Implementation of Smart Refrigerator based on Internet of Things

Mohammed Abrar Ahmed, R. Rajesh

Abstract: In this modern era, the Internet of Things plays an important role to make human life much easier and more convenient. Smart appliances have overtaken conventional appliances by improving efficiency, robustness, power consumption, connectivity. ‘Smart’ is associated with appliances which are interfaced with the Web. Thus, smart appliances are set forth to extend into every household these days. Smart appliances include Television, Dishwasher, Washing machine, Water purifier, Refrigerator. In this paper, we propose a methodology to make traditional Refrigerator smart. Smart Refrigerators help in food management by adding computational intelligence that involves the use of a microcontroller and various kinds of sensors to improve the functionality of the fridge. Using automation techniques, a cost-effective intelligence is added to the refrigerator. This smart fridge is user-friendly and enhances human life. The features that can be provided are numerous and mobile or web application is designed to prior control the fridge and application act as a connection between fridge and user. The smart refrigerator senses the shortage of items in it and upon granting access orders the item online or messages the grocery store to deliver the items. The smart module monitors temperature, humidity and uploads to cloud platform with real-time updates to the user.

Keywords : Arduino UNO, Cloud platform, Google Firebase. Internet of Things, Loadcell, Mobile application, Smart refrigerator, Temperature and humidity sensors, Wi-Fi module.

I. INTRODUCTION

A refrigerator is an essential household appliance and it is the most frequently used appliance within the household to store food items and drinks. Improvement in technology has created an effective impact on kitchen room appliances. Refrigerator has made human lives more convenient keeping food fresh and preventing spoilage. Over time there has not been much improvement in the features since the basic function of refrigerator is to keep things cool and people didn’t prefer any additional features for which the cost of a product is increased but in the recent times, intelligent refrigerators are introduced which are not well known to many people. A smart refrigerator is which has connectivity to the internet through the Internet of Things where it can do a lot more other than just keeping food cool. The Smart refrigerator proposed in this paper provides the user with lot more other than just keeping food cool. The smart refrigerator is a machine developed to sense the items inside the fridge, current environment in the fridge and act intelligently accordingly. The first internet fridge was proposed back in 2000 by LG company and was named R-S73CT which can sense the temperature inside the fridge giving freshness of food stored, a camera mounted can actually let you see what is inside and monitor the food items. It also had an LCD display for real-time applications such as notes, messaging, internet access. Despite these features, people found this overrated and could not find proper use other than storing food chilled thus it was a flop model. The only plus point attracted them is nearly half the current consumption and low sound. Samsung RH2777AT homepad can operate using wireless communication and was first to do so. It had the capability to manipulate the freezer temperature, modes in the fridge with light indication, dispenser for water. This series came with a lot of security issues and since the fridge is connected to internet it was a target for many net viruses which caused problems such as exposing mail contents to hackers and had to be called off for a while. In 2005 a smart medical refrigerator concept order to scale back spoilage of food. The smart refrigerator can also come handy in notifying if ice cubes are ready giving a notification buzz if ready to use. The smart fridge also has the ability to tell if the door is kept open by giving a notification via mobile or web application. Some modules also has features to let you know recipes with the items in the fridge. Automatic data capture is the feature of it since RFID tags can be embedded in a system and RFID readers can capture information by a good vicinity range. RFID (Radio-Frequency identification) tags are helpful replacing the traditional barcodes to track and provide details of an object. These tags can store a lot more information than linear barcodes and QR codes. The actuators sense various data required for working and transmit to the microcontroller and from which networking is done to cloud service using ESP8266 NodeMCU Wi-Fi chip from which users can retrieve information to mobile application via internet protocols. The proposed IoT based system uses Arduino UNO as the microcontroller to make refrigerator smart. Load cell sensor is employed to measure the weight of items. The inbuilt Analog-Digital converter is used for digital output of weight. The Temperature Sensor LM35 series is used to measure temperature, and humidity sensor DHT22 are employed in order to sense the temperature and humidity of the fridge and display in the mobile application in real-time. Mobile application is made in Android studio or MIT’s app inventor which is more user-friendly. Through this application users can view the temperature and humidity of the refrigerator, the number of food items in the fridge can be shown and a shortage of items can be ordered to refill which will be very helpful features to a Smart connected Refrigerator. Smart refrigerator is a machine developed to sense the items inside the fridge, current environment in the fridge and act intelligently accordingly. The first internet fridge was proposed back in 2000 by LG company and was named R-S73CT which can sense the temperature inside the fridge giving freshness of food stored, a camera mounted can actually let you see what is inside and monitor the food items. It also had an LCD display for real-time applications such as notes, messaging, internet access. Despite these features, people found this overrated and could not find proper use other than storing food chilled thus it was a flop model. The only plus point attracted them is nearly half the current consumption and low sound. 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was proposed which monitors the medical requirements of patients and dispenses medicines or notifies relatives or doctor if medication is not taken by the user[8]. A paper was proposed intending to provide better nutrition to the users by the use of smart refrigerator[9] the concept of this model is to provide better diet consciousness, calorie counting, nutrition suitable by creating recipes sensing what is available in the fridge. Using this, eating habits can change tremendously as an approach to a better lifestyle is the main concept. Intelligent refrigerator based on RFID technology [10] is also a feat achieved since these product identification technologies are very rapid developing and evolving these can be interfaced to the internet for placing orders of required items. This concept can be applied through ARM processors using embedded C-language in KEIL software [11] the user is notified via SMS if the fridge is low on items and an online link to buy the products is mentioned in the SMS. An efficient user notification interface can be designed by the use of ‘pushbullet’ software which is monitored by IoT platform ‘Thinkspeak’ and a paper is published using this concept for reference[12]. Researchers also applied artificial intelligence concept for a better performance and age detection feature of foods in the fridge. This concept uses an aging algorithm used in image processing techniques. A camera is mounted inside the fridge for the use of image capture from time to time and data is monitored in microcontroller attached to the module. Automatic classification of images is done using image processing algorithms and the items can be classified based on age, texture, color, respectively. Many efforts have been made to connect cloud services to a microcontroller such as Arduino, RaspberryPi using Arduino cloud platform, Google firebase, amazon cloud services, and an efficient cost-effective refrigerator is designed by using several methods. Most of the technologies in interfacing a smart refrigerator to the user use the internet as the medium as Bluetooth, local area networks are limited to short range, but cloud service can be accessed from anywhere in the world. The following sections describe point to point on how to achieve the smart refrigeration and accessing the cloud platform.

II. PROPOSED METHODOLOGY

A. The architecture of proposed system of Smart fridge:

![Block diagram of proposed system]

Fig.1 Block diagram of proposed system

The Fig1 shows the basic structure of the methodology which is being used. The purpose of the proposed system is to control the quantity of food inside the refrigerator as well as quality. A series of sensors get input to Arduino UNO which process the information and sends it to Wi-Fi module for data transmission from where data is put in the cloud service through wireless communication and the data can be accessed from cloud to mobile.

B. Setting up firebase cloud service:

Firebase is a google platform for database which provides services in cloud storage and syncing in different devices connected to it.

1. We must create an account on the firebase website.
2. Click ‘Go to console’. 3. Add a project and provide the project a name, upon accepting all terms and conditions project gets created. 4. On the left window of webpage click ‘settings’ beside project overview and from the choice select ‘service accounts’
5. Move to the Database secrets and click the ‘show’ button beside encrypted secret and copy this to clipboard.
7. Select start in test mode which gives us 30 days to access the data and press continue.
8. Now just above the database, here you can see “https://your_project_name.firebaseio.com/’
III. IMPLEMENTATION

The Load cell is a pressure transducer that senses the force and generates an electrical pulse and gives analog output. Load cells are mounted to the bottom of the tray where bowls or utensils containing vegetables, fruits, milk, eggs, cheese, meat are placed and the bowls are named. For each type of items, a threshold value of weight is fixed. This analog output of weight is made digital by A-D converter present already in the microcontroller board and this digital output is given to microcontroller input pins and the data is monitored and uploaded to firebase. If the weight value drops below the threshold value for example 150 g, through the cloud the user is notified and permission is asked to order online in order to refill and feedback is collected in order to stop the notifications if the product is ordered. If the user grants access the app redirects to an online grocery store or the user can allow the app to send messages to the contact like a grocery store owner. Using the LM35 series sensor temperature and DHT22 humidity are recorded and sent to the app via cloud. Using these data user can sense defects in cooling or lower temperature of the fridge if needed to store some foods which require appropriate temperature and humidity for storage.

IV. RESULT AND DISCUSSION

With this smart module application, we can infer that Internet of Things is making revolutionary change in the field of electronics since it resolves many problems in human hectic schedule. Firebase provides an effective medium for data transfer and user control over the fridge. Temperature, humidity is monitored effectively and spoilage of food is reduced. Online ordering system provides hassle free ordering which becomes automatic process of refilling effectively. The load cell is able to calculate weights with high precision than other pressure sensors available in market. The application designed uses graphical interface of app inventor and using java script to make buttons functional by interfacing it to firebase. The smart module is able to perform effectively in the cold temperatures of refrigerator due to the components used have threshold temperature of operation below the refrigerator temperature level. The firebase has effective computational capacity and thus saves time for transferring data to it and from it. The Wi-Fi module connected to home network is able to communicate effectively with the cloud server and there is no observable lag in data transfer between them. User is able to get real-time updates and is able to communicate with the microcontroller effectively. The smart module can be interfaced to any fridge and as the cost of the module is also low consumers don’t hesitate to buy and can be implemented in remote areas too with ease of access to new technology. Testing is done and reliable output is achieved, and functionality of sensor is observed. This smart module
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can be installed in homes, restaurants, offices, and in any commercial places. Combining the idea of Internet of things and cloud storage a smart kitchen is to be implemented just like smart refrigerator.

V. CONCLUSION

The conversion of traditional refrigerator to smart and intelligent is done using Arduino UNO and firebase and the module detects the shortage of food items and notifies the user and uploads the data to cloud service along with data of fridge temperature and humidity. This system is cost-effective and can be used for any fridge just consuming some space in the fridge. The future work can be implementation of amazon web services like image recognition software to detect what’s inside the fridge by mounting a camera and using image processing algorithms of the software which returns user the item name along with lot other details. Using Google API for speech recognition which uses natural language processing algorithms and recognizes commands by strong neural networks and gives response.

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Mohammed Abrar Ahmed, currently 3rd year student of Electronics and communication engineering at Vellore Institute of Technology, Vellore, India. His research interest includes Digital communication, signal processing, Internet of things, Computer languages.

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