DEVELOPMENT OF AN INTERNET OF THINGS (IOT) BASED FRAMEWORK FOR CROP STOCK CONTROL MANAGEMENT

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Abstract : Internet of Things (IoT) is the cutting edge technology which is going to create a lot of opportunities in the near future. Development of Smart Devices that interact with the environment and make intelligent decisions will make life easier for all. Particularly, in the case of agriculture, there are varied applications of IoT. From smart farming to smart irrigation control, there are a lot of possibilities. A major application area is Crop Stock Control Management. India is a primarily an agriculture oriented country. Being a developing nation, technology has not found its way to remote villages. As a result, a lot of farm products get destroyed due to decay and improper management. In this paper, we propose a novel framework for Crop Stock Control Management using IoT. The methodology proposed in this paper is based on three parameters-pressure, temperature and time. With the app implementation, it will be easier for the manager to monitor the status of stored crops. The same framework can be implemented in two variations, one for storage areas that are utilized for seasonal storage and the other one for storage areas that are utilized for continuous storage. The objective is to provide a decision support system to the manager so that wastage could be minimized and timely disbursement of the crops can be done.

Index Terms **- Sensors, IoT, automation, inventory management, Decision Support, Crop stock control**

I. INTRODUCTION

According to the United Nations, the world population will reach more than nine billion by 2050. The agricultural industry would be facing a lot of pressure in the coming 20-30 years to fulfill the food requirements of the growing population. The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits and reduced human intervention.

Internet-of-things (IoT) could be a solution for increasing agricultural productivity as it includes various technologies for sensing, communication, software solutions, hardware support and data analytics as shown in figure 1. Additionally, crop conservation will be an extremely pressing concern in the near future. The agricultural productivity can be increased if wastage of crops due to decay and rodent infections can be minimized. Technology, especially IoT, will play a major role to find efficient solutions to these issues.

Figure 1: IoT Integrated Technologies

Traditional Crop Stock Control Management

In the Indian traditional set-up, once the crop is ready in the fields, it is transported to a local storage. Based on the demand, the crops are sold to retailers. Monitoring of the crops is done manually in the local storage. Due to lack of automated monitoring and disbursement framework, a lot of crops are damaged every year. The major reasons for damage of crops are:

- Decay of crops
- Rodent infection
- Delay in disbursement
- Lack of availability of crops on time

With the use of technology, the wastage of crops can be minimized which will ultimately result in better productivity. The challenges faced by the farmers to integrate technology with crop stock control are:

- Lack of electricity in rural areas
- Lack of mobile connectivity
- Non-availability of appropriate apps
- Lack of technological awareness

Due to the above mentioned reasons, farmers still use conventional methods to keep stock of their farm produce which results in a lot of wastage and loss.

IoT based Crop Stock Control Management

IoT is emerging as a solution provider for a variety of applications. In agricultural scenario also, IoT is making its presence felt. If the above mentioned challenges can be addressed, then IoT can be a useful technology for the monitoring of crops. IoT based stock control management involves the use of sensors, RFID, smart phones, apps, cloud infrastructure and analytics to provide real time decision support to the farmers. The major advantages of using IoT based stock control management are as follows:

- Minimum wastage of crops by decay
- Timely disbursement of crops
- Ensure availability of crops on time
- Minimum delay in crops reaching from producers to consumers
- Protection from rodent infection
- Decision support for crop stock control
- Analytic support for future decisions

II. LITERATURE REVIEW

A considerable amount of research and work has been published on monitoring and tracking items in the kitchen, supermarkets etc. using different sensors, RFID, smart phones and digital cameras. Kitchen utensils such as knives and egg-whips have been augmented with accelerometers enabling real-time streaming of data on a PDA. Sensors are also mounted on doors and cupboards in the kitchen to enable quick search of the items needed. Supermarkets also use sensors to monitor the rate of consumption of items and replenish them accordingly.

The research work [1] describes the design and manufacturing development of food containers, whose use has been enhanced through the incorporation of an UHF RFID Tag. The primary use of these containers was to store fresh products, such as sauces or fruits, in industrial kitchens at restaurants and hotels. Due to the addition of the RFID tags in these containers, more accurate and historic information about product and usage can be gathered. Hence, this new information RFID-based system helps to achieve better inventory control, improve events management such as cold-storage room replenishment or reduce products close to expiration date.

The paper [2] reviews the current research of IoT, key enabling technologies, major IoT applications in industries, and identifies research trends and challenges. A main contribution of this review paper is that it summarizes the current state-of-the-art IoT in industries systematically.

The researchers in their paper [3] introduce the characteristics and basic application of RFID technology, analyse the data flow of intelligent inventory system from the perspective of business and function, then put forward the specific framework programs and function modules of intelligent inventory management system based on IOT RFID technology. They focus on elaborating the design and implementation process of the intelligent inventory system. The system realizes full control and management of all products, faster in/out warehouse and dynamic inventory, utilizes warehouse efficiently and improves the capacity of warehouse by effective combining with the ERP system in enterprise.

Hardi Desai et.al. in their paper [4] provide an insight into the development of an IoT based prototype to monitor the grocery levels at homes and supermarkets. A compatible and affordable wireless sensor network is implemented in their work. Serving as

an asset for research in the food industry, the implementation can be used to observe the food consumption patterns. Using this prototype as a base, real-time applications can be developed to manage our current inventory efficiently with its implications in food and e-commerce industry.

Lizong Zhang et.al. in their paper [5] address the issue of safety storage in large warehouse. They have emphasized on the requirement of such a storage system so that efficient storage could be done safely. Their paper proposes an inventory management system for a warehousing company. The system integrates RFID technology and a self-Adaptive distributed decision support model for inbound and outbound actives, inventory location suggestions and incident handling. The model consists of three major components: environment recognition, knowledge merging and the decision making. In addition, a 'selfadaptive' feature is adopted for adjusting the knowledge used in decision making procedure. An experiment is also outlined to validate the utilisations of their model and the proposed system.

Fredy J. Valente et.al. in their research work [6] have described the use cases of RFID in several industries around product logistics in the last years and the vision D-Business. An existing RFID solution architecture based on the reference EPCGlobal/GS1 framework was modified in order to be extended to the IoT domain to fulfil these requirements. The project environment, the RFID automation strategies and the innovative IoT solution architecture are presented in their paper.

III. PROPOSED MODEL

In this section we propose a framework for crop stock control monitoring using IoT. The major components of the model are Raspberry Pi 2 Microcontroller, Temperature sensor, Temperature controller, Pressure sensor, Timer, RFID and Ultra Sonic Generator. Raspberry Pi 2 is the microcontroller through which the various sensor readings would be taken as an input and sent to ThingSpeak cloud platform for monitoring decision on the Mobile device. The idea is to integrate the IoT technologies for providing decision support to the farmer/store manager. This will be very advantageous with respect to efficiency and wastage minimization. The basic block diagram is shown in figure 2 below:

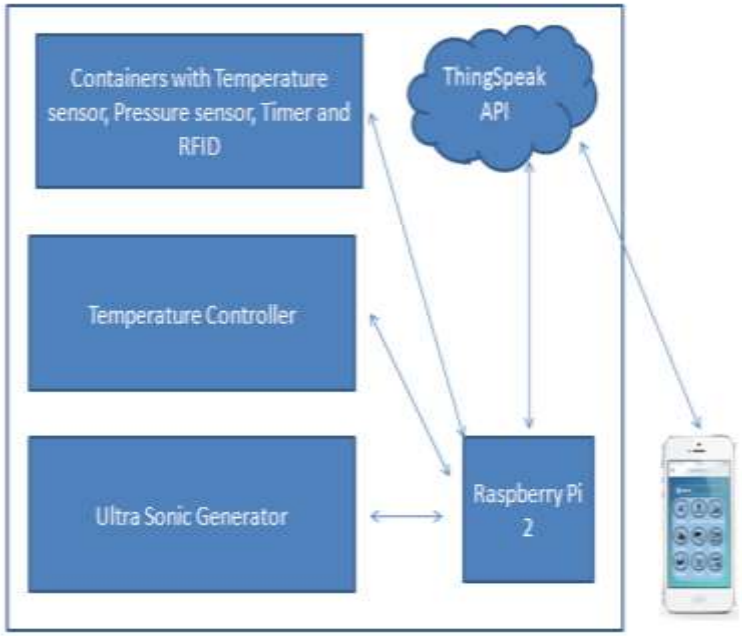

Figure 2: Block Diagram of Proposed model

The same framework can be implemented in two variations, one for storage areas that are utilized for seasonal storage and the other one for storage areas that are utilized for continuous storage. In case of seasonal storage, there is no requirement of replenishing the crop that gets sold out. Therefore, pressure sensors may not be employed in this crop stock control management system. But in case of continuous storage, crops need to be replenished in the warehouse as and when it falls below a threshold limit. This can be achieved using pressure sensors.

In storing crops, it is absolutely essential that the temperature should be maintained according to the crop type. The temperature sensor will be monitoring the temperature and sending the data to the Microcontroller. Based on the conditions set in the ThingSpeak, messages would be sent to the mobile app of the user. This will help the user to make strategic decisions and control the temperature of the storage space through the temperature controller attached to Raspberry Pi 2.

The temperature settings can be done according to figure 3 shown below:

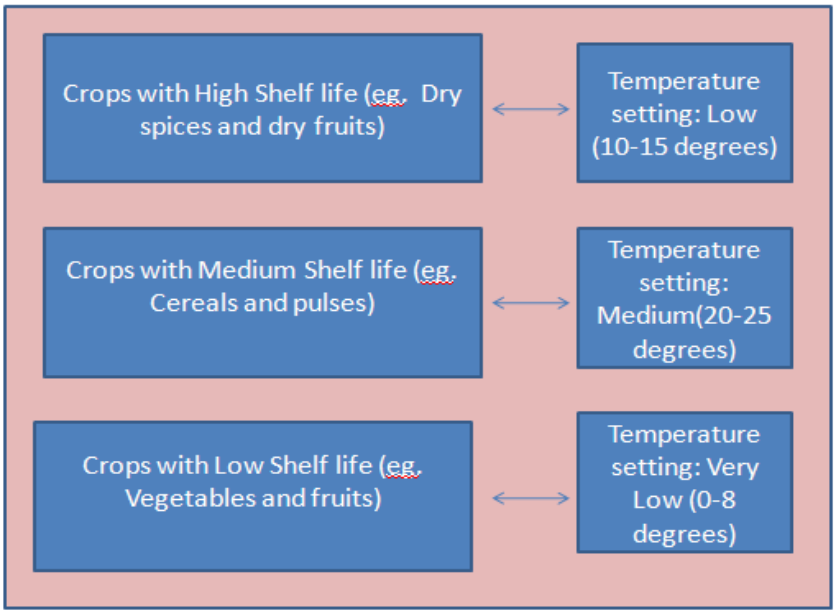

Figure 3: Range for Temperature settings

The pressure sensor indicates the status of the commodity stored. The weight of the commodity will exert pressure on the pressure sensor equipped with each storage tray. Pressure is the force on an object that is spread over a surface area.

Pressure=Force /Area

This force can be exerted through the weight of the commodity stored on the area. As weight will be directly proportional to the pressure, the pressure sensor will indicate how much of commodity is stored in the area. The higher the pressure, the larger is the weight of the commodity stored in the storage space. This can be used as an indicator to timely replenish the stored commodity to meet the demand. The values of the pressure sensor could be set through the app and when these values fall below the threshold an alert would be given to the user. This will help the user to timely replace the commodity. The timer can be set using the app for various storage requirements as shown in figure 4 below:

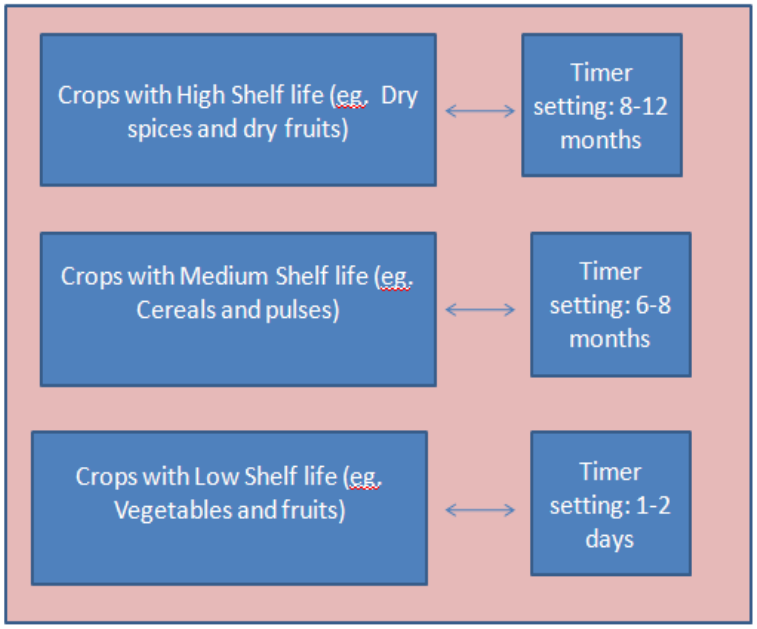

Figure 4: Range for Timer settings

One of the major requirements of a stock monitoring system is to search for various commodities in the storage area. This can be effectively done using RFID tags. Every packaged commodity can be attached with an RFID tag. This tag can be used to uniquely identify the place of storage in a large warehouse.

One of the major challenges that is encountered while storing crops is to protect it from rodent infections. Rodents cause a lot of damage to stored crops. Additionally rodent infected crops can be a health hazard too. In order to keep rodents away from stored crops, an Ultra Sonic Generator can be used in the warehouse. The sound emitted from the USG will be of high frequency which will keep the rodents away. The major advantages of using a USG in the storage area are as follows:

- Effective against rats, mice and rodents.
- No use of harmful chemical or poison
- It is humane (PETA recommended), because rats are not being killed, they are just chased away.
- Totally safe for the environment. The ultrasonic sound can be heard only by the pest and not by human beings.
- Repellent is eco-friendly, as it does not harm other animals.
- There is no chance of inhalation of harmful chemicals.
- The pests are not killed. So there is no mess of removing the dead rats / mice etc.
- Very economical as it consumes less than 2 units of electricity per month.
- Units can be plugged into standard 220V AC outlets.

The data from all these sensors and devices shall be sent to ThingSpeak cloud platform for providing real time decision support. The parameters can be controlled using an app on the smart phone and the alert messages can also be received by the user on time.

This framework will be useful for the farmers at large but the Government needs to provide infrastructural and technological support on a massive scale. Basic facilities like electricity and mobile connectivity must be provided in rural areas. High speed internet facility must also be made available to the farmers. Mobile apps must be developed to support the farmers and measures must be taken to increase technological awareness among the rural population. Only then technology can reach to masses and it will help in the socio-economic development of rural India.

IV. CONCLUSION

In India, a lot of farm products get destroyed due to decay and improper management. In this paper, an efficient framework is proposed for Crop Stock Control Management using IoT. With the methodology proposed in this paper, it will be easier for the farmer/store manager to manage stored crops and avoid wastage by decay or rodent infection. The various advantages that have been mentioned in the paper add to the merits of the proposed framework. The framework provides a decision support system to the farmer/store manager so that wastage could be minimized and timely disbursement of the crops can be done. Thus the model, if implemented commercially, can be a boon to the farmers and wholesale dealers.

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