the smart buildings of each floor and data collection units and routers in the open spaces between smart buildings, and transferring the sensor thing data back to the information processing center for real-time display. In this implementation, all sink nodes send out air quality detection information to the information processing center through ZigBee wireless protocol. Information processing center receives and analyzes real-time information being collected from the sensors, stores all information to the database. Through reading IOT thing data stored in the database, web front-end system will draw real-time, high-quality air quality monitoring maps of the inside and outside of the buildings. Further, a detailed system power optimization is also presented [1].

This paper presents a water quality monitoring system based on the Beat Sensors. The Beat Sensors successfully measures salinity, water level and pH of water. As shown in Table I, they consumes average power of 500uW, 90uW, and 70uW, respectively. These low power natures could realize energy harvesting, and wireless water quality monitoring Beat Sensor, which can be applied to application of Agri and Acqua Culture. This paper presents water quality monitoring IoT Beat Sensors. The interval times of ID code transmitted wirelessly from Beat Sensor nodes correspond to amount of salinity, water levels, and pH, so that receivers can acquire these parameters from many sensor nodes in agriculture and aquaculture fields. In experiments, this system can measure salinity in range 0.58%~6.48% with average power consumption of 500uW, water level in range 3.5~10.5cm with average power consumption of 90 uW and pH in range 3.45~9.58 with average power consumption of 70 uW [2].

This paper presents a novel scheme of fruit quality measurement based on loT. The proposed system is developed using an Arduino microcontroller (ATMega 328). A case study is carried out on a set of apples. The ripening index is calculated and calibrated with predetermined ripening index and accordingly stored on a remote loT Cloud (Carriots). The results obtained from this study shows a promising aspect of relationship between analogue read value and establishment of probes (in distance) on the apples. Upon further modification, this cost effective and portable design can be practically implementable in fruit processing industries. In today's world, food processing industries are immense part of human livelihood be it directly or indirectly. Human population consume enormous amount of foods that are sold in packaged form manufactured in several food processing industries around the globe. Packaged fruit products such as juice, jam, jelly, tomato ketchup, fruit cakes etc. are the most popular examples of such intake. But, when quality of fruit comes into the scene, maximum fruit processing industries do still depend on direct human intervention. Especially, in the selection process of good quality fruits from a dynamic fruit chain. This method is obviously an error prone task in nature. Henceforth, intluenced to abolish this practice, a study is conducted on how automated quality checking (i.e. ripening percentage) can be done. To counter this problem, a simple, easy to design and portable solution based on Internet of Things is presented in this paper. This study has been carried out using a set of Apples (Malus Domestica) to proof of this concept. The preselected apples are numbered per their ripening (i.e. measure of good taste and quality). Later, an Arduino based microcontroller board performs analog read operation, based on which a precalibrated indexing table is compared to disseminated the ripening index. This information is instantaneously sent over the Internet of Things based cloud platform for storage, and real-time knowledge processing. This way, this successful experiment can further be modified and optimized to be practically useful in fruit processing industry [3].

In this article, the design and development of low cost system for real time monitoring of water quality and controlling the flow of water by using IoT is presented. The proposed system consists of sensors for water quality monitoring and solenoid valve for controlling the water flow in the pipeline. These devices are low in cost, high efficient and flexible. These are connected to Raspberry pi core controller and IoT module. Finally sensed values viewed and controlling is performed by internet and also through Wi-Fi to mobile devices. This system is used in many fields like water distribution system, industries and aqua farming. This monitoring and controlling process can be performed at anytime and anywhere in the world. In future, we can include biological sensor for better detection of contaminants in water and can install the system in several locations for high spatiotemporal coverage. Water is a prerequisite element required for humans and therefore there must be mechanisms put in place to vigorously test the quality of drinking water in real time. This paper proposes a low cost system for real time water quality monitoring and controlling using IoT. The system consist of physiochemical sensors which can measures the physical and chemical parameters of the water such as Temperature, Turbidity, Conductivity, pH and Flow. By these sensors, water contaminants are detected. The sensor values processed by Raspberry pi and send to the cloud. Finally the sensed data is visible on the cloud using cloud computing and the flow of the water in the pipeline is controlled through IoT [4].

Although we are living in the era of technology and blessed by the advent of technology innovations, however in agriculture industry, the considerable amount of grain is declared as wastage during storage due to lack of technology usage. A good storage system using information technologies can ensure the grain's quality by controlling and monitoring environment related factors, like temperature, light, humidity, pests and hygiene. This paper presents a smart monitoring system for improving storage facilities of grains inside silos through efficient sensing and monitoring, in order to reduce food wastage [5].

III. Proposed Work

In pervious paper used only two types of sensors (humidity and temperature sensor but in that project used extra three sensor's Weight sensor, dust sensor, UV sensor including Humidity and temperature sensor.)

a) Humidity and Temperature

The outdoor Humidity and temperature can be measured by the help of DHT11 sensor which is connected to the microcontroller. The controller processes the data and sends to the master after every 2 minutes of intervals

b) UV Sensor

UV sensor measures the power or intensity of incident ultraviolet (UV) radiation. This form of electromagnetic radiation has shorter wavelengths than visible radiation, but is still longer than x-rays. UV sensors are used for determining exposure to ultraviolet radiation in laboratory or environmental settings.

c) Weight sensor

A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. The various load cell types include hydraulic, pneumatic, and strain gauge. A load cell is a sensor or a transducer that converts a load or force acting on it into an electronic signal. When weight is applied, the strain changes the electrical resistance of the gauges in proportion to the load. Other load cells are fading into obscurity, as strain gauge load cells continue to increase their accuracy and lower their unit costs.

d) Dust Sensor

This module is a dust sensing system based on the sensor GP2Y1010AU0F designed to sense dust particles. An infrared emitting diode and a phototransistor are diagonally arranged into this device, to allow it to detect the reflected light of dust in air. It integrates an internal infrared emitting diode (IRED) to detect the reflected light of dust in air and generate an output voltage proportional to dust density so as to measure dust and smokeconcentration.

Proposed System Architecture

a) Internet of Things using Arduino

Most of the researches will Use the arduino platform for developing the tiny nodes. Since arduino is low cost and open source, we are also implementing the arduino to form nodes. There are currently various existing controllers on arduino platform each having a different version of flash memory and IO pins. According to our demand in the project the Arduino UNO is the best suited for making the nodes of the sensor since it is low cost and easily available. Also the SMD version of the node will consume less power which can last up to 6 Months depending upon the type of battery power supply given. Also the Analog pins which are available on the controller are enough for the need of the project making it best suited to make tiny nodes.

b) Using NRF24L01

The NRF24L01 is a single chip 2.4GHz transceiver with an embedded baseband protocol engine (Enhanced Shock Burst), designed for ultra low power wireless applications. The NRF24L01 is designed for operation in the world wide ISM frequency band at 2.400 - 2.4835GHz. An MCU (microcontroller) and very few external passive components are needed to design a radio system with the NRF24L01. The NRF24L01 is configured and operated through a Serial Peripheral Interface (SPI.) Through this interface the register map is available. The register map contains all configuration registers in the NRF24L01 and is accessible in all operation modes of the chip. The embedded baseband protocol engine is based on packet communication and supports various modes from manual operation to advanced autonomous protocol operation. The radio front end uses GFSK modulation. It has user configurable parameters like frequency channel, output power and air data rate. The air data rate supported by the NRF24L01 is configurable to 2Mbps. The high air data rate combined with two powers saving modes makes the NRF24L01 very suitable for ultra low power designs. Internal voltage regulators ensure a high Power Supply Rejection Ratio (PSRR) and a wide power supply range. This ultra Low power consumption and low cost makes the NRF very suitable for using in the WSN technology, since it will make the whole structure cheaper and fast to implement.

c) ESP8266

The ESP8266 WiFi Module is a self-contained with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

d) ACTUATORS (RELAY AS SWITCH)

The relays nodes plays an important role in switching electrical devices like water pump, Fan, Air Conditioner etc. The relay node comprises of arduino based microcontroller connected directly to the cloud using wifi module (the same module available on the master i.e. gateway node). This node continue checks the incoming data from the cloud in polling method and when the command changes like "Device ON" or "Device OFF" the relay gets turned ON/OFF.

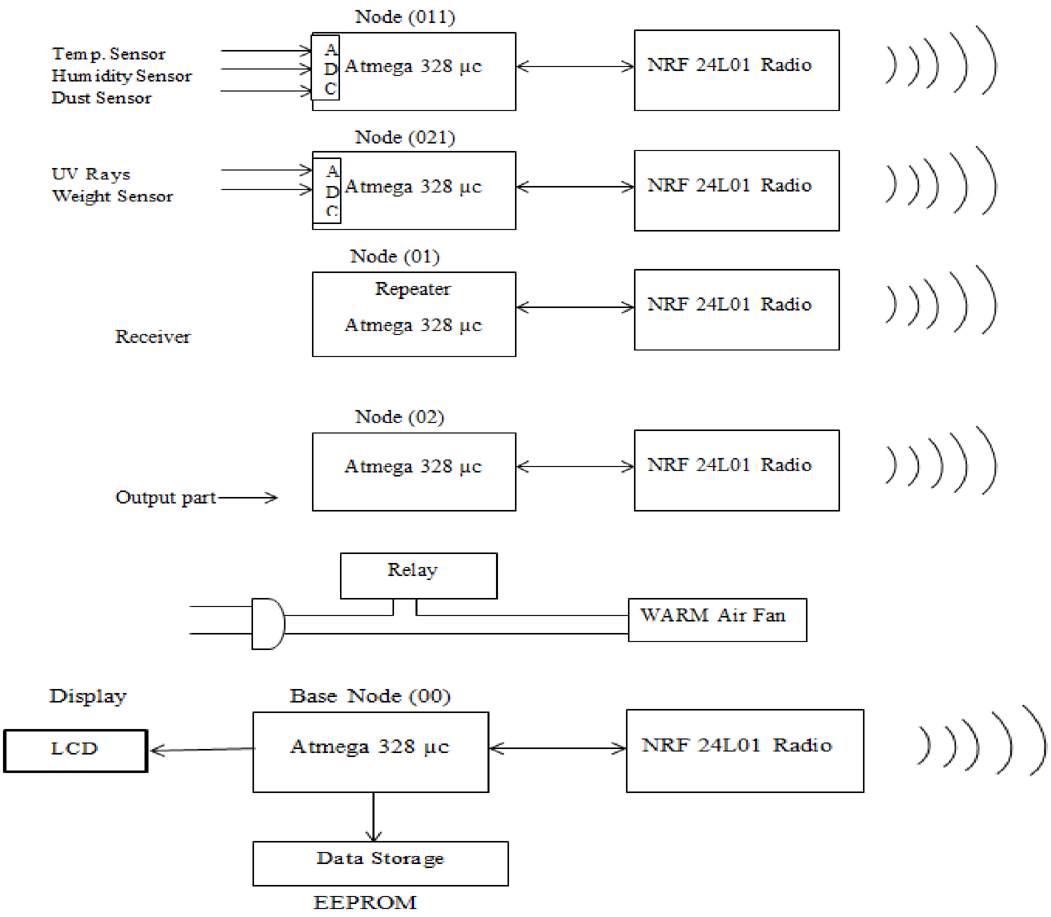

Fig. 1 Block Diagram of System

- Sensor way, sensor unit, and transmitter in a wireless sensor network used, all sensors like temperature, humidity, dust sensor are connected to the ADC to the microcontroller At mega 328 transmitter to transmit and then receive to the trans receiver NRF 24L01 Radio and at the same way UV rays, weight sensor collected to the ADC to the microcontroller Atmega 328 transmitter unit transmit to the receiver NRF 24L01 Radio.
- Atmega 328 μc are complete sensing unit called as transmitter.
- Addressing mode, Node (011) and Node (021) transmit to the repeater at Node (01) and Node (02) transmit to the Node (01). Node (02) connected to the relay through warm air fan.
- Base Node (00) is a master node transmits to the Node (01). Node (01) is a receiver.
- In repeater block not connected to the any type of sensor because it repeats type of information repeat to the receiver NRF24L01.
- Display, coordinator node, node control monitoring separate Node to show it and overall to the stared the data EEPROM.
- Node (02) is an output part, relay is an additional Node connected through warm air, Node (02) is an actuate to the data.
- When we required we add extra Node if they are possible.

IV. Conclusion

Reducing loss and waste throughout the food supply chain should be considered an effective solution to reduce the environmental impacts of agriculture, to improve the income and livelihood of the chain actors and to improve food and nutrition security for low-income consumers. An increasing urban population, changing food consumption pattern and trade globalization have rendered food supply chains extremely complex and lengthy, which calls for a change of mindset from the traditional way of addressing the causes of food loss at each stage of the food supply chain to an integrated approach. Investing in efficient, low-cost and sustainable processing technologies, adequate storage and packaging solutions, road infrastructure and market linkages as well as providing training and education to chain actors, including consumers, are among the tried and proven interventions which increase the efficiency of the chain and therefore lead to a reduction in food loss and waste.

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