IoT-Based Smart Food Storage Monitoring and Safety System

Saleem Ulla Shariff, M. G. Gurubasavanna and C. R. Byrareddy

Abstract It does not take much to see and experience the rapid advancement of technology in the world. We can observe personal technologies are getting smaller, smarter and overall more efficient but that is not to say that technological advancement is stopping at consumer level. People of this generation are busy in their day-to-day life as such that they do not get enough time to maintain the food storage facilities at home. Due to busy life schedule, they have to shop for the food commodities such as grains, etc. in bulk quantity to be maintained and used for over a period. We are proposing a system to monitor food grains and to maintain storage system at home. The proposed system is equipped with auto SMS and email alert system to alert the owner regarding the food storage level and the information related to the food spoilage. We come across local unscientific food storage systems in home-based kitchens. There is a chance for food grains getting spoilt due to moisture, humidity, temperature and various other factors. Hence, it becomes very important for us to monitor the food storage level and maintain it to lead a tension-free healthy life. For this purpose, we are going to use various sensors. For our design, an advanced board such as Renesas GR Peach has been used as a central processing unit with different sensors embedded to create a smart home food and grains storage maintenance and monitoring system.

S. U. Shariff (✉)
Department of Electronics and Communication, University Visvesvaraya College of Engineering (UVCE) (Under Bangalore University), KR Circle, Bengaluru 560001, India
e-mail: saleem_shariff@yahoo.co.in

M. G. Gurubasavanna
Department of Electronics and Communication Engineering, Government Sri Krishnarajendra Silver Jubilee Technological Institute, KR Circle, Bengaluru 560001, India
e-mail: gurumg2005@gmail.com

C. R. Byrareddy
Department of Electronics and Communication Engineering, Bangalore Institute of Technology, Bengaluru 560004, India
e-mail: byrareddycr@yahoo.co.in

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Personal technologies · SMS · Email

1 Introduction

Smart containers are in use to monitor and maintain the food grain storage levels from earlier days. It is often observed that homemakers keep different types of utensils for storing various food commodities by printing their names or using transparent glass-based utensils. The same concepts have been used here, by connecting various sensors inside the utensils which are used for storing the food commodities such as grains, etc. We are going to set the threshold. If it is observed that the food storage level goes below that threshold level then an auto alert system has to be activated. The owner or homemaker or both should be alerted with SMS as well as email alert. An advanced board such as The GR Peach board by Renesas can be utilized as a central processing unit by connecting the GR Peach board with the available various low-cost sensors to create a smart food and grains storage monitoring and maintenance system. In the proposed system, we are going to monitor various different parameters with the help of the moisture level, humidity and temperature level conditions inside the kitchen and storage area and also the same will be tracked. An alert should be triggered if unnecessary changes in the conditions are detected by the sensors which can damage the food grains. Implementation of the alert system is done via SMS; a GSM module can be interfaced with the GR Peach board for the same. As we know that the GR Peach is an advanced board; we can add extra features such as safety system as well into the design. We can use various low-cost safety sensors such as fire detection sensor, LPG gas sensor, etc. which are available easily at an affordable cost in the market. All these sensors should be interfaced by properly programming the GR Peach using the correct pin details to create a safety alert system.

For designing the proposed system, we can choose three utensils, in which we can use different sensors such as using LDR (light dependent resistor) in Utensil 1, IR infrared (obstacle sensor) sensor in Utensil 2, Ultrasonic sensor in Utensil 4 and moisture sensor in Utensil 3. The concept behind using these sensors is very simple and straightforward; to explain it, let us take up the case of LDR. The functionality of LDR is that LDR usually detects light and its resistance will vary depending on the intensity of the light. For instance, if we keep the LDR at a fixed height in Utensil 1, and the grains are filled inside the utensil and once if the grains are full or above the threshold value then LDR is not fed with enough light hence its resistance will be quite high, similarly if the grains are filled below the threshold value inside the utensil then LDR will get sufficient light automatically and hence its resistance will gradually decrease depending on the amount of light intensity received. We can design an alert system using this approach such that whenever the light with suitable intensity falls on LDR, it means the grains are below the threshold level otherwise it is considered as above the threshold level.

Similar and simple idea behind using the IR sensor is that IR sensors are used to detect the obstacle coming in front of them; hence if the IR sensors are placed at a certain threshold height, then they will sense the obstacles presence easily. Hence here in Utensil 2, if the food grain, for instance rice is filled above the IR sensor level, then it will detect it as an obstacle; hence, we can interpret it as rice is above the threshold level; the utensil is filled full with rice, and similarly, the IR sensor will not be detecting any obstacle if the rice is below the threshold level. The idea behind using the ultrasonic sensor is same as IR. Ultrasonic sensor can sense the obstacle and the distance can be calculated. Hence by using the ultrasonic sensor, the threshold level height can be adjusted easily by programming. The concept of using the moisture sensor is to design a system which can detect the liquid and moisture content. The sensor can be placed at a certain height and when the sensor detects the moisture then it means the liquid is above the threshold level else it should be interpreted as the liquid is below the threshold level. As discussed earlier, the ultrasonic sensor can measure the distance and hence exact height up to which the utensil is filled can be known and tracked easily. Compared to other sensors, the ultrasonic sensor is more effective but comes with an increase in cost. With these simple, low-cost sensors, we can design easily an effective smart food storage maintenance and monitoring system.

2 Literature Survey

A. *Motivation for the Project*

India has many cosmopolitan cities with IT hub Bangalore one among the metropolitan cities having the high density of population. We can observe that people of today's generation are lazy enough due to technical advancements and are very much dependent on the technology. We can blame this dependency on the busy lifestyle. It is often observed that people shop and store the food grains in bulk quantity to be maintained and used over a particular period. In this paper, we are proposing a system which is smart and low cost to maintain and monitor food grains storage at home with less human intervention. The proposed design which has an auto SMS and email alert system equipped to alert the owner/homemaker regarding the storage level and also on the status if the food is on verge of decay or getting spoilt. If we are to conduct a survey, we can come across many local food storage systems in home-based kitchens. Usually, they are designed in unscientific way with fewer applications. Hence, there will be a chance for food grains getting spoilt due to moisture, humidity, temperature and various other factors. The time-saving nature of the people by storing the food in bulk quantity in unscientific manner sometimes leads to uncalled problems such as sudden shortage of the food grains due to improper tracking of food storage level, negligence, spoilage, etc. It is very important for us to monitor the food quality by properly storing and maintaining it to lead a tension free healthy life. Hence to maintain and monitor the food grain storage levels, we are designing a system by

choosing the low cost but effective sensors with GR Peach board. Renesas GR Peach board will be used as a central processing unit along with the various other easily available sensors to create a smart home food and grains storage maintenance and monitoring system.

B. *Survey for the Literature*

The GR Peach board is a new board which has been developed by Renesas Company as part of their Gadget Renesas series. The details have been collected from the various websites and the same has been used and mentioned in the references section.

The Internet of Things: A Survey authored by Atzori et al. [1] has discussed how the Internet of things concepts is evolving. The inspiration for the proposed project is the concept of IPv6 which powers the idea to have a unique identification to be kept or used for every device. IPv6 routing protocol for low-power and lossy networks [2] has been explained in the paper [2] by Winter et al. Convergence of MANET and WSN in IoT Urban Scenarios [3] by Bellavista et al. gives an idea how the concepts can be utilized effectively in IoT. Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation [4] by Schaffers explains how the smart cities can be designed using the concepts evolving from IoT and how future of innovation will be in IoT field. The concept of IoT has changed how the design of our future smart cities would be. The paper explaining the Internet of things for smart cities [5] by Zanella et al. shows case how the technology can make human civilization smarter. With the concept of smart cities, the idea to have the better and effective healthcare system arises; an effective approach has been explained for healthcare applications by giving a solution based on the Internet of things [6] by Bui and Zorzi.

Secure communication is very important for achieving smart IoT concept; the paper on Secure Communication for Smart IoT Objects: Protocol Stacks, Use Cases and Practical [7] by Bonetto et al. explains how the secure communication can be established. The concept of smart food monitoring has been designed using the proposed approach whose details are available in the video uploaded in YouTube [8] and the videos on smart room automation [9] by Shariff.

The details about the GR Peach are obtained from Renesas website [10]. The website designed and developed for the students to create awareness about project ideas [11] for helping and sharing ideas such as helpshareideas.com and other websites are the basis for the idea for this project. The project details uploaded in toolcloud.renesas.com [12] explains the details regarding how a smart food monitoring device can be developed using GR Peach. The idea has been taken from the [13] GR Peach India Design contest. The ideas for a smart container has been provided in [14] and explained briefly regarding smart food tracking [15, 16] by Srivastava et al. Next sections will explain briefly about the components which are used in the project.

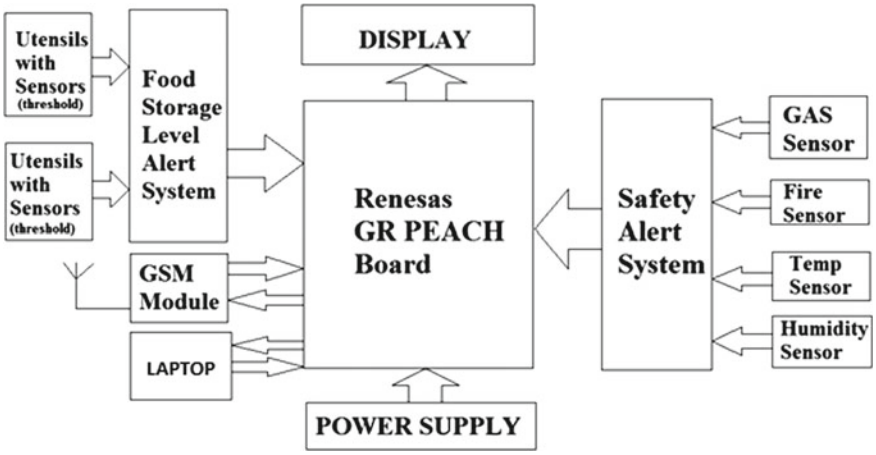

Fig. 1 Block diagram of the proposed system

3 Block Diagram/Schematic of the Proposed System

The proposed block diagram of smart food monitoring and safety alert system is given in Fig. 1. We have built three sections like food storage and monitoring, safety and temperature monitoring system with alert system. The central processing units operations will be handled by the GR Peach. We have tried to use low-cost sensors such as LDR, IR and ultrasonic sensors. The safety system is operated by monitoring different parameters such as gas, fire, smoke, temperature and humidity. Alert SMS can be triggered via GSM module or through any bulk SMS operator. The schematic diagram of the proposed system is shown below in Fig. 2. All the components are interfaced with GR Peach using the pin details mentioned below.

4 Algorithm of the Proposed System

The proposed algorithm of smart food monitoring and safety alert system is given in Table 1; GR Peach will be continuously monitoring for the changes in the surrounding and trigger the alarm whenever required.

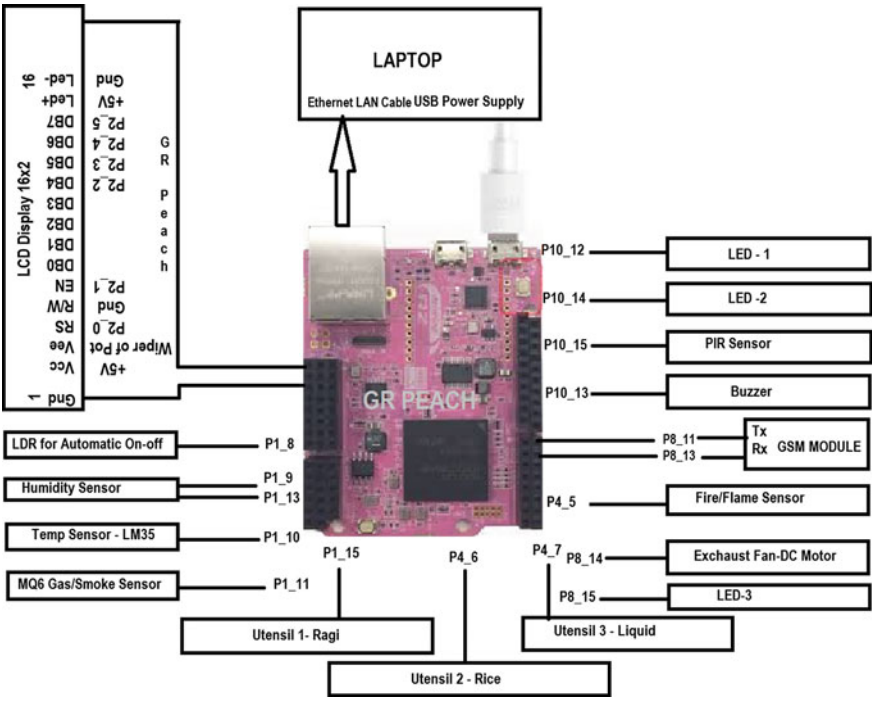

Fig. 2 Schematic of the proposed system

Table 1 Algorithm of the proposed system

Input: Level of Food Storage (grains in containers) and temperature humidity conditions, Smoke or Fire alert
Output: Alert SMS to the owner.
1. GR Peach Continuously receives the data related to food storage level, temperature, humidity and smoke & fire related activities.
2. Comparison of the received data with the stored data from the database.
3. An Alert will be issued depending on the necessities.
4. Alert SMS is triggered to the owner
5. Buzzer will trigger the alarm initiated by GR Peach.
6. The Process repeats and GR Peach monitors continuously.

5 Result and Performance Analysis

After the components have been connected, the results have been studied, which will be presented in this section.

A. *Utensils with Food Grains*

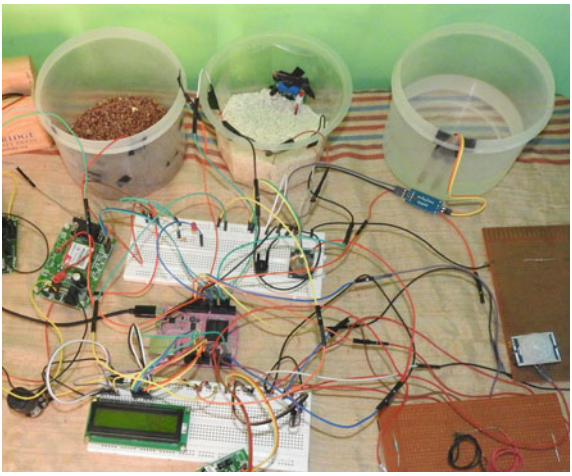

Fig. 3 Sample image of the devices connected with GR Peach

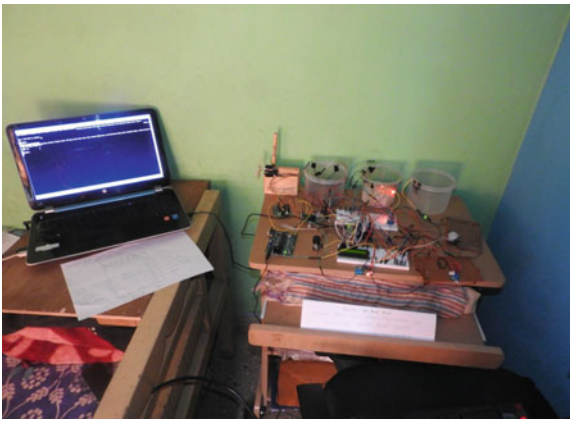

Fig. 4 Full setup along with components turned on

The utensils are filled with the grains such as rice rage, etc. Below picture in Fig. 3 depicts the same (Fig. 4 shows the full setup along with all components turned on).

B. *Results*

The prototype of the proposed system has been implemented and the results have been discussed in this section.

Terminal Application Screenshots: We have used Tera Term [17] terminal application software. The screenshots taken during the demonstration of the model explains the system behaviour. Screenshots shows how GR Peach was triggering the messages to the PC via terminal applications software [17]. Figures 5, 6, 7 and 8 depict the same.

Figure 6 shows how LDR sensor is monitoring the food storage level. When the GR Peach detects the ragi (millet) level below the threshold in Utensil 1 then the

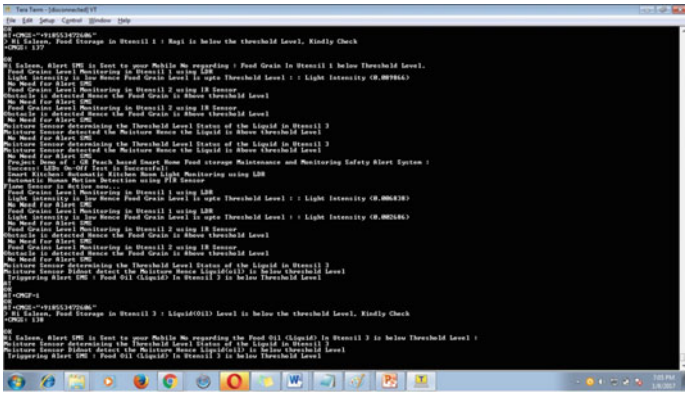

Fig. 5 Terminal application results

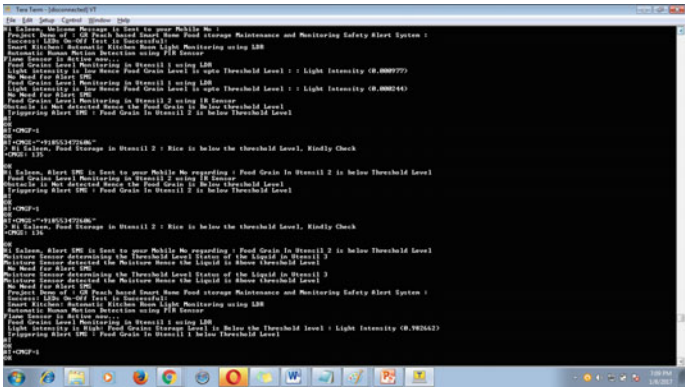

Fig. 6 Terminal application results—LDR sensor

alert gets triggered. Similarly, Fig. 7 shows how IR Sensor or ultrasonic sensor is monitoring the food storage level in Utensil 2. When the GR Peach detects the rice level below the threshold in Utensil 2, then the alert gets triggered.

Figure 8 depicts how PIR Sensor is monitoring the Human motion for room automation. Similarly, Fig. 9 shows how smoke sensors like MQ6 Sensor are monitoring the LPG or other gas leakage with smoke detection. When the GR Peach detects the gases, then the alert gets triggered.

Figure 10 shows how GSM is used by GR Peach for triggering the SMS by using AT commands for monitoring the food storage level. Similarly, Fig. 11 explains how alert was raised while monitoring the food storage level in Utensil 1. When the GR Peach detected the ragi millet level below the threshold in Utensil 1, then the alert got triggered.

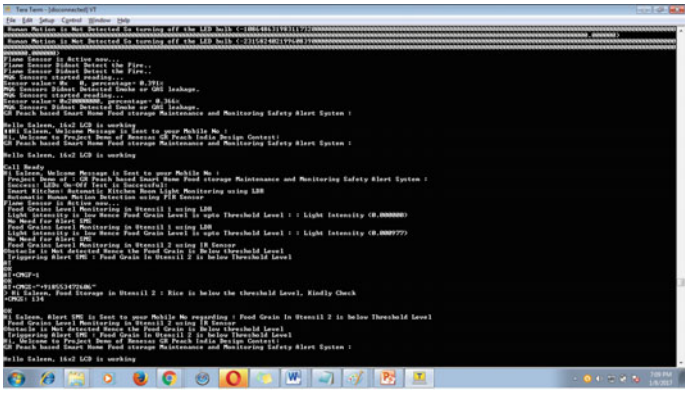

Fig. 7 Terminal application results—IR sensor

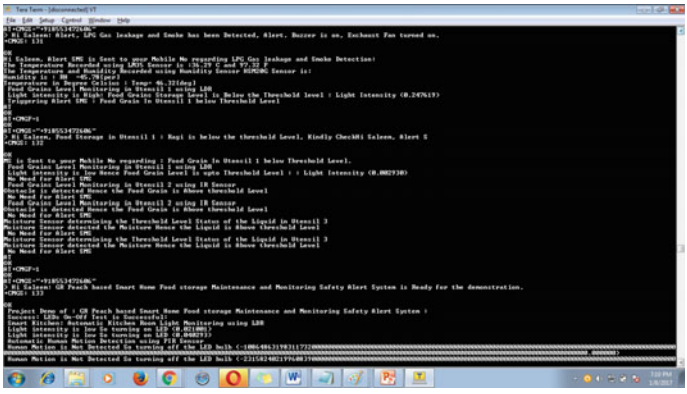

Fig. 8 Terminal application results—PIR sensor

Figure 12 shows how alert was raised while monitoring the food storage level in Utensil 2. When the GR Peach detected the Rice level below the threshold in Utensil 2 then the alert got triggered. Figure 13 explains room automation.

Figure 14 shows how GSM is being used by GR Peach for triggering the SMS by using AT commands for monitoring the safety in the surrounding. Also, Fig. 14 explains how alert was raised while monitoring the smoke and gas leakage.

Alert [18, 19] SMS screenshots taken from the mobile when alert triggered SMS's each time explains how GR Peach has been interfaced with GSM module for triggering the alert to the registered mobile number. The SMS received screenshots [18] taken from the mobile sent by GSM module, which were triggered by the GR Peach for alerting the owner are shown in Figs. 15, 16 and 17.

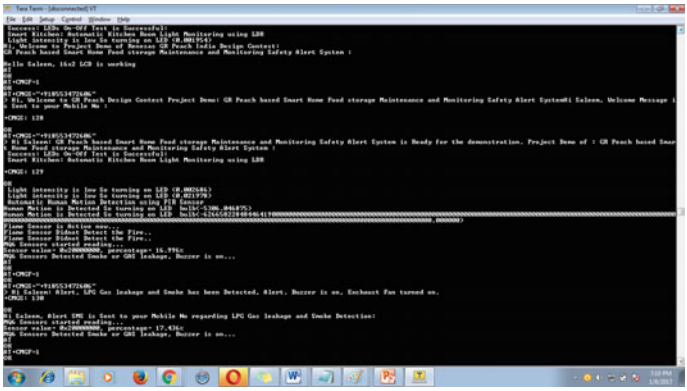

Fig. 9 Terminal application results—MQ6 sensor

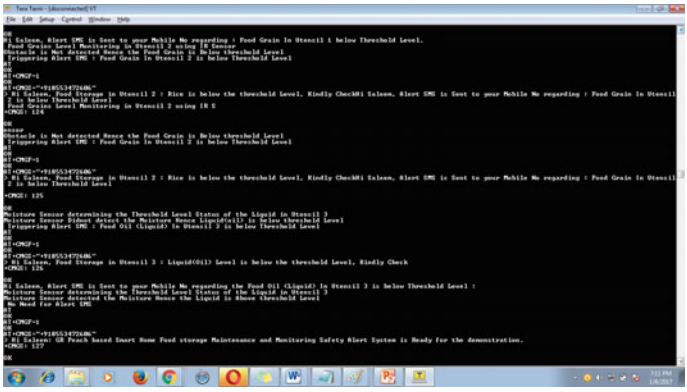

Fig. 10 Terminal application results—GSM message triggering

6 Enhancement to the Proposed Project

1. The interfacing of the GR Peach with the laptop with Ubuntu operating system can be easily done. Audio voice acknowledgement can be developed.
2. Whenever an alert SMS gets triggered or storage level goes below the threshold value, then an audio alert can be issued.
3. A text file can store all of the alert messages coming from the GR Peach which can be accessed.
4. LAMP server can be installed on the laptop, and a simple website can be designed, which can display the smart containers' status for food storage maintenance and monitoring from remote areas using Internet.

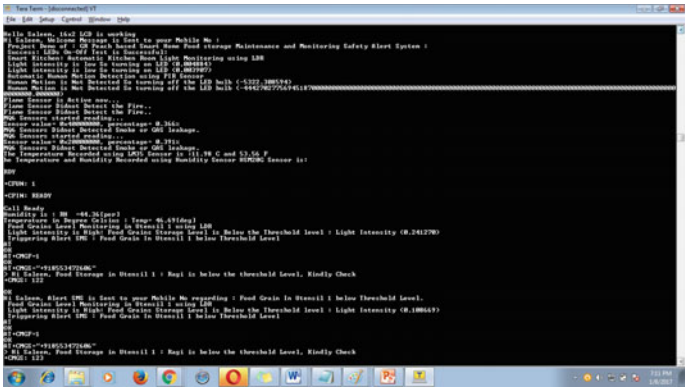

Fig. 11 Terminal application results—GSM Utensil 1 Alert

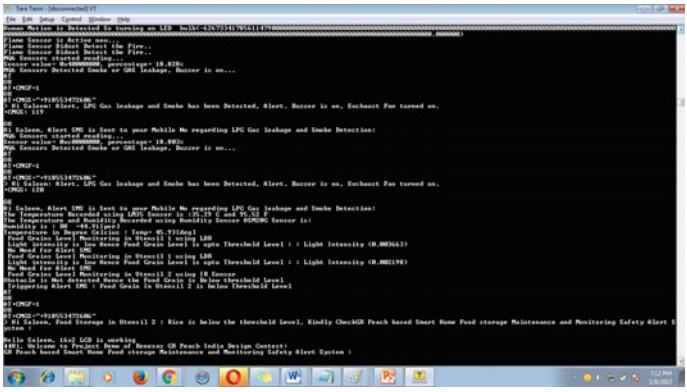

Fig. 12 Terminal application results—GSM Utensil 2

7 Applications of Proposed Project

1. Project can be used in food storage godowns as smart containers.
2. It can be used in restaurants and hotel kitchen rooms.
3. In homes to create a smart kitchen.
4. In rural areas, it can be used to store the food crops and monitor them.
5. As the project is low cost, it is used for the purpose of food storage maintenance and monitoring as well as for safety purpose.
6. The system can be used in hotels or restaurants food storage facilities.

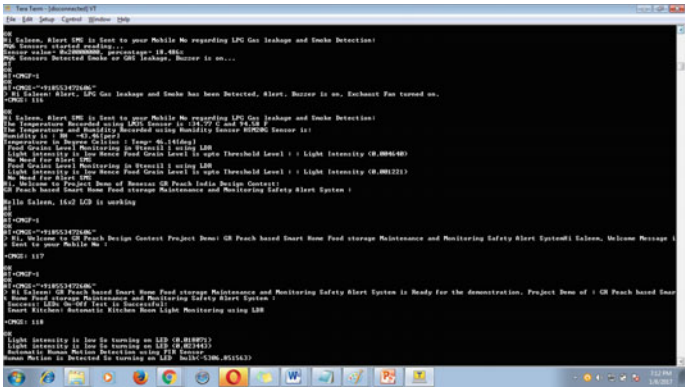

Fig. 13 Terminal application results—room automation

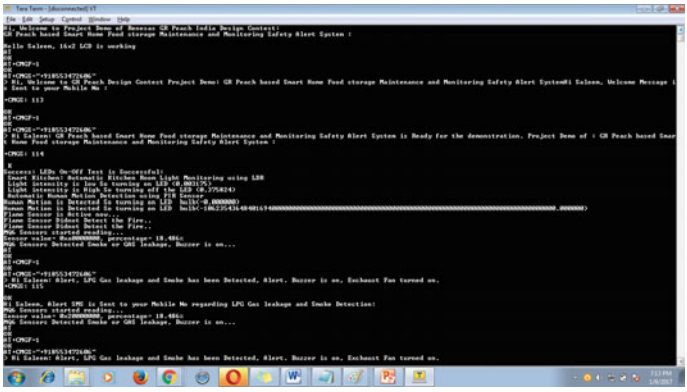

Fig. 14 Terminal application results—smoke alert

8 Conclusion

As GR Peach is an advanced board, the Internet of things (IoT) is allowing for a veritable network created not from computers as we know them, but of things, like containers and equipment. These things are embedded with an array of sensors, and tracking technology such as GPS along with RFID chips allows manufacturers, carriers and shippers to easily monitor temperature, vibration, losses and location of their cargo more accurately.

The proposed GR Peach-based smart home food storage monitoring maintenance and safety alert system has been designed with the current latest trends in mind. The proposed system will be of utmost importance for day to day life of the busy working-class families who depend on the accurate data for their monthly home budget preparation. The proposed system has been designed based on the principle of multilayer security. We have demonstrated successfully how smoke and fire sensor

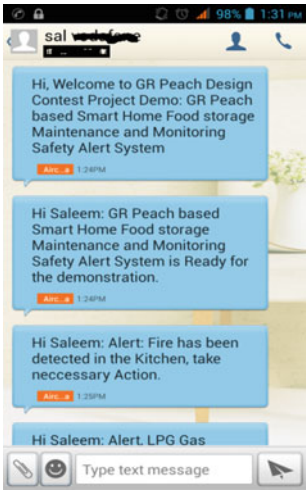

Fig. 15 SMS alert delivered to mobile

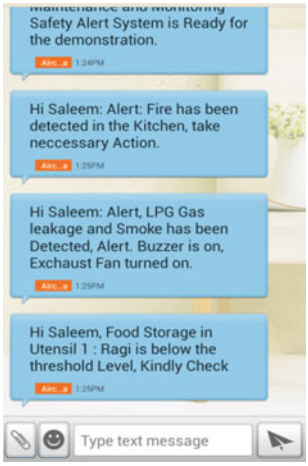

Fig. 16 SMS alert delivered to mobile

can be used integrated with temperature and humidity sensor for monitoring and developing safety alert feature, and also it is a low-cost easily affordable device. The proposed system not only works well as a food level monitoring system but also as a safety device in kitchens and food storage godowns.

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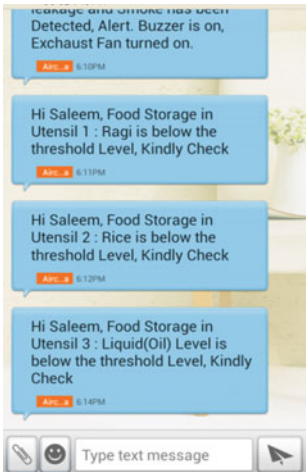

Fig. 17 SMS alert delivered to mobile

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Mr. Saleem Ulla Shariff was graduated from Bangalore Institute of Technology Bangalore (under Visvesvaraya Technological University Belgaum Karnataka India in 2011) with B.E. in E&C. He has worked for IBM India Pvt. Ltd. as a Software Engineer prior to joining for Master of Engineering (ME) in Electronics and Communication in University Visvesvaraya College of Engineering (UVCE) Bangalore (under Bangalore University). His area of research interest includes microwave communication, antennas and wireless communication and embedded system design with a keen interest in processors and microcontrollers like 8051, ARM microcontrollers, Arduino, Beagle Bone Black and Raspberry Pi.

Mr. M. G. Gurubasavanna has completed his B.E. in Electronics and Communication from Gulbarga University and M. Tech in Applied Electronics from Dr. M.G.R Deemed University and Research Centre, Chennai. He is a research scholar in Electronics Engineering at Visvesvaraya Technological University, Belgaum. He has more than 15 years of teaching experience and is presently working as an Assistant Professor in Government Sri Krishnarajendra Silver Jubilee Technological Institute, Bangalore, Karnataka, India. His areas of research interest include wireless communication, sensor networks and antenna system design with a keen interest in processors like Arduino, Beagle Bone Black and Raspberry Pi.

Dr. C. R. Byrareddy graduated from Bangalore University with B.E. in Instrumentation Technology and the M.E. in Electronics in 1990 and 1999, respectively. He is currently Professor in Department of Electronics and Communication Engineering, Bangalore Institute of Technology, Bangalore. He got his Ph.D. from SV University of Engineering College, Tirupati. His area of research interest is microwave communication, antennas and wireless communication, with a keen interest includes analysis and design of patch antenna for wireless communication. He has published more than 20 papers in national/international journals. He has also presented paper at IconSpace2011 in Malaysia.