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Smart Refrigerator Using Internet of Things (IOT)

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Abstract—Smart appliances with multimedia capability have been emerging into our daily life. Smart appliances include washing machine, television, refrigerator etc. In this modern era, human being is used to intouch with this technology or we can say it as internet of things (IoT). As we look around ourselves we see modernization with superior technology, for example cell phones, kitchen, appliances and many more. It uses fast advance of computing technology and the wide use of the Internet, smart home is one of the most prominent areas of intelligent appliances. Kitchen is one of the places where such intelligent appliances are mostly used. Existing systems used high technology that increases its complexity. The products currently available are expensive so the user has to buy the whole costly refrigerator. The Smart Refrigerator module is designed that modifies any existing normal refrigerator into a smart refrigerator which is cost effective, using various sensors.

Keywords— Refrigerator, Internet of things (IoT), Arduino board, Arduino IDE software, Android studio, Sensors.

I.INTRODUCTION

Refrigerator is the most frequently used domiciliary/kitchen electrical appliance all over the world for food storage. Principally this appliance is used for various tenacities like storing vegetables, fruits etc. Smart refrigeration module is designed to convert any existing normal refrigerator into a smart and low cost machine using sensors. Smart refrigerator compares the status of the food for e.g. weight, quantity etc. Significance of this work will be removable of food spoilage, reduce illness and make healthier lifestyle of modern age human being. The smart refrigerator is capable of sensing and monitoring its contents and also provides advantageous features. The smart refrigerator is also able to remotely on-off control and notify the user about scarce products via wifi module (internet)on user's mobile android application. It also facilitates the purchase of scarce items by providing a one-touch button on mobile application from predefined nearer grocery vendor of that particular item by sending SMS. The core functionality of the smart fridge is to maintain, with minimum effort, an food items which might want to be purchased as soon as they run out. As a result, the user is notified every time if eggs are finished. The load cell triggers a notification of available less vegetable to user as soon as the applied pressure is below threshold kg. IR proximity sensors monitor the containers in which milk or juices are sensed. Additional functionality includes the ice ready indication, power saving, smell detection, over weighting etc.

A.State of the art development

By the late 1990s and the early 2000s, the idea of connecting home appliances specially refrigerator to the internet (Internet of Things) had been popularized and was seen as the next big thing. In June 2000, LG company had been launched the world's first internet refrigerator, the Internet Digital DIOS. Smart refrigerator (also known as Internet refrigerator) is a refrigerator that has been programmed to sense what kinds of food items are being stored inside a fridge and keep a track of the available stock through barcode or RFID scanning. This kind of smart refrigerator is often equipped to determine itself whenever a food item needs to be replenished (restore). But this refrigerator was an unsuccessful product because the consumers had seen it as an unnecessary product and due to more expensive (more than $20,000) and that the problems solved were obscure. For example, many juice bottles or milk bottles are transparent, providing a visual reminder that a buying is needed eventually; vegetable drawers are similarly transparent and contain

items often removed from packages, thus eliminating a bar codes for inventory which meant manually keying in descriptions, dates and other details. Moreover, the ability of the device to remind users of upcoming purchases when there are often multiple buyers in a household who communicate informally is not typically addressable as a use case.

This chapter discusses the development of the SRIOT (Smart Refrigerator Using IOT) module. This module could be seen as a combination of smaller modules namely:
1. Sensing module
2. Control module (Arduino board)
3. Transmission module
This modules works together perform all the functions and features of Smart refrigerator.

A. Design Considerations

Design section addresses the issues that need to be resolved before attempting to devise a complete design solution.

1) General Constraints
The following considerations must be kept in mind while developing the design.
- Power supply of module should be switched off when module not in use.
- The food items that to be sensed have to be placed in their respective places.
- The design must be applicable to any existing normal refrigerator.

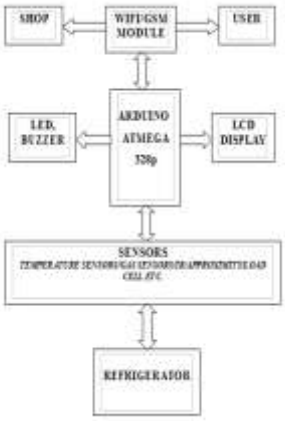
2) Architectural Strategies
This section describes the design decisions and strategies that affect the overall organization of the system and its upper level structures. These strategies will provide insight into the key abstractions and mechanisms used in the system architecture.

III. IMPLEMENTATION

This section deals with the detailed hardware and software description and implementation of the various sensors and components.

Hardware and Software Implementation
This section provides description of the hardware and software used for implementation of the Smart Refrigeration module.

The hardware used for Smart Refrigeration module are: Power supply unit, Arduinouno board (ATmega328p), electromagnetic relay, various sensors, GSM module, LCD display. Figure shows the block diagram of Smart Refrigerator.



1) Development Tools

Programming for Arduino may be written in any programming language with a compiler that produces binary machine code like C and C++ programming. AVR Studio and the newer Atmel Studio, which can be used for programming Arduino microcontroller. Atmel provides a development environment for their microcontrollers.

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming code language Java. It originated from the IDE for the languages *Processing* and *Wiring*. It was created for people with no profound knowledge of electronics. It provides features such as syntax highlighting, cutting-pasting, and searching-replacing

text, and automatic indenting, and provides simple one-click mechanism a code editor with to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a series of menus.

A program written with the IDE for Arduino is called as a "sketch." Sketches are saved on the development computer as the file extension with'. no.' Arduino Software (IDE) pre-1.0 saved sketches with the extension .pde.

The Arduino IDE supports the programming languages C and C++ using special rules to organize code. The Arduino IDE also supplies a software library from the Wiring project that gives many common input and output procedures. The user-written code only requires two functions, for starting the sketch and the main programs loop, that is compiled and then linked with a program stub *main()* into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program *air dude* to convert from executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

2) Android Studio

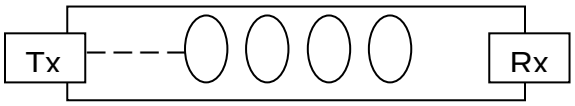
Android Studio is the official Integrated Development Environment (IDE) for Android application development, based on the IntelliJ IDEA. On top of IntelliJ's, there is a powerful code editor and developer tool; Android Studio offers even more advantageous features that enhance your productivity when building Android applications, such as follows:

- A flexible Gradle-based build system
- A feature-rich and fast emulator
- A unified environment where you can develop for all the Android based devices
- Instant Run to push changes to your running app without building a new APK file
- GitHub Integration and Code templates to help you build common app features and import sample code
- It provides extensive testing tools and frameworks
- Lint tools to catch performance, version compatibility, and other problems
- Programming languages: C++ and NDK support
- Built-in support for Google Cloud Platform, making it simple to integrate Google Cloud Messaging and App Engine

IV. WORKING

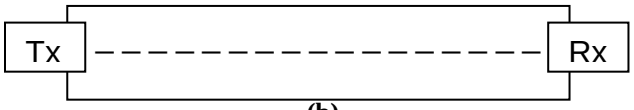
(1) Working on IR sensor module (eggs detection):

The pair of IR sensor (i.e. transmitter & detector) are mounted in eggs compartment on opposite wall such that eggs can be placed between them. When eggs are present, there is no contact between transmitter and detector as shown in fig.(a)



(a)

In the second case when all eggs are lifted, there is direct contact between transmitter and receiver as shown in fig.(b) that provides a signal to microcontroller for further processing. Microcontroller generates 'eggs finish' signal and sends to user on the mobile android app with the facility of the one-touch auto order of eggs from predefined grocery shop through wifimodule.



(b)

(2) Working on IR proximity sensor module (milk/juice detection):

An ultrasonic sensor in a compartment of milk vessel or bottle will detect the presence of milk level. If milk level is low then 'milk finished' message will be generated and send to the user through wifi module on Android app with auto order link.

(3) Working on load cell:

(a) Vegetable detection:
The load cell is mounted below vegetable tray in the refrigerator that continuously measures the weight of vegetables in the tray. Since the weight of vegetable tray goes below threshold weight (set by user approximately 500gm), it senses the less presence of vegetables. Low signal will be generated corresponds to it which will be sent to the user on the mobile app.

(b) Over weight detection:
The load cell is also used to measure the overall weight of fridge and compares this weight with the maximum possible capacity to carry the material inside fridge set by the manufacturer at which the cooling process of the refrigerator works properly. When the overall weight crosses the threshold level, buzzer will turn ON indicating overweight
.

(4) Working on the gas sensor (smell detection):
Rotten vegetables produce a mixture of gasses. Gas sensors are fixed inside the fridge to detect the odor of rotten vegetables. If gasses detected by the gas sensor, the message will be displayed on the front panel of the refrigerator as well as on user's mobile, indicating to clean the fridge.

(5) Push buttons on main door and freezer door:
While the closing of main door or freezer door of the fridge, by mistake it may remain open by the user. When any of the doors is opened the push button release its contact and triggers the timer. If timer exceeds the threshold time of 5 minutes, the buzzer turns ON.

(6) Ice ready indication:
Typical temperature in the freezer is -5 to -10-degree Celsius. At this temperature, the water in ice tray takes nearly 30 minutes to prepare complete ice. IR sensor is fixed in a compartment of ice tray that detects when the ice tray is placed in the freezer and starts the timer. After 30 minutes the timer stops and displays the message 'ice ready' on front panel LDC.

CONCLUSION

The Smart Refrigerator module can remotely notify the user about the low contents of food items inside the refrigerator. It also able to remotely on-off control and notify the user about scarce products via wifi module (internet)and purchase of scarce items by providing a one-touch button on a mobile application (sends SMS to shopkeeper) from predefined nearer grocery vendor of that particular item. This module provides other advantageous like power saving, smell detection, ice-ready indication and others features.
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Advantages

• No need of human intervention as automatic Functioning performs the proper operation without any supervision.
• Complete automated operation.
• One-time installation.Low maintenance cost

Limitations

• Operations may take longer time.
• Difficult to install and implement on large plants.
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• Need proper calibration otherwise it will not work properly.

Future Scope

The concept of the smart refrigerator is far more reaching than notifying the user about the available contents of the refrigerator. It should give importance on maintaining a healthier lifestyle by providing the nutritional value of the contents.

The future smart fridge will use barcode scanner that will scan the expiry date products while keeping in the fridge. This gives alert to the user when any product in the fridge is expired.
Ultrasound-scanning technology built into the door will allow the fridge to 'swipe and capture' the food on a plate before and after mealtime, meaning it can assess what type and amount of food are wasted.
Cameras can be placed in the refrigerator that the user can able to see the contents available in the fridge on user's mobile application from a remote area.
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