An RFID based Smart Logistics Management System for Monitoring Perishable Goods using Internet of Things

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***Abstract*:- In the era of Internet of things and data analytics this paper has proposed system architecture for RFID based shipment tracking using Arduino equipped with RFID module. The logistics is an important subset of supply chain management and plays a vital role for any organization. In this paper IoT based smart logistic system for various food grain and pharmaceutical industries is designed. The perishable goods like fresh food, floricultural, Pharmaceuticals and chemicals are considered as temperature sensitive sectors and required to be maintained in a specific temperature during the transportation. Therefore based on the nature of the goods, the cold chain required physical facilities to ensure the goods to be in a suitable temperature condition. To ensure security of the transported goods the containers are equipped with vibration sensors in order to detect any form of theft activities. By adapting this smart logistic system achieves live monitoring of goods from shipment to customer place at lower cost of investment. The sensor devices are connected through the internet and real time data transfer will provide an opportunity for the organization to react immediately if any changes required in the logistic process.**

Keywords: Internet of Things (IoT), radio frequency identifications (RFID), Pharmaceutical industry, Food Grain Industry, Smart logistic, Supply chain

1. INTRODUCTION

Logistics plays a vital role for any organization. The logistic companies are focused to implement a best logistic management system for an effective product supply from the factory floor to the customer end. The logistic companies have undergone considerable changes in the process of transportation and needs a technological update in the logistics management [1]. Intelligent logistics is the critical success factors for manufacturer and retailers. Effective logistics necessitates delivering the right product, in the right quantity, in the right condition, to the right place, at the right time, for the right cost and it has a positive impact on the success of the vendors in the supply chain. Tracking and traceability in the food supply chain have considered as a vital factor in the past few decades [2]. For an instance in the pharmaceutical company must maintain the accurate temperature and monitor the mitigation and risk factors during the transportation of goods (medicines). According to the customer perspective they care for the goods what they purchased should meets the quality standard and safety for usage [3]. In pharmaceutical industry, the cold chain system is followed.

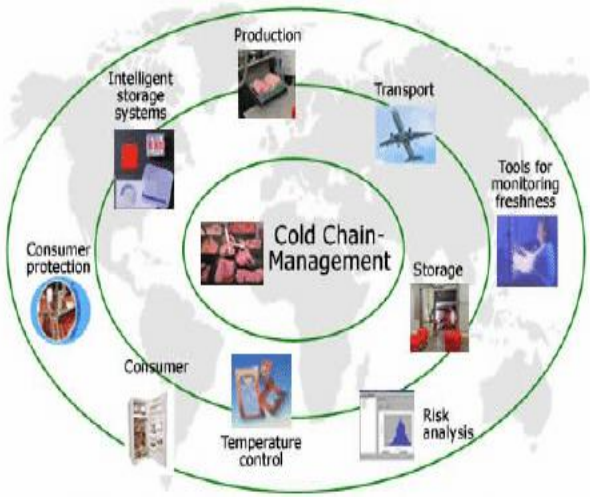

Fig.1 Cold Chain System

The cold chain is defined by as "the transportation of temperature sensitive products along a supply chain through thermal and refrigerated packaging methods and the logistical planning to protect the integrity of these shipments". Also the flow of food grain goods has increased tremendously in the outline of varieties in goods, quality and quantity in goods, just-in-time delivery, globalization of marketing and seasonal variations etc. The important role of food grain industry is to adapt an accurate traceability and monitoring facility during transportation [4]. Some food grains should be maintained in an accurate temperature and monitor the mitigation and risk factors during the transportation of products. The lack of timely, accurate and inconsistent information transfer during transportation of food grain goods is the reason for the risk factors like product damage, wastages and insecurity of the goods [6].

- ***IoT in pharma***

IoT applications for manufacturing and supply chain management have become popular investment areas for many industries [8]. The online tracking system and real time decision making are more complicated for the perishable industries. The physical facilities may be specialized warehouse, loading and unloading facilities, and refrigeration units are required for the live temperature control.

There are multiple scenarios in pharma manufacturing and supply chain management where the Internet of Things can help clear bottlenecks, ensure greater GMP/GDP compliance, and reduce operational expenses. Because pharma and food companies rely heavily on batch manufacturing they must constantly move men and material on the shop floor. Some raw materials, as well as finished products, require very specific storage conditions [11].

The backbone of such a solution is made up of sensors attached to manufacturing equipment. The sensors collect and send data to a central system that connects the sensors, then analyzes and converts the raw data into meaningful information on such things as performance and conditions [14].

Fig.2 IoT in Pharma manufacturing and supply chain management

2. PROPOSED SYSTEM

The proposed system here overcomes the disadvantages and shortcomings in the logistics industries transporting perishable goods. In this paper we propose a system that not only monitors the live physical position, temperature, humidity of the goods containers for the cold chain system but the sensor data is transmitted wirelessly to a cloud based application that continuously analyzes alarms and events and takes corrective actions.

The IoT based technologies like RFID and wireless sensor network are the key technologies used for monitoring the real time temperature of perishable goods, humidity of the circumstance and real-time status of perishable goods. To realize the IoT-Food grain, Pharma logistic system, which is able to constantly monitor and track the product quality and safety during the whole supply chain from production to customer, there are several requirements have to be considered. They are visibility, traceability, accuracy and controllability of the goods should be smartly governed at all levels of packaging or carriers. RFID with multi capacity in terms of sensing functionalities, energy sourcing and saving capacities, processing and storage capacities and wireless sensor interfaces can be installed in the containers.

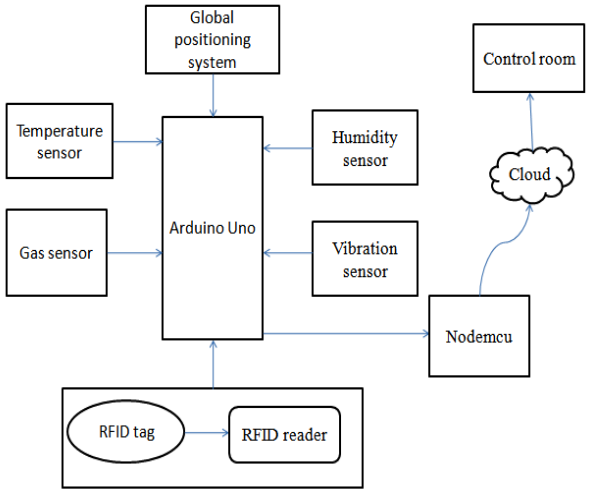

Fig.3 Block Diagram of proposed System

This paper also provides solution for various other risk factors involved in the logistics industries with refrigerated containers. Digital technologies such as GPS location and condition monitoring afford real-time visibility and security during transport. Tags and sensors are inexpensive and energy-efficient under energy autonomy conditions. The master node is a reader to collect the data from the tag and link to the Internet cloud through standard air interfaces like WiFi, WiMax, GSM/GPRS and 3G. The master node should be a superior wireless sensory location, which is regularly equipped with sophisticated sensors such as imaging sensors and motion sensors as well as GPS for geographical tracking [16]. The proposed network architecture links the objects (goods, vehicle etc) via internet to transfer the real time data for the purpose of realizing intelligent detection of objects, namely object current location/status, tracking, monitoring and management, with the help of RFID tags, sensor devices, actuators and positioning devices.

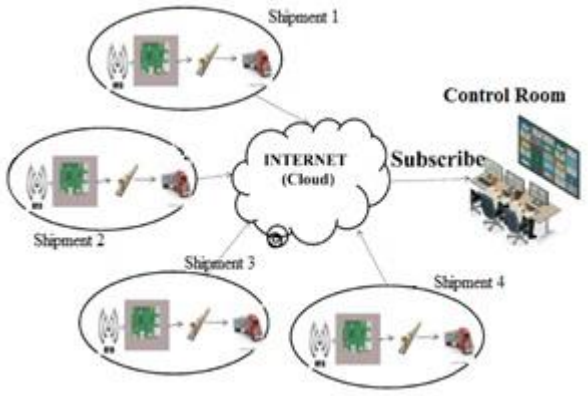

Fig 4: Overall system architecture

The temperature sensor starts monitoring the temperature, if the temperature is more or less than the storage temperature of the perishable goods then the refrigeration unit starts operating until the temperature of the container is same as that of the storage temperature.

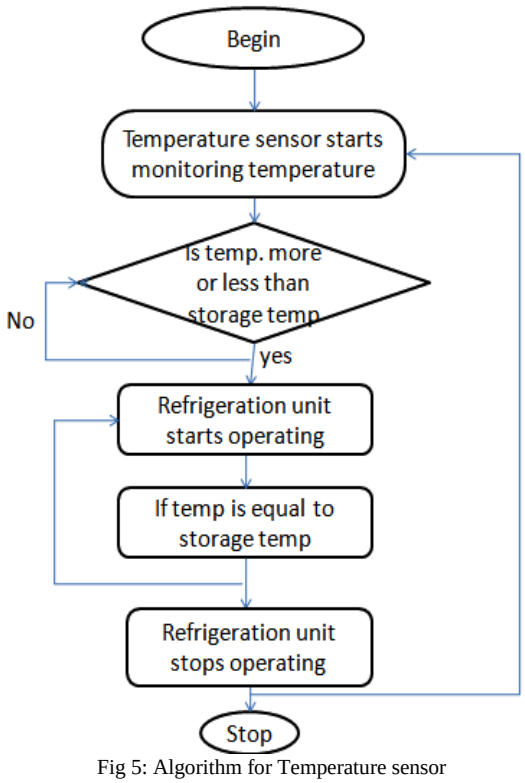

Fig 5: Algorithm for Temperature sensor

The container is equipped with the vibration sensor so if there is any kind of cargo theft activity during the transportation the concerned authorities get notified when they try to break the container door. One of the most common Problems in refrigerated shipping containers is leakage. The leakage can be detected through the gas sensor and an alert message will be sent through IoT to the control room of Logistics industry.

3. LITERATURE SURVEY

The IoT based technologies like RFID and wireless sensor network are the key technologies used for monitoring and tracking the live condition of the goods, present location of the goods and the concern delivery point. RFID technology gains importance in logistics system, which helps to combine logistics control with logistics management. Angeles (2005) explains the importance of RFID technologies roles in the supply chain, especially in retailing and logistics. This article provides an introduction to the technology, several case examples, and implementation guidelines for managers based on published reports.

The logistics and supply chain network is a complex amalgam of actors which need coordination, collaboration and information exchange with the objective of increasing productivity and efficiency (Choi and Krause, 2006; Myerson, 2007). Yue et al. (2008) [8] introduced the RFID based application framework for pharmaceutical industry. The paper provides a reference for the organizations which intend to adopt RFID, and accelerate the speed of RFID application in pharmaceutical supply chain. The growing complexities and uncertainties between business-to-business and business-to-customer relationships can be overcome through the implementation of auto-ID enabled tracking and tracing solutions. It ensures supply chain visibility, agility, adaptability and security (Urciuoli, 2010; Xu et al., 2011). To tackle such needs, each step in the supply chain, such as transportation, packing, distribution system, etc., should have its own information associated within the tracing system (Ruiz-Garcia et al., 2010).

An independent tracking system for the delivery of goods contributes to reducing the costs for claims as a consequence of goods routing errors. There is increasing demand for tracking and tracing in the supply chain, statutory requirements are growing stricter, and there is increasing pressure to develop standardized systems to tackle such logistics needs (Kandel et al., 2011).

Jia et al. (2012) [11] introduced the RFID technology and its implication in internet of things (IoT). The paper explains the importance of information processing equipment, such as RFID, WSN, GPRS, etc and analyzed the applications and challenges of RFID technology. From the above literature it is clear that RFID and wireless sensor devices are the major contributors for real time monitoring of logistics in the industrial sectors. Many research works focused on real time temperature monitoring system for the perishable goods like fresh food, floricultural, and Pharmaceuticals. There are very fewer research work focused on IoT enabled technology in the perspective of Leakage and theft detection of refrigerated containers. So, in this research paper an IoT based logistics management system for perishable goods is proposed.

4. CONCLUSION

Monitoring the live temperature, humidity, physical position, and transferring the live data is important in supply chain network. In this paper an attempt has been made for implementing the IoT based intelligent monitoring system for pharmaceutical and food based logistic industry in addition with Theft detection and leakage detection. The combination of available information technologies such as GPS and wireless data communications can provide complete monitoring information about fruits and vegetables transported in reefers containers (refrigerated containers). They also allow compliance with the legal requirements of food traceability. By adapting the proposed system the company can easy track and monitor the goods during transportation.

The number of recent IT applications published shows that research into intelligent transport systems is an emerging field fuelled by advances in technologies and worldwide concerns about security and food safety, and the concept of the smart container is now coming to the fore. This system will avoid the physical damages, moisture, humidity and counterfeit drugs. The technologies now available make the development of a standard monitoring system for reefer containers feasible. The system should comprise multiple types of sensor in various locations in the container. The future research is focused on field testing of the proposed methodology and collects a live data for data analysis.

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