Wireless Sensor Networks based Monitoring and Controlling of Food Storage System

[1]Mr. Dinesh Kumar M, [2] Arthi Lakshmi K S, [3] Atchaya R,[4] Harish V, [5] Pradiksha E
Knowledge institute of technology,
Salem

***Abstract*—The safety of food storage is a significant issue concerning people's living quality and national economic development. InIndia, nearly 20% of food grains are going as waste due to storage losses. The food storage losses are accounted mainly due to the changing environmental conditions and improper infrastructure facilities. This paper proposes an integrated system to monitor and control the environmental factors like temperature, humidity and light illumination of food depots using wireless sensor networks. The food products chosen are Grains, Wheat, Rava and Maida flour. The ZigBee mesh networking technology is used to send the measured parameters from remote food depots and the LabVIEW software is used to monitor the environmental factors. The images of the food product are captured from remote end and checked for the right food product by image analysis. An automated aeration control strategy is employed to maintain the temperature and moisture content within the threshold limits for each of the food products, thus ensuring food security.**

***Index Terms*—Food Storage, Temperature, Moisture, Wireless Sensor Networks, Internet of things.**

I. INTRODUCTION

In the field of soil environmental monitoring, real time monitoring the temperature and humidity of soil can correctly guide agricultural production and improve crop yield. It also can provide scientific basis for high-precision monitoring and calculating for farmland drought and flood area. Traditional wired communications exist many problems. It has broad application prospects in soil environmental monitoring field.

The age of the Internet of things comes; wireless sensor networks become the core of networking. In order to achieve greater things on the technical requirements of the Internet of things, we adopt the technology of wireless sensor network based on Zigbee, GPRS and Web Services technology designing a set of low cost, low power consumption, flexible automatic networking. And the system is a complete set of wireless sensor network induction, acquisition, storage, application, reporting, solution, has a good man-computer exchange interface. Users need not go into farmland, in a corner anywhere in the world, could prompt understand the changing condition of farmland soil temperature and humidity, and scientifically guide agricultural production. Now days WSN has wide applications. In India we found grain storage at farm or village level in warehouses and godowns. Maintenance of atmosphere at the warehouses and godowns is essential. In India, due to atmosphere, insects and rodent up to 30% grain waste is going on at conventional storage houses. In this paper we proposed the development of WSN system to monitoring grain storage; this system will support to monitor environmental conditions such as temperature, humidity and moisture as well as insect and rodent. The desired WSN systems could be more energy efficient, low cost, light weight and portable. Also integrated RFID based WSN system may be useful for grain tracking andsecurity purpose.

II. EXISTING SYSTEM

Wireless sensor networks have a strong impact all over the world over the wired networks due to the development of new standards and technologies from the last decades. Wireless sensor networks are used in a wide range of applications including remote Monitoring, health care, industrial automation or environmental monitoring. Each WSN may have specific objectives and application goals. Here our objective is to assure maximum quality and minimum spoilage of the stored food in food industry, by maintaining and monitoring of the temperature and humidity of the environment. Sensory data comes from temperature and humidity sensors of different locations, where food is stored and received at the receiver. WSN is formulated by a group ofsensor nodes equipped with short-range communication capability. Every sensor node consists of at least a transceiver,a processing unit, a transducer and a power unit. New standards and technologies like Bluetooth (IEEE 802.15.1), Zigbee (IEEE 802.15.4), having a specific parameter of low power consumption, are used for short range wireless communications. This paper provides the implementation of monitoring and controlling of temperature and humidity in the food industry using Zigbee & Bluetooth modules and to checkthe performance of the network using both modules.

III. PROPOSED SYSTEM

Wireless sensors networks (WSNs) are characterized by flexibility and scalability in any environment. These networks are increasingly used in agricultural and industrial environments and have a dual role in data collection from sensors and transmission to a monitoring system, as well as enabling the management of the monitored environment. Environment management depends on trust in the data collected from the surrounding environment, including the time of data creation. This paper proposes a trust model for monitoring humidity and moisture in agricultural and industrial environments. The proposed model uses a digital signature and public key infrastructure (PKI) to establish trustin the data source, i.e., the trust in the sensor. Trust in data generation is essential for real-time environmental monitoring and subsequent

analyses, thus timestamp technology is implemented here to further ensure that gathered data are not created or changed after the assigned time. Model validation is performed using the Castalia network simulator by testing energy consumption at the receiver and sender nodes and thedelay incurred by creating or validating a trust token.

IV. SYSTEM IMPLEMENTATION

In this IoT project, we will build a Food Monitoring device using Arduino IDE, to monitor the temperature and humidity of the stored environment and control it. To control the temperature, we are going to use a DC motor as a cooling mechanism. To find the temperature, and humidity the DHT11 sensor module is used, and to determine the status of the food, the MQ4 gas sensor module is used. In the future, ifneeded we can also use an IoT based Weight sensor to also monitor the food quantity in the storage area.

The real-time values of the temperature, humidity, and methane gas will be measured and sent over the web to be displayed on it. If the temperature is at the critical value, we will receive an email warning, and the fan will also be automatically controlled. You can also check this article on how IoT is used in the food industry to find out other ways inwhich the food industry can be modernized.

A. HARDWARE SPECIFICATIONS

- Arduino Uno
- Liquid-Crystal Display (LCD)
- 12V Relay
- Pressure Sensor
- Temperature Sensor
- Step Down Transformer
- HC-05 Bluetooth Module
- GSM
- IR Sensor
- Crystal Oscillator
- Bridge Rectifier

B. SOFTWARE SPECIFICATIONS

- Arduino Compiler
- MC Programming Language: Embedded C

C. SYSTEM ARCHITECTURE

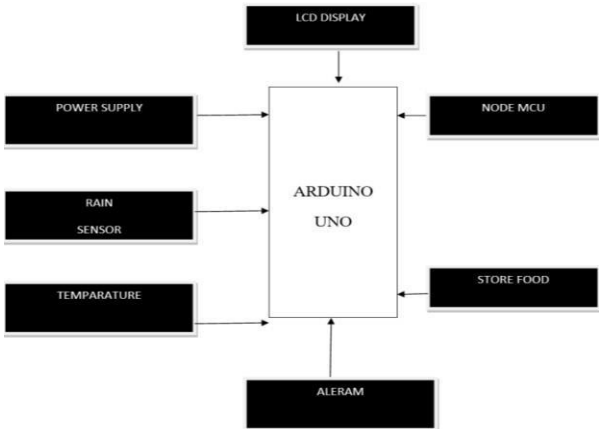

Fig 1 : Block Diagram

The power to the motor is given by the regulated power supply. The positive terminal of the RPS is connected to the positive terminal of the motor; the negative terminal of the motor is connected to the collector terminal of the BJT. The emitter terminal of the BJT is grounded, and the base terminalof the BJT is connected to the D0 pin of the MCU with a current limiting resistor 1K. The base terminal of the BJT is connected to ground with a resistor whose value is greater than the current limiting resistor. This resistor acts as a push- down resistor to the BJT. The VCC and GND of the MCU are connected to the one side of the power rails as shown in the fig below. The positive terminal and GND terminal of both the sensors are connected to the VCC and GND power rails asshown in the figure above. The A0 pin of the gas sensor is connected to the A0 pin of the MCU while the data of the DHT11 sensor is connected to the D4 pin of the MCU.

Modern day scenario of agriculture has changed. Over the years, population has increased. According to UN's world population prospect 2017 report, population is estimated to reach 9.8 billion by 2050 (United Nations, 2017). Along with population, demand for food is also multiplying. According to Food and Agriculture Organization of the United Nations (FAO), although there are 30,000 types of edible plants available, humans cultivate only 4% of it (FAO, 1999). The agricultural land has considerably reduced due to various factors like urbanization and industrialization. To cope up with these situations, modern-day technological solutions are required. Other than this, water scarcity, increase in fertilization and dynamic climate changes have also strained to integrate technology to achieve required production in agriculture with minimum wastage of resources. WSN is one prominent technology that has developed over past few years and has found its path in many applications like military, defence, healthcare, agriculture, etc. In agriculture, WSN is particularly used to achieve a state called Precision

Agriculture (PA). PA works on the phenomenon of observing(using sensors) and responding (using actuators) and tries to achieve parametric values and conditions required for optimum health and yield of crop. PA also focuses on optimizing resources used for production. Fig. 1 shows the complete process of monitoring and control in a field. Sensors are placed at required stations in suitable and optimal deployment. Sensed information is sent to central repository through available wireless channel. After analysing the information, either that information is utilized for futuristic improvements or appropriate control action is commanded. Greenhouse or Polyhouse is an agricultural innovation to provide a regulated and controlled environment to crops. Greenhouse forms a closed loop in itself and crops are shielded from outside environment. It forms a protected environment for cultivation and has great importance in the era of changing climatic conditions. So greenhouse is an example of precision agriculture. Greenhouses work on the concept of the greenhouse effect. Sunlight comes inside greenhouse through transparent roof and walls. Due to closedstructure,

heat is not able to escape and trapped inside greenhouse. Modern-day greenhouses are equipped with artificial systems to provide ventilation, light, heat, etc. A modern greenhouse may have exhaust fans, sprinklers or cellulose cooling pads. It may have provision for artificial lighting. Majority of energy in greenhouse is consumed by heating and ventilation systems. WSN can help in controlling these equipment and provide an optimized environment to crops.

temperature of the storage is between 40F to 140F, it is a danger zone because during that temperature bacteria grow rapidly, doubling its number in 20 min. Similarly, the humidity in the food storage room should be around 50-55% to keep the quality of the food at high, as long as possible.

VI. ADVANTAGES

1. A Sensors automatically collect environmental data and send them to monitoring stations over a wired or wireless network in industrial production contexts. Production processes that require expensive production operations and raw materials that are monitored by sensors require a reliable and confidential data transmission network.
2. Monitoring and controlling such processes requires a network with mechanisms that enable reliability and a high quality of communication as well as the availability of data, authenticity, and confidentiality.
3. A designed an efficient WSN for monitoring and control in an industrial environment. The system met industry requirements and was designed so that it could be extended to measure other parameters.
4. The design of the monitoring system included sensors, communication between the sensor and the base station, transmission from the base station to the monitoring system, and data storage.

V. APPLICATION AND MAINTAINANCE

The major application of the developed system resides in modular storage facilities for small scale farmers and middle level marketers of grains. The shortage or inaccessibility of small-scale farmers and marketers of grains to resourceful storage bins has been eliminated. Furthermore, the system can possibly be deployed in existing large volume granary storage systems provided by governments in cities and major towns, for effective monitoring purpose. In most developing countries, many of the storage units provided by the governments for bulk grains are poorly managed. The relevance of this study is justified in its contribution to the provision of information on the selection of comparatively resourceful components for wireless monitoring systems. The network system analyses various components, topologies, and technologies based on specific criteria in order to identify the ones with comparative advantages. In summary, the developed wireless sensor network system helps to ensure food security and good economic returns of quality grains through well-monitored, controlled, and affordable storage facilities.

It is important to maintain the safety and hygiene of the food to keep it fresh and edible which helps in decreasing the food wastage. One solution for this is to maintain suitable environmental conditions for the stored food to control the rate of decomposition. There are different parameters on which food decomposition depends, the parameters like humidity, bacteria, and temperature are major factors on which the rate of decomposition of food depends on. If the

VII. DISADVANTAGES

1. Cold storage of fruits and vegetables was used extensively by our ancestors to keep food safe after the harvest season. In modern times, availability of fresh produce in the food industry has reduced the use of home storage.
2. Often excess fruits and vegetables are kept in food industry, which cannot be consumed immediately but could store well.
3. There is a need of maintaining the temperature and humidity of the environment, where the food is stored. It is necessary to monitor the temperature and humidity to assure maximum quality and minimum spoilage of the stored food in an effective way.
4. With the advent of low-power embedded systems and wireless networking, it is possible to implement in a reliable manner.

CONCLUSION

The system aims is to establish monitoring and controlling platform in the food storage system based on Zigbee and Bluetooth and to find the more suitable wireless network for the food storage system. The Central monitoring unit can receive the monitoring data of sensor units and stores them in the database, and also can call and print that at any time. Both wireless standards have their own applications, advantages and drawbacks depending on the parameters, but especially Zigbee is more effective and economical as compared to Bluetooth. The proposed implementation shows that wireless sensor network based on Zigbee offers low power consumption and high range as compare to the network based on Bluetooth. It can be concluded that for the food storage system implementation using Zigbee is more suitable than Bluetooth.

REFERENCES

[1] J.-Y. Wu, H.-I. Hsiao Food quality and safety risk diagnosis in the food cold chain through failure mode and effect analysis Food Control, 120 (2021), p. 107501 Article Download PDF View Record in Scopus Google Scholar.

[2] X. Xiao Improved traceability process for frozen tilapia waste elimination in cold chain Cleaner Eng. Technol (2021), p. 100148 Article Download PDF View Record in Scopus Google Scholar

[3] X. Wang, H. Feng, T. Chen, S. Zhao, J. Zhang, X. Zhang Gas Sensor Technologies and Mathematical Modelling for Quality Sensing in Fruit and Vegetable Cold Chains: A Review Trends in Food Science & Technology (2021) Google Scholar

[4] L. Qi, M. Xu, Z. Fu, T. Mira, X. Zhang C2SLDS: a WSN-based perishable food shelf-life prediction and LSFO strategy decision support system in cold chain logistics Food Control, 38 (2014), pp. 19-29 Article Download PDF Google Scholar

[5] X. Xiao, Q. He, Z. Li, A.O. Antoce, X. Zhang Improving traceability and transparency of table grapes cold chain logistics by integrating WSN and correlation analysis Food Control, 73 (2017), pp. 1556-1563 Article Download PDF View Record in Scopus Google Scholar

[6] P. Visconti, R. deFazio, R. Velázquez, C. Del-Valle-Soto, N.I. Giannoccaro Development of sensors-based agri-food traceability system remotely managed by a software platform for optimized farm management Sensors, 20 (2020), p. 3632 View PDF CrossRef Google Scholar

[7] A. Sharif, R. Kumar, J. Ouyang, H.T. Abbas, A. Alomainy, K. Arshad, et al.

[8] Making assembly line in supply chain robust and secure usingUHF RFID Sci. Rep., 11 (2021), pp. 1-17 View Record in Scopus Google Scholar

[9] X. Xiao, Z. Li, M. Matetic, M.B. Bakaric, X. Zhang Energy-efficient sensing method for table grapes cold chainmanagement J. Clean. Prod., 152 (2017), pp. 77-87 Article Download PDF View Record in ScopusGoogle Scholar

[10] P. Escobedo, M. Bhattacharjee, F. Nikbakhtnasrabadi, R. Dahi ya Flexible strain and temperature sensing NFC tag for smart food packaging applications IEEE Sensor. J., 21 (23) (2021), pp. 26406-26414 View PDF CrossRefView Record in ScopusGoogle Scholar

[11] C.-M. Ou, J.-F. Tu The WSN and 3G/NFC embedded into IoV (Internet-of-Vehicle) fulfill cold chain logistics Microsyst. Technol., 24 (2018), pp. 3977-3983 View PDF CrossRef View Record in Scopus Google Scholar

[12] X. Xiao, Q. He, Z. Fu, M. Xu, X. Zhang Applying CS and WSN methods for improving efficiency of frozen and chilled aquatic products monitoring system in cold chain logistics Food Control, 60 (2016), pp. 656-666 Article Download PDF View Record in Scopus Google Scholar

[13] H. Feng, J. Chen, W. Zhou, V. Rungsardthong, X. Zhang Modeling and evaluation on WSN-enabled and knowledge- based HACCP quality control for frozen shellfish cold chain Food Control, 98 (2019), pp. 348-358 Article Download PDFView Record in Scopus Google Scholar