Design and Development of Smart Containers using Smart Sensors to Maintain Inventory

Neha M R[1], Mr. Madan G[2], Dr K R Prakash[3], Mr. Shivraj C S[4]

[1]M. Tech CAID, Dept. of Electrical & Electronics Engineering, The National Institute of Engineering, Mysuru, Karnataka, India
[2]Manager, Incubation center, The National Institute of Engineering, Mysuru, Karnataka, India.
[3]Professor & Head, Center of Automation Technology, The National Institute of Engineering, Mysuru, Karnataka, India.
[4]Assistant Professor, Dept. of Electrical & Electronics Engineering, The National Institute of Engineering, Mysuru, Karnataka, India.

ABSTRACT:-This paper describes smart containers, a system for automatically maintaining inventory status of any items for the purpose of updating the users. Containers were instrumented with embedded system with level sensor to determine the height of dry/liquid goods commonly stored in it. The containers periodically "wake-up" and communicate to a base station regarding their inventory status, the fill status is automatically updated using the same sensor. The volume is displayed by graphical user interface using geometrical parameters of the container based on user requirements

Keywords — Portable, Low Power, Wireless Connectivity, RF modules.

I. INTRODUCTION

Fig. 1 working diagram of smart inventory

Measuring the container with dry/liquid materials varies based on the consumption and it needs manual inspection to check the quantity of each container. This process of visual inspection is quite tedious when the containers are more; even the containers are missed out in this mode of inspection. Smart container is a system for automatically maintaining material integrating it with base unit.

Through smart sensing containers, the system measures the fill status of the containers and passes the message to the user for updating the whole process shown in Fig 1. The smart system interfaces with a base unit with a cloud connection. These extensions include improved sensing within the containers themselves and volume can be calculated by using standard program based on container geometry.

INVENTORY MANAGEMENT

Inventory means complete list of items such as property or goods in stock. Here we are considering four types of inventory management;

- Kitchen inventory
- Warehouse inventory
- Industrial inventory
- Grocery shop/mall inventory

The smart containers can also be used for following purpose:

1. The automatic food maker which prepares the food based on the program uploaded and quantity selected for cooking the food. The food materials are preliminarily categorised based on the daily requirement for the house of 4 to 6 members. This included rice, dal and food grains such as rava, broken wheat and seeds etc are considered as high volume consumables and other items such as mustard seeds, chilli powder, salt, sugar etc are considered as low volume consumables. Keeping this in mind the volume of containers is designed to store raw materials at their respective position. However the level of Inventory keeps

varying depending on the daily usage. In such cases smart container can play a major role in updating status of Inventory.

2. Smart containers are used in industries to know the raw materials in the warehouses and in storage unit. In warehouses to know the amount of materials present inside the container so that the decision making will be easy and also if some materials are lost or if material is expired it can be known to user easily.

3. The Hydraulic Power Pack (HPP) is a standalone unit with no assembly required other than filling the hydraulic reservoir with fluid.

OBJECTIVE OF THE PAPER

1. The first and foremost objective of this project is to raise the level of the automation that is currently employed in the existing system.

2. Increase in the level of automation means least human intervention and maximum features.

3. A system for automatically maintaining inventory status of dry/liquid items for the purpose of updating the material.

4. This project is so designed that, it is simple to operate and easy to handle and also it is user friendly system

II. PROJECT DESIGN

The implementation of smart container with RF module is as follows: The entire RF slaves are communicating to the RF masters and RF master is connected in the network communicated with the node via Modbus protocol. This node in turn communicates with the server via GPRS and all data of the smart containers will be saved in the cloud. Hence the saved data of the smart containers can be accessed from anywhere and at any time.

A. CONTAINER

Different types of containers were used based on the application with the provision for mounting sensor and routing wire for example shown in Fig 2 provision for mounting sensors on to the containers is made during the design stage in the container cap.

Fig. 2 Different containers

B. ULTRA-SONIC SENSOR

The role of the sensor was to estimate the quantity stored in the containers, this project uses ultra-sonic sensor. The role of sensor was to identify the amount of material. The sensor input data are considered in a program to indicate the lower and higher levels. Also the working of ultra-sonic sensor used inside the container will help in deciding the amount of material present in the container at any instant.

HC-SR04™ ultra-sonic sensor Fig 4 provides an easy method of distance measurement and cost effective, hence the implementation utilizes HC-SR04 to measure the raw material in the container. The sensor will be interfaced to controller through wired or wireless mode. A two I/O pins is used to trigger an ultra-sonic burst and then listen" for the echo return pulse (Trigger pulse and Echo pulse). The sensor measures the time required for the echo return and returned value to the controller as a variable-width pulse via echo.

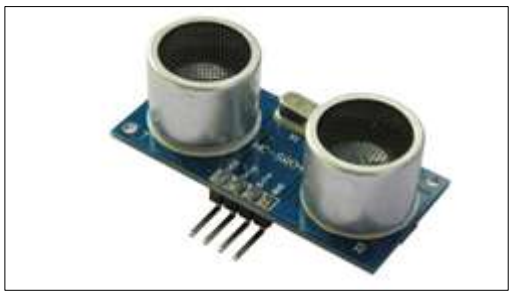

Fig 3. HC-SR04 Ultra-sonic Sensor

C. RF SLAVE

Ultra-sonic sensor connected to the container measures the distance/height/level of the dry/liquid and sends signal to the RF slave as shown in Fig 5. Up to 15 RF-slave can be connected to one RF Master. The distance in terms of centimeter is transmitted to the RF Master device from the RF slave device. The microcontroller we are using is PSoC

and the RF transceiver we are using here is TARANG™P-20 module.

TARANG™P-20 MODULE

TARANG™ P-series modules are designed in such a way that they transmit low and medium power. The modules operate within ISM 2.4-2.4835 GHz of frequency band. The operating frequency of TARANG™P-20 is ISM 2.4GHz. The radiofrequency data rate of TARANG™P-20 is 250Kbps the receiver sensitivity is 105dBm. The transmit current is 1654 mA. The supply voltage is 3.3-3.6V. The TARANG™-P20 module is connected either to USB board or RS-232board. If we use RS-232 board we have to give the external supply of 5-12V. The 2 modules are connected to the RS-232 boards the LED light blinks in the board and further these 2 modules are connected to the 2 ports of PC. Here one module acts as a transmitter and other acts as a receiver.

Fig 4. TARANG™-P20 module

Fig 5.RF Slave device

The data will be updated for every 300 sec and sends from RF slave device to RF master device and monitored with the help of the software tool. The communication between the low power slave and the master is through RF. The RF slave consists of RF transmitter, microcontroller, battery and power circuit unit.

D. RF MASTER

The RF Master receives the data from Rf slave. The distance in terms of centimeter is transmitted to the master node from the slave nodes of different containers. The master connected in the network communicated with the node via Modbus protocol. This node in turn communicates with the server via GPRS (General Packet Radio Service). Up to 15 RF slave devices can be connected to the RF master device, which is connected to GPRS system via Modbus. As shown in fig 6 RF receiver consists of ground (0V), data (serial data output pin), NC (linear output pin, not connected), Vcc (supply voltage, 5v), Vcc (supply voltage, 5v), ground (0V), ground (0V), ANT (antenna input pin). The master device also contains the TARANG™P-20 module. It also contains external power circuit which converts 230V to 24V DC. The RF master and RF slave works in half duplex mode.

Fig 6.RF Master device

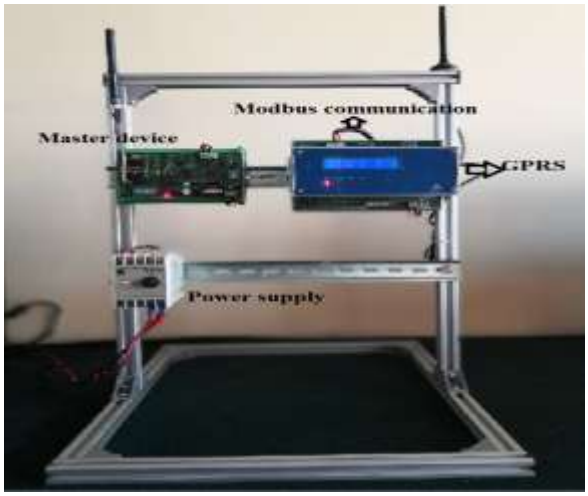

Fig 7.RF Master device connected via Modbus to GPRS

E. SOFTWARE IMPLEMENTATION

To implement software part PHP and Java language is used. PHP is a widely used open source general purpose scripting language that is especially suited for web development and can be embedded into HTML.

Java has strong support for web development and frequently used at the server side. Instead of running application directly on a dedicated server, you could also run it in a cloud environment. This cloud environment provides the necessary server for your application.

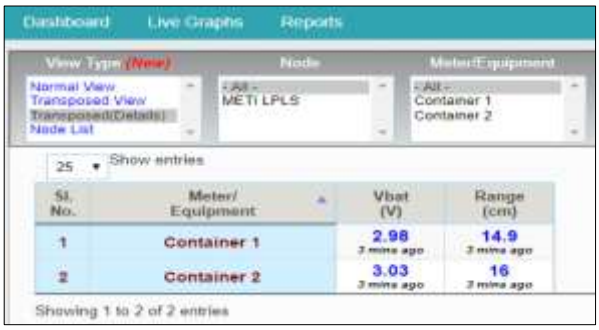

Fig 8.Smart container information

The information sent from the GPRS will be given to the cloud and the information can be collected from any part of the world by entering to the web page. Fig 8 shows the information of container in terms of centimeters. The actually length in terms of centimeter is 20cm and the ultra-sonic sensor measures the length of the filled ingredients inside the container and updated every 300 sec. Even the battery voltage of the RF slave device is monitored and both container level as well as battery voltage will be updated for every 300 sec. Even the level of the container and battery voltage measured in terms of graphs.

Fig 9.Graphical representation of container information in centimeters

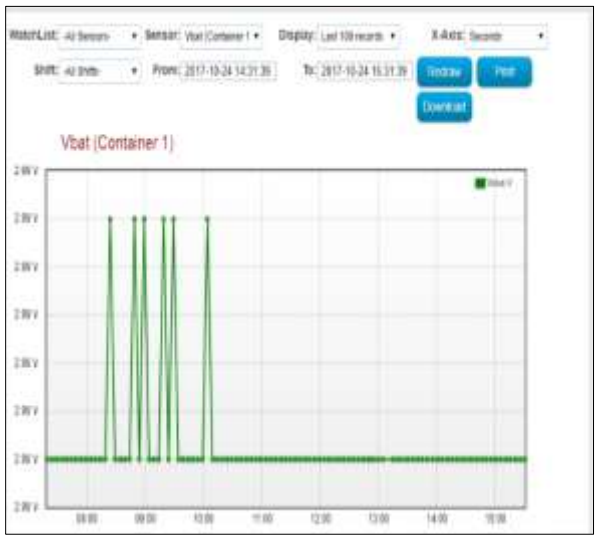

Fig 10.Graphical representation of container battery in voltage

Fig 11.Single window information of container and smart container battery

The Fig 11 shows the smart container range and the battery information in the single window and also these information is displayed in graph in this window.

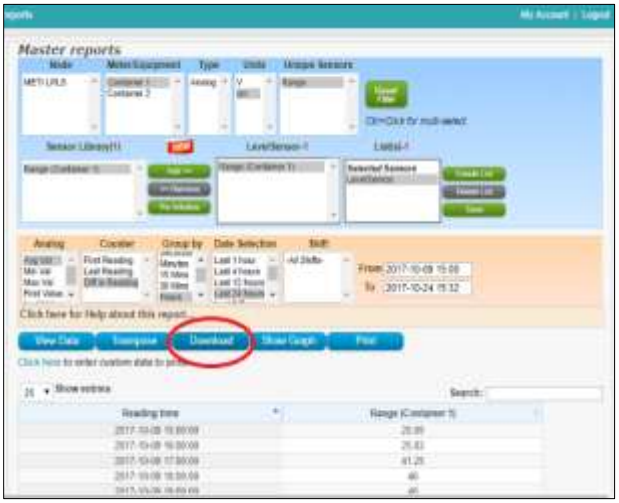

Fig 12.Dry/liquid material Usage information

The Fig 12 gives the information of the container from given date to desired date. Here we can download the date wise information in the Excel format by clicking on the download option.

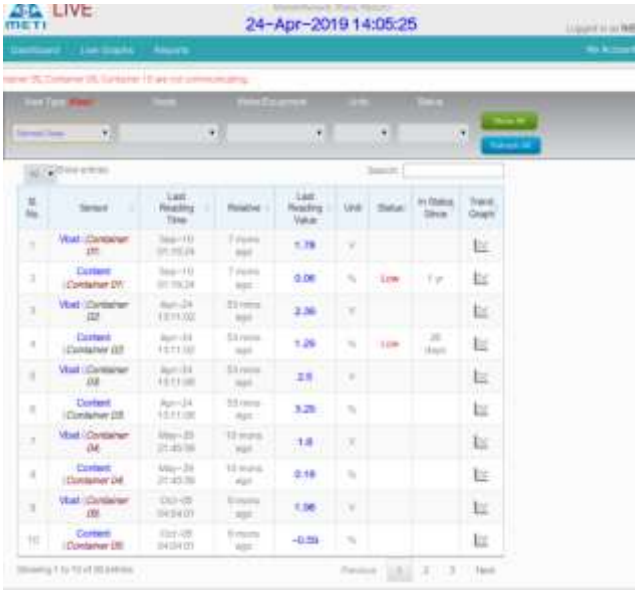

Fig 13. Normal view

The Fig 13 shows the last reading of the container content and when it is updated, last reading of the container, status of the battery whether it is low /medium/high and also the graph of content varying in the container& also it shows the normal view of screen.

Fig 14.Full model of smart container using Ultrasonic sensor

III.CONCLUSION

Smart containers integrated with the sensors, RF Master - Slave module and network for communication can reduce tedious work of manual checking of the inventory. Thus, making life more easy and comfortable, with the smart containers in place. This whole device is suitable for all industries, groceries shop and kitchen inventory management.

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