

RESEARCH ARTICLE

CHILD CENTRIC FOOD ADVISORY ENABLED SMART SYSTEM FOR REFRIGERATORS

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Abstract-- Innovative Smart appliances with an interactive approach and their consumers are growing exponentially. Smart refrigerators are such a prominent intelligent kitchenware and hence published studies on smart homes and smarter kitchen appliances have been around in recent years. Although published research is available on smart refrigerators which describe its use for managing items stored in it and advising its users with cooking methods etc., a targeted and consumer focused smart refrigeration system is still amiss. In this paper we propose and present a design-driven approach for a smart refrigerator which may function as a modified child centric food-advisory system.

Today's smart child needs the stimulus from a modernistic technology combined with interactive communication that may excite him to relish home-made food instead of packed, or ready- to- eat foods. Especially when a child returns home from a daylong school, it is effectual to have fridge which communicates. An interactive refrigerator with smart access and a food management system is proposed, with convertible see-through glass surface door. The door becomes transparent based on identification of people by a face recognition software system. To enhance the capabilities, software interface is Android driven telecommunication system. After the person is recognized, this Smart-Refrigeration System is capable of communicating the suggested food intake for the day, especially to children, back from school. The main intention behind this intelligent system is to encourage children to consume fresh homemade food. Daily fresh food specially prepared by multitasking and working mother(s) is kept in one designated compartment. Sensor enabled techniques informs mother about consumption of food placed in this compartment. "No consumption alert" is sent via SMS as monitoring application. The characteristics and design details of such a child centric the smart fridge, are presented in detail.

Keywords: Smart fridge, Sensors, RFID, Android, Ubiquitous Computing

1. INTRODUCTION

"Smart homes with smart technologies" is the new concept which every industry and research is focusing on. Research is already underway for making our homes elderly-friendly and hence on similar grounds, smart homes with technology enabled appliances are the need for professional working mothers as well. Kitchen is the most important place in the home, which takes care of proper nutrient values especially to growing up children. In an endeavor to introduce to the market 'Smart Home Technologies', both researchers and the manufacturing sector are working towards altering the conventional fridge functionalities by introducing its integration with TV, radio, internet, web etc[1,3]. Such smart system for refrigerator is the focus of our work.

Modern living patterns have introduced unhealthy lifestyle, bereft of exercise, an undue consumption of packaged readymade food and an unhealthy diet. Such unhealthy eating patterns especially in school going kids may affect their overall expected / needed growth. Therefore it is extremely essential to have proper nutritional daily food intake, which is homemade food. Hence applications focusing on health of growing up children are important.

It is also observed that the children of Generation Z are smarter and more tech savvy. A household refrigerator with interactive communication which greets them and displays the options of home cooked food laid out in the fridge by their mother might catch their attention and interest them to consume homemade food instead of packaged food. The paper intends to propose the working and the design of an intelligent refrigeration prototype that uses Ubiquitous Computing technologies [2], to suggest the food intake for the day, especially to children when they operate the refrigerator.

The first phase of system greets the kid, displays information suggestive of food and its nutrient level. Mother is just an SMS away to update required details. In the next phase the surface of electrochromic glass door [4] turns transparent as triggered by a face recognition unit. At this stage, the kid gets the look of food available. Once finished, the panel reverts to its formal digital display on an opaque background. This smart switchable glass door system helps to keep food fresh longer, with low energy consumption, as numbers of “door open” operations are reduced. Maintaining completely transparent fridge in Indian kitchen is not advisable and hence these efforts.

Such a user friendly, modified appliance with a vision system can be programmed to advise the foods that are being stored inside it. This proposed system will include software application units based on Android platform, hardware units such as an electrochromic glass door, telecommunication devices, devices for network connectivity and sensors [5] configured to check accessibility to food compartment etc.

2. RELATED WORK

To preserve nutritional values in better way and for good health a new idea of fridge is given by authors in [1]. The idea is to check what the current contents of fridge are and then suggest recipes to user. This fridge is also equipped with analyzing eating routines, diet preference etc. The authors in [6,7] present a screen panel for an intelligent refrigerator system, which replace the existing flat screen with a touch screen panel PC and equipped it with a RFID tag. This system also performs online shopping, reminders, message board and recipes. In their research paper [8] authors implied ideas based on “novel lesser-invasion-communication” with fridge. Author suggested item-based communication system with fridge. When the user is about to take-out something from fridge, trigger is activated.

The authors of [9] propose an intelligent fridge which self monitors quantities of the stored food items. The stock management feature in the fridge detects and alerts the owner to stock-up on the depleting food items. Freshness of food detection facility is introduced by authors in paper [10]. They also have fridge based on RFID technology, which gives detailed report of freshness of fruits and vegetables. According to authors, this is the most economic suggestion to smart fridge.

Pervasive computing technology is used by authors in paper [11] to focus on precise expiration date of eatables. Also speech and image recognitions technologies are incorporated in this fridge design by authors. This fridge is also enabled with sending SMS alters to owner, mentioning food loss, if any.

The idea of a touch interface door in a refrigerator is explored by a researcher [23] as achievable by using a touch screen (electrochromic) display and attached sensors. This transforms the door into an interface and interactive information is displayed on the surface of the glass door. The design of a smart home appliance with preinstalled apps which may suggest the user with food recipes from a recipe bank, using available ingredients in the refrigerator is suggested in [24]. LG’s smart refrigerators [25] using Wi-Fi provides for food and refrigerator management which allows convenient handling of food items and refrigerator functions. It also provides various features such as Google calendar, recipe bank apps.

3. TECHNICAL PERSPECTIVE OF PROPOSED SYSTEM

The existing refrigerators with technology to hear recipes while cooking, live TV, phone, internet etc. are the new trends extending in the same areas. Smart fridge concentrating to improve kids eating habits, focusing on homemade food, making fridge more kids friendly by introducing transparent door on identification, is lacking. Also the available technologies with smart fridge are complex for Indian home. The proposed design has the potential to be incorporated as a smart appliance in the Indian kitchen. The Activity flow of the proposed child centric food advisory refrigeration system is shown in Fig 1. Interesting and functional use of fuzzy logic algorithm software combined with sensors/voice integration in electronic appliance helps further implementation and communication.

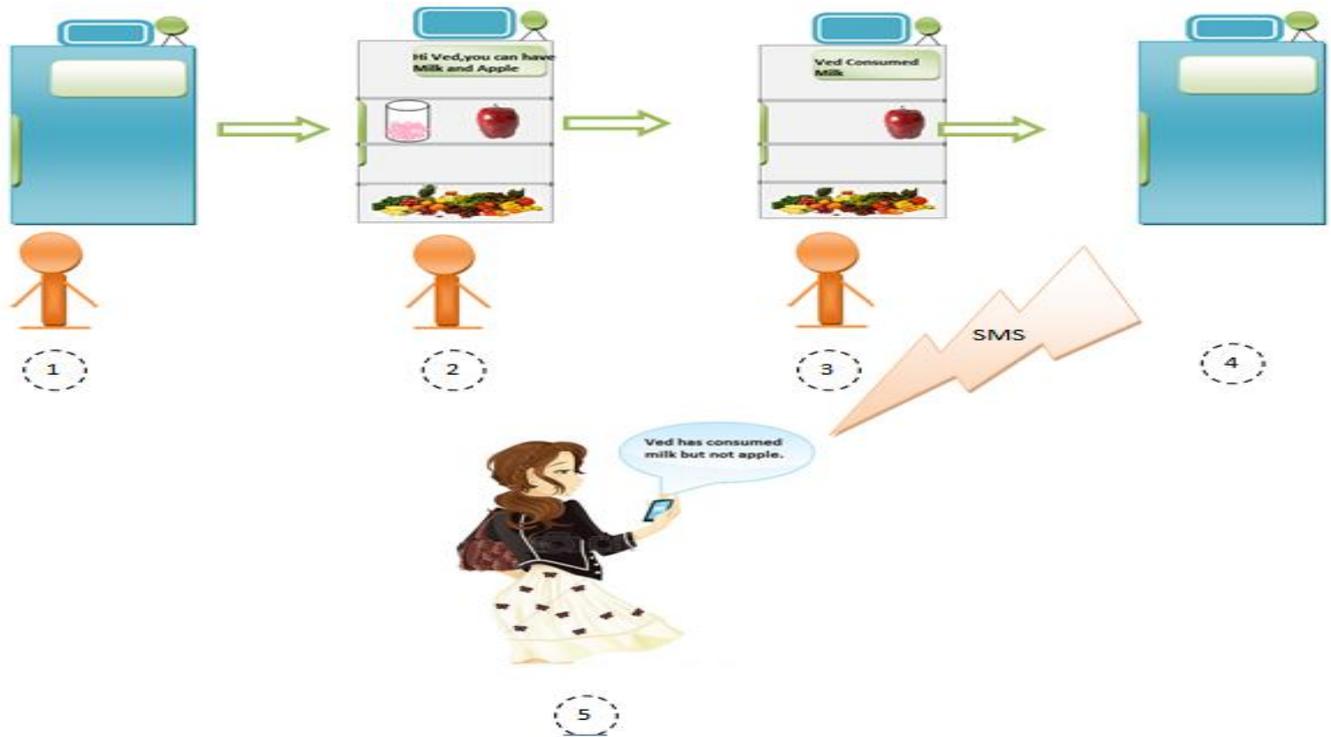


Fig-1: Activity flow of Child Centric Food Advisory Enabled Smart Refrigerator System.

The main aim of this practical light-weight system is to suggest archetype of food advisory system which help children develop good food habits. The system has a built-in backend server, microcontrollers, control logic, sensors etc. To establish communication with mother at work, this system requires various apps and they are message services (via SMS), personal organizers, databases, embedded operating system with internet connectivity.

Proposed system has an embedded system which would consist of a controlling computer that will fetch information from the face recognition system and the sensors that are attached to the smart fridge. Based the input information the system will display the food list to the child, lock the restricted compartments and accordingly update the consumption status on an android device.

A significant and unique feature of this prototype is to save electricity. This is achieved by using convertible transparent door, to attract children towards customized fresh food. It also caters the need of particular user. Further, retains the stress-free work-home balance to mother with available interface.

3.1 Functions and Features of the Prototype

The following list gives the features implemented in the proposed prototype system:

- Identify child
- Greet child (time specific)
- Display message and list of food items (kept inside for consumption)
- Lock the fridge compartments except child compartment

- Generate and update list of food items
- Send SMS to mother in case of non-consumption of food (time sensitive)
- Friendly control panel and apps
- Store family members recommended food consumption information.

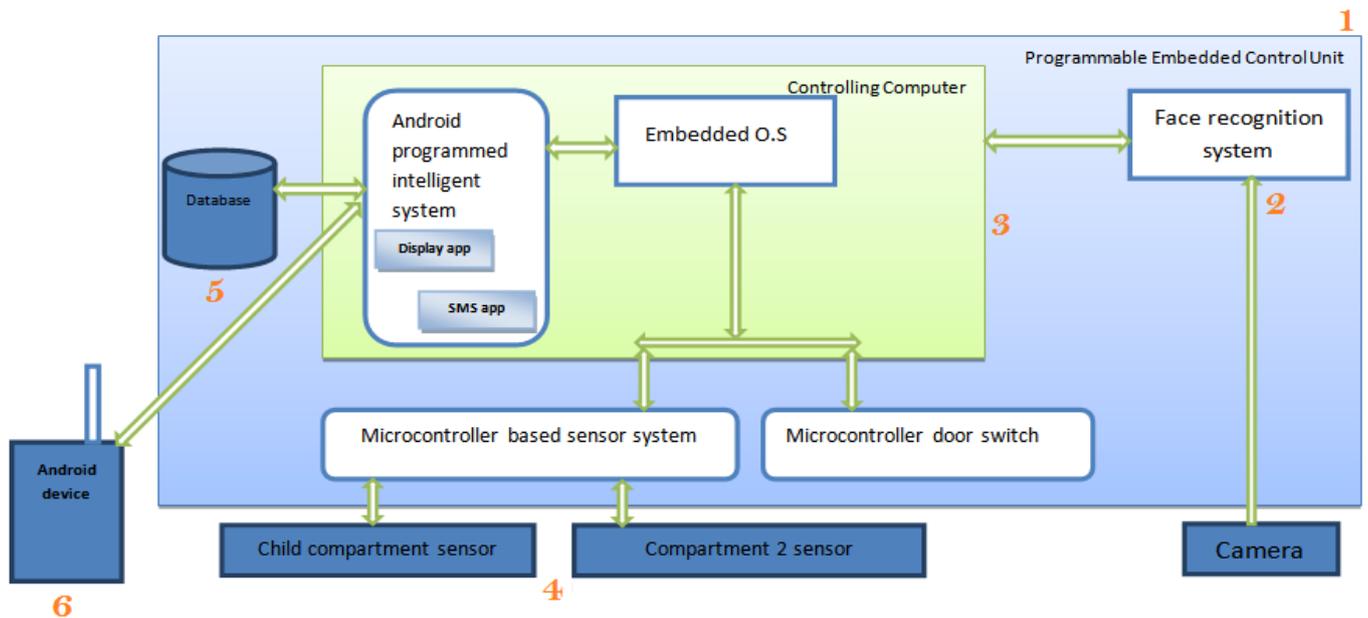


Fig-2: Block diagram of the Proposed Prototype

4. SYSTEM DESIGN AND IMPLEMENTATION

The entire system as shown in Fig.2 will comprise of “programmable controller unit”, “face recognition system”, Controlling Computer, Sensors , Microcontrollers, Database and android device.

A. Programmable Controller Unit

This unit is a combination of camera (for identification of user’s face) and hardware components kit to communicate identified persons details to LCD display unit. This LCD display unit is attached to door of fridge. This door receives an electric trigger after identification of face. This electric trigger will convert the normal looks of fridge door to transparent. This transparent door allows user to look what is stored for them, without operating the door and in turn saving electricity bill. (This programmable controller unit + LCD display unit can be easily replaceable with latest smart phone having humongous db of apps which can be customized for user).

B. Face Recognition System (1)

A face recognition system is one of the fastest biometric technologies. It is a computer application which automatically detects or verifies a person from a camera captured digital image. These systems analyzes the facial features such as structure of eyes, nose, mouth, face edges etc. of the input image and develops a matrix of feature vectors which are then compared with the feature vectors that are stored in the database and provides identity information to the controlling computer. Face Recognition Unit consists of

- i. *Image Acquisition Unit:* Which captures the digital image of the person standing in front of the refrigerator, using a camera mounted on the top of the modified refrigerator and transfers the image to the preprocessing unit.
- ii. *Preprocessing Unit:* This prepares the acquired image for subsequent stages by filtering and smoothing, and performs contour detection of the image. It also locates eye position as well as color variance of the image.
- iii. *Output Unit:* Displays the percentage of similarity of the given person’s input image with the existing family member images in the database and forwards information to controlling computer unit.

C. Controlling Computer

Controlling Computer Unit is the actual manager of the whole system which will take input from the face recognition system, display the list of food items to the user, then track and inform the food consumption status to the concerned person. The main controller of this unit will be Embedded O.S which is a specialized operating system for embedded computer systems.

Embedded OS will be coordinating with the android programmed device which can either be a smart phone or any other programmable device. Two main task performed by this android programmed device would be:

- Communicate with the User and display apt food list.
- Locks and unlocks the prescribed compartments of refrigerator.
- Send message regarding food consumption to the mother /concerned person.

D. Sensors and Microcontroller Based System

Microcontroller based system will basically be used to transfer and process the real time data from sensors to the embedded O.S. This system will also be used to lock and unlock the compartments according to the user. For this functionality we may use different kind of microcontrollers but the most recommended is Arduino Microcontrollers. It is a single board microcontroller which takes input from various sensors and issues controlling commands to motors, lights etc.

The most useful compartment in fridge which will be visible (through transparent door) to children is attached with sensors. These sensors will be activated only after kid is identified by system (to save electricity). For this purpose basic motion sensors can be mounted at the compartment levels for detecting the consumption motion of the kid. Various options in this are also available which are mentioned in table.1.

Name	Features	Image
Microwave Motion Sensor (Recommended)	<ol style="list-style-type: none"> 1)High reliability 2)Less detection deviation by dust, Temperatures 3) High detection accuracy. 4)Ideal for mounting inside other electrical appliances 5)Sensitivity range upto 9 meters 	
Passive Ultrasonic Sensors	<ol style="list-style-type: none"> 1) Doesn't require physical contact with the target. 2) Detection capacity for shiny objects is very good. 	
Passive Infrared Sensors	<ol style="list-style-type: none"> 1)Inexpensive 2)Consumes less power 3)Sensitivity range upto 6 meters 	

Table.1 Comparative features of various available sensors.

E. Database System

Proposed system implementation requires SQL server, and related databases. The tables in this database include family information table, photos table for validations, list of items to consume (updatable daily), standard list of messages table (to send via SMS to mother), list of suggestions (for next week by kid) etc.

F. Android Device

Any android enabled device can be used to receive tracking information anywhere and anytime.

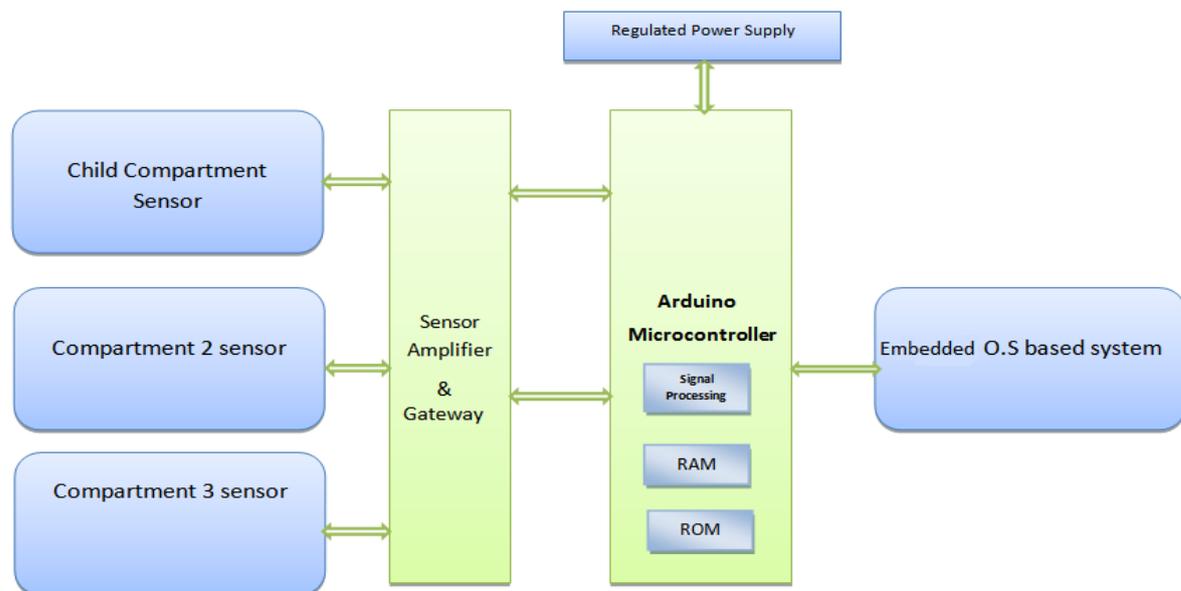


Fig-3: Microcontroller based sensor system

CONCLUSIONS

This paper introduces a novel, “one of its kinds” smart system for refrigerator which is child centric. The proposed system definitely assures better nutrition and health for growing up kids. It is specially designed for working mothers to imbibe homemade food consumption habits. We are confident that such a smart fridge will be an important component in future smart home. The scope of this proposed system is still limited but can be extended to great details by introducing some more features. It is possible to extend this work by using RFID enabled utensils to actually count how much food was consumed by child. With introduction of “in fridge network”, use of smart phone and its apps, it is easily feasible that multiple fridges will exchange data, and in turn save more electricity. An appliance like this could do wonders for increasing independent life skills of children and adolescents with autism and other pervasive developmental disabilities.

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