Smart Refrigerator with Internet of Things

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Abstract : Intelligent appliances with multimedia capability are emerging into our daily lives. Kitchen is one of the places where such intelligent appliances are being used. The smart refrigerator module is designed to convert any existing refrigerator into an intelligent cost effective appliance which is capable of sensing and monitoring using various sensors. It can also remotely notify the user about the scarce products via SMS or E-mail. The core functionality of the smart refrigerator is to maintain with minimum effort, an inventory list of food items which might be needed to be purchased as soon as they run out. It facilitates the purchase of scarce items by providing a link of the online vendor, additional functionality includes the acknowledgement of a placed order in order to avoid the purchase of same item by different users of same refrigerator.

***IndexTerms* - Smart Refrigerator, Sensors, IOT, RFID, KEIL**

I. INTRODUCTION

Developing Smart Appliances is directly proportional to developing smart home environment [1]. Kitchen is one among the foremost important place for a sensible home because it consists of the many appliances which provides better services to the household [2]. Many efforts within the event of the smart refrigerator are made, none of which has been energy efficient or cost effective. The modern living and therefore the fast paced environment doesn't allow the user to stay a track of the food items inside the refrigerator. Although efforts are put by the industry to develop the smart refrigerator, the present or the prevailing technology remains not cost effective or energy efficient. The technology is just too complicated or complex for an easy household user who have little knowledge of how all the mechanism behind the smart refrigerator works [3]. The smart refrigerator or the web refrigerator because it is named, is employed to watch the things inside it and notify about scarce products [2]. The idea of connecting home appliances to the web or the smart home environment has been seen because the future and is very considered subsequent big thing.

II. RELATED WORK

In 2013, Samsung announced innovation of a smart refrigerator with an LCD screen, referred to as the T9000 [5]. Although it was still a prototype, the LINUX-based system inside the refrigerator contains several amazing functions, such as Samsung's smart home applications, Google calendar applications, and Evernote applications. The prototype allowes users to use Evernote as a cloud-based service to create ingredient lists and shopping lists, which could be accessed from any device.

Three years later, Samsung released a new kind of smart refrigerator at CES 2016 [6]. With a 21.5-inch touchscreen and a built-in camera, Samsung's Family Hub is that the latest model of smart refrigerator. In previous models, users still needed to manually enter the list of foods, leading to fatigue when users grew tired of typing. This new model solves that problem and adds a built-in camera that allows the user to check the actual image inside the fridge with a smartphone.

The Family Hub also allows users to access e-mail, browse photos, or watch television using mirror-casting. By naming the new product the Family Hub, Samsung is trying to give their product a central role in the household.

A cost-effective space sensing prototype for an intelligent refrigerator was described in [7]. The proposed system was cost-effective and automatically monitored the quantity of space, and indirectly usage, in a refrigerator compartment.

Advancement to the proposed design allowed the system to automatically alert the homeowner of the refrigerator's status through short message service (SMS).

III. CONCEPT

The proposed system revolves round the core concept of product identification supported RFID technology. All or most products bought from the shop will have a tracking RFID tag, with information stored during a global level database by all or most manufacturers. Below is an overview of them.

3.1. IDENTIFYING NEW PRODUCTS

Same as intelligent refrigerator system for storing pharmaceutical products, the proposed system will scan all products at a fixed time interval and identify whether or not a certain product was already marked as found in a previous scan. If not, then the product is considered new and a web request is made to a global database from which information like product name, manufacturer and expiration date is fetched and stored locally.

3.2. INVENTORY AND SHOPPING LIST

Not everyone buys an equivalent product over and once again but there are those few products that are essential in every household's refrigerator (e.g. milk, eggs, cheese, etc.). For this purpose, an important Inventory was created during which the refrigerator owners can add new products that they want to possess available in the least times or save an already available product in the Essential Inventory. A product that is marked for the Essential Inventory and has been permanently removed from the refrigerator, as described above, will be added to the shopping list. The Shopping List is a web application that the refrigerator

owner can access on any internet connected device (smartphone or tablet). The list of products is a live feed because it does not interact directly with the refrigerator and the data is stored off site, in a remote database.

3.3. INFORMATION OUTPUT

One information output source is the Shopping List application, but this is not the only one. Inventory is another web application has been developed in order to easily see what products are in the refrigerator at any time and even display what products were available in past scans. Along with the available product list other information is displayed, such as product type, manufacturer and expiration date. Also, any product can have multiple tags assigned to it, such as a person based product reservation (e.g. "Amul milk") or an event based product reservation (e.g. "Chocolates after dinner"). Similar to the Shopping List, the Inventory application stores its data off site in a remote database so this information is accessible from any internet connected device in any remote location.

IV. ARCHITECTURE

The below figure depicts the block diagram of the proposed project.

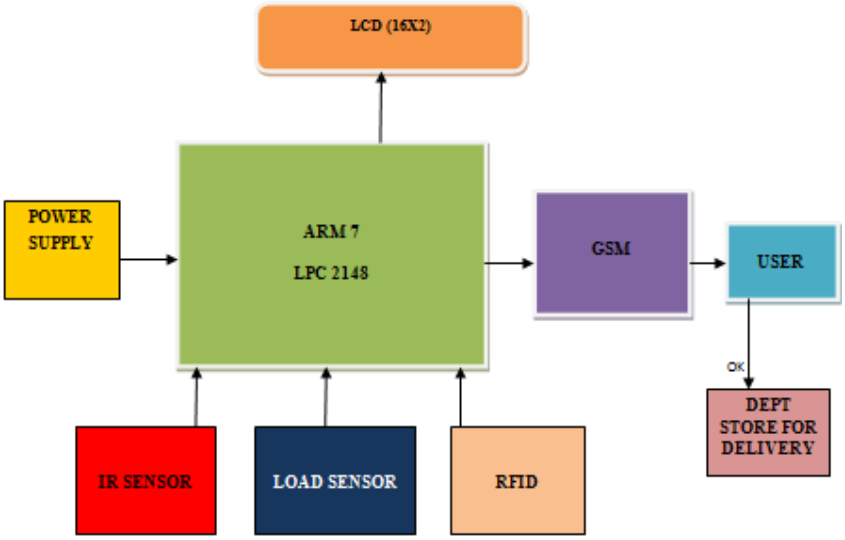

Figure-1: Block diagram of IOT based smart refrigerator

4.1. POWER SUPPLY:

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications.

4.2. ARM MICROCONTROLLER:

The microcontroller used is ARM LPC 2148.

Figure-2: ARM Microcontroller

4.3. IR SENSOR:

The IR Sensor-Single is a general purpose proximity sensor. Here we use it for collision detection. The module consists of a IR emitter and IR receiver pair. The high precision IR receiver always detects a IR signal. The module consists of 358 comparator IC. The output of sensor is high whenever it IR frequency and low otherwise. The on-board LED indicator helps user to check status of the sensor without using any additional hardware. The power consumption of this module is low. It gives a digital output.

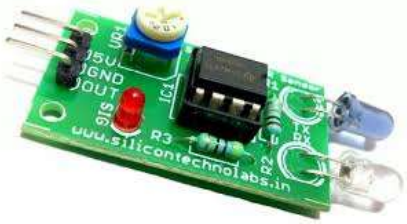

Figure-3: IR sensor

4.4. LOAD SENSOR:

A load cell is a transducer which converts force into a measurable electrical output. Although there are many varieties of load cells, strain gage based load cells are the most commonly used type.

Figure-4: Load Sensor

4.5. RFID:

The NSK125 series RFID Proximity OEM Reader Module has a built-in antenna in minimized form factor. It is designed to work on the industry standard carrier frequency of 125kHz.This LF reader module with an internal or an external antenna facilitates communication with Read-Only transponders—type UNIQUE or TK5530 via the air interface. The tag data is sent to the host systems via the wired communication interface with a protocol selected from the module Both TTL and Wiegend

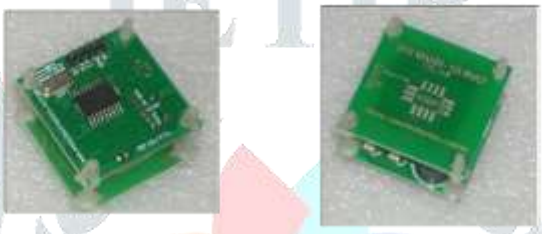

Figure-5: RFID

4.6. GSM

The GSM module is used for communication.

4.7. LCD

The LCD controller provides a relatively simple interface between a processor and an LCD.. LCDs can be added quite easily to an application and use as few as three digital output pins for control.

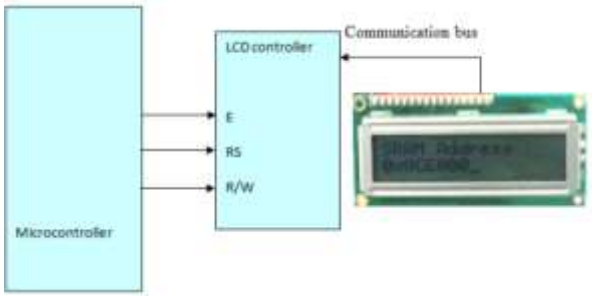

Figure-6: LCD Connection

V. IMPLEMENTATION

The system presented has been implemented at a proof of concept level, meaning that a refrigerator was not actually used in the process and the system was built and assembled on working bench, partly because of the necessary funds required but also because in this case, it would not bring an added value to this paper. However, the full implementation was part of the design process and was thought of. In order to have the widest coverage inside the refrigerator the antenna was to be placed and the top or bottom of the refrigerator. Using a vertical implementation will result in not requiring multiple antennas, one for each level compartment, thus reducing the costs and the entire system complexity. Figure 7 better describes the hardware implementation inside the refrigerator.

The µVision2 IDE is Windows-based software development platform that combines a robust editor, project manager, and make facility. µVision2 integrates all tools including the C compiler, macro assembler, linker/locator, and HEX file generator. µVision2 helps expedite the development process of your embedded applications.

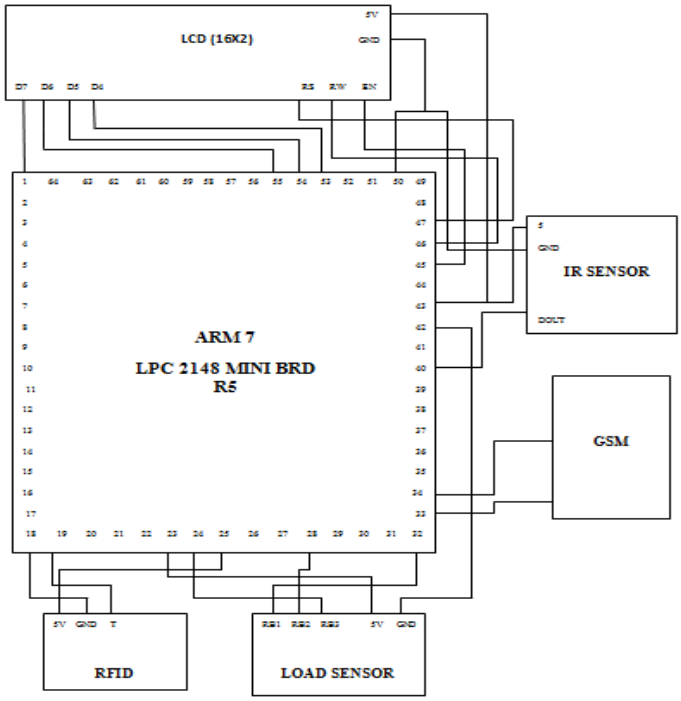

Figure-7: Circuit Diagram

VI. Evaluation and Results

The goal of the proposed architecture is to enhance the sustainability of IoT applications by exploiting smart and reliable (networks of) things and by being able to utilize a big number of heterogeneous device platforms. The proposed architecture enables the development of an environment for IoT applications through cross-platform channels that incorporate technologies for Data, Information, Things and Decentralized Management [14].

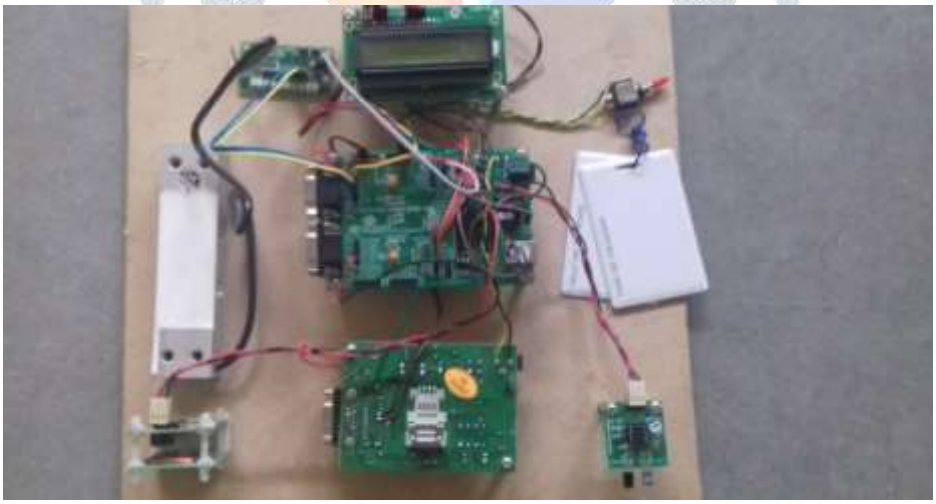

Figure-8: Hardware Setup

VII. Conclusion

The internet refrigerator which is a typical IoT makes our daily life more convenient. Considering the positive side and the development this will bring to our daily life, convenience and comfort will be inevitable in our routines. This affects or impacts not the consumer or user alone but food manufacturers, food retailers, the product (refrigerator) manufacturers and even repairers or maintenance officers. According to [10], for users, it makes lifestyle easier, quick and efficient and of good quality as menu can be planed easily, short or no time is spent arranging item based on expiration, no food wastage, more efficient shopping and so on. For Refrigerator manufacturer, it saves the labor cost, easy plan can be made for future products based on the understanding 3rd International Conference on Advances in Engineering Sciences & Applied Mathematics (ICAESAM'2015) March 23-24, 2015 London (UK) from the consumption pattern; this new technology becomes a new source of income, and so on. Food manufacturer gets to easily advertise their products to the right customers efficiently, cost of inventory and labor becomes reduce, origin of a food item can be traced easily. For retailers or distributors of items workload is reduced, better projections can be made on market conditions and sales also cost of product can be controlled. Therefore there is no facet of life that embraces the internet refrigerator that will not benefit from its emergence positively regardless of whatever pitfalls attached to this. If embraced the potentials of nation's economy will definitely become greater.

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