OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

SMART REFRIGERATOR AND VEGETABLE IDENTIFICATION SYSTEM USING IMAGE PROCESSING AND IOT

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Abstract: **There is research going on for smart refrigerator having intelligence to identify the refrigerator content and having smart management system as in Intelligent Screen fridge, a Intelligent refrigerator designed to allow users to identify vegetables with weight of the vegetables, recipe suggestion with add and update new recipe as per availability of vegetables using Smart Phone over the Internet. Smart Refrigerator system communicate with their users via smart phone, which design the application to understand natural language requests, are the examples of existing smart refrigerator. The proposed system will suggest the recipe information as per availability of vegetables which includes inside the refrigerator and process it to know about vegetables status, Temperature and vegetables items for the recipes that need to be purchased if not available inside the refrigerator. Python programming used for image processing to take pictures of vegetables using a web cam and compared it to its classifier which process the multiple objects and identify the object using machine learning classifier. After identifying and labeling a list for an item talk about its weight gain from the Arduino and ESP Module connected with load cell to measure the weight and then that name appears in the IoT for adding weight to each item. The result and analysis will be based on list of available material and consumed material; it will also predict the dishes which can be cocked in available material.**

Keywords: *Internet of Things, Arduino, Android Apps, Python Open CV, Recognisation, Temperature.*

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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 tenancies like storing vegetables, fruits etc. Smart refrigeration module is designed to transfigure any existing refrigerator into a smart cost effective machine using sensors. Smart refrigerator compares the status of the food/ vegetables for e.g. expiry date, weight, quantity etc. Significance of this work will be removable of food spoilage, reduce illness and make healthier lifestyle of modern age human being. Smart applications with hypermedia capability are being used in today's life, all the major credit goes to digitization of technology and wide usage of internet. In this modern era, human being is used to deal with 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. Smart appliances include washing machine, television, refrigerator etc.

The paradigm of the Internet of Things (IOT) requires pervasive connectivity to billions of heterogeneous devices. In recent time, rapid growth of IOT devices in smart home environment envisioned a wide range of novel services and applications. Kitchen is one of the most important places for a Smart home as it consists of many Appliances which provide better services to the household. With the improvement of people's living standards and the accelerating pace of people's life. The refrigerator is playing a increasing important role in our daily life, it has brought great convenience to people's live as more and more food are put into the refrigerator. However, it also bring some issues with the food in the refrigerator continues to increase, first of all if you can't eat these foods in time, then the food is very easy to expire, followed by the traditional refrigerator is

difficult to figure out which food are surplus, which food has been used up for cooking and how much quantity of each vegetables. So it is important to design a smart refrigerator.

II IMPORTANCE OF RESEARCH

According to the data from the Food and Agriculture Organization (FAO) of the United Nations, approximately 1.3 billion tons of vegetables is lost or wasted every year. Similarly, from the reports prepared by the Natural Resources Defense Council, that an approximately 218 billion worth of uneaten food by the Americans is deposited in the landfill that eventually contributes to the greenhouse gases. The FAO website also states that in developed countries, approximately 40% of the vegetables wastage occurs at the consumer level. A significant portion of a consumer's daily vegetables is stored in the refrigerator and most of the discarded vegetables is primarily because they have surpassed the expiration date printed on the packaging. Given, the hectic lifestyle of an average individual, it becomes difficult at times to keep a record of the vegetables on a regular basis. Therefore, connecting the Internet of things (IoT) to a regular refrigerator can be an effective approach for the vegetable Identification And Management at the user level that can eventually help reduce the vegetable wastage.

III LITERATURE SURVEY

In recent days, various IoT systems were developed for Refrigerator systems. Wang et al [6] designed a compatible IoT system for home devices which was having multiple communication standards. For the crop quality management the recognition of food/ vegetables and their extent has always been a major concern in home apparatus field. Till date, many researchers have already been done in the same problem area. Many recognition systems based on image processing using MAT-LAB techniques have been proposed earlier. Some already developed systems area is explained below:

The Smart Refrigerator system is mainly implemented to convert the existing refrigerator into an intelligent cost effective appliance .The smart refrigerator system is capable of sensing as well as monitoring its contents. The smart refrigerator system is able to remotely notify the user about the scarce products via SMS and email .The Monitoring unit of the system has a software module in its memory, which will be always in the monitoring mode and will scans its input. He has [1] proposed a system," IoT based Intelligent home using Smart Devices" that sense the daily needs of particular items in the refrigerator and automatically places an order to the grocery shop. They have proposed [2] the system "Smart Refrigerator" which can sense the weight of the food items placed in the refrigerator and sends a notification to the user's mobile through an application when the weight falls below the threshold value. He has proposed the system [3] "Smart Refrigerator for Grocery Management" which identifies the weight and expiry dates of the food items in the refrigerator and sends customized notification to the user. The proposed system finds the weight and expiry dates of the food items and notifies the user through application which helps to place the order when the contents fall below the threshold value. He has proposed a system "Home Automation System using Android and Arduino Board" which implements the methodology of using mobile application to control the home appliances remotely [4]. It uses GSM modem to transmit the data to mobile.

A hardware prototype is to be developed which senses the contents inside the refrigerator, triggers when the contents inside is below a certain threshold (set by the user). In case of scarce products, this trigger is sent to the users mobile and eventually to his email id through an IoT. The message comes with information about the product which is low on quantity inside the fridge and comes with a recipe suggestion system according to available product.

In the scope of home automation, little progress has been made towards improvements in organizational methods for consumer purchased goods. With a focus on perishable food goods, a lack of efficient organization can generate a number of issues for typical consumers. The first issue is the amount of time a consumer spends grocery shopping. This includes both the actual time spent in the store as well as potential return trips to purchase forgotten items. The average time spent in a grocery store for a typical consumer is 41 minutes. Additionally, the average shopper will go to the grocery store between 1 and 1.5 times per week yielding on average between 35 and 53 hours shopping per year. While standard grocery lists assist with shopping efficiency and organization, items can still be forgotten or items that may have been previously purchased can be purchased again. Such duplicate purchases can cause unused goods to expire and be thrown out contributing to unnecessary food waste. Additionally, the inability to find where a purchased good has been stored within a household can lead to food expiration also leading to unnecessary food waste.

In 2005 a smart medical refrigerator concept 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].

IV. PROBLEM STATEMENT

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V PROPOSED SYSTEM

IoT based Smart intelligent internet refrigerator includes Better Food Management, No wastage of food, Efficient Shopping, Quick Decision for Cuisine.

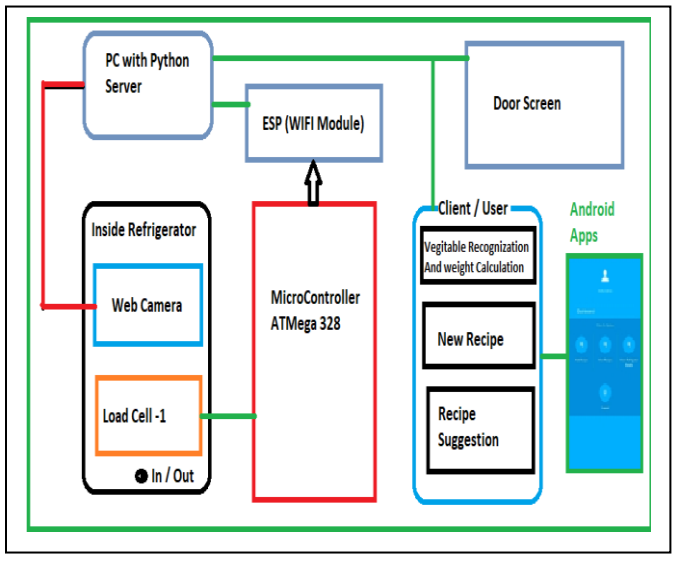


Figure No-1: Block Diagram

User Friendly Operation, Better Food Management, Improve Sales, Create new source of revenue, Target Marketing, Consumer Buying, Habits Information, automatic vegetable recognisation and weight measurement also recipe suggestion. Regardless of these benefits, there are some risks attached to this upcoming technology internet refrigerator. As with any Internet-connected device, internet refrigerators have potential security vulnerabilities.

Figure 1 shows the block diagram of the smart refrigerator. The block diagram of IoT based Smart fridge which shown in figure-1 includes hardware and software system. Vegetable identification is a new approach to identify the items inside refrigerator and identify using image processing. We developed a IoT based smart refrigerator management system according to weight and material availability. ATmega-328 is basically an Advanced Virtual RISC (AVR) micro-controller is used. 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. 1push button is used differentiate in storing the vegetable or taking out for use which respectively updates the database. The ESP wifi module is a very user friendly and low cost device used to provide internet connectivity with the projects. It can easily fetch data and upload it to the internet making Internet of Things as easy as possible. Web Camera is used inside refrigerator which continuously keeps on captures the things without human intervention and update the list of vegetables available in refrigerator by identifying it.

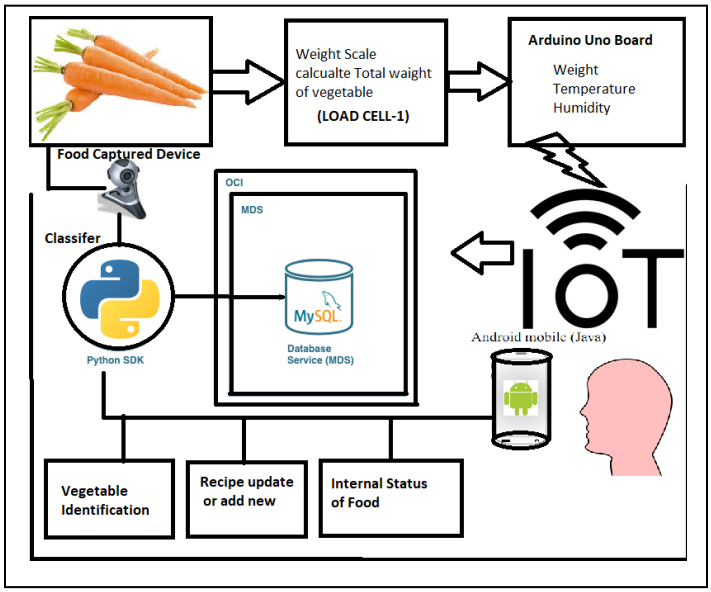
Most of the technologies in interfacing a smart refrigerator to the user use the internet as the medium as IoT cloud service can be accessed from anywhere in the world. The following sections describe point to point on how to achieve the smart refrigeration and accessing the IoT. The Figure -1 shows the basic structure of the methodology which is being used. The purpose of the proposed system is to recognize the food name, Wight and temperature and the recipe suggestion from available 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 IoT to mobile. At the client side Android mobile application is built which shows the current status of refrigerator items with quantity and list of vegetables. Where in user can search through for various recipes and get to know the available food items to make that recipe with weight.

VI. METHODOLOGY

We developed a smart refrigerator management system according to weight and material availability and automatic

identify name of vegetables. The proposed system is to predict the recipes that can be cooked according to available material. All components are fixed in single plastic box that is original research model which shown in figure-2:

being placed on weight cell and camera captures the snap of the vegetable and through Arduino board input is send to python server where vegetable identification algorithm detects the type of vegetable put on the load cell and Arduino status monitor shows the humidity and temperature level and weight of the vegetable. Sensors produce a mixture of gasses. Gas sensors are fixed inside the fridge to detect the temperature and humidity.



comprises of many sections where the sensors are placed. A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. This electronic signal can be a voltage change, current change or frequency change depending on the type of load cell and circuitry used. The electrical signal output is typically in the order of a few milli-volts. Whenever the food items kept in the refrigerator goes below the present value than it generates an alert which is being transmitted in the form of message to the user. After following the above steps we are now able to get real time information, quantity of food items which are stored inside the refrigerator. The proposed system architecture explain the complete working of smart system which helps the society decrease the ratio of wastage food as shown in figure-3

Figure above shows the procedure of smart refrigerator to identify the type of vegetable.

1) Food items we put on the kit where in load cell is attached below it which and in front of the web camera

2) Web camera captures the picture of food item and takes that snap as a input and forwards it to the algorithm written in python which identify the food type. Then depending on the outputs from the algorithm it updates the database on the server and same change reflects in the mobile application.

3) While capturing the type of vegetable Arduino measures the weight and temperature and humidity of the current environment

4) On the client side in android mobile app admin user can add various recipes by entering the name, requirement of food items and procedure.

5) Normal user can see various food items available in refrigerator along with their weight and can search for various recipes

In our work we put all vegetables into single bucket of load cell for calculating total weight of the vegetables but how to recognize the name of vegetables.

VI. 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, and 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 IoT the user is notified and suggest the new recipe in suggestion and feedback is collected in order to stop the notifications if the recipe is updated. If the user grants access the app redirects to add the new recipe 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.

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. 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 function able 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 Python 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 complete Design module is shown in figure-2 which 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 can be installed in homes, restaurants, offices, and in any commercial places. Combining the idea of Internet of things and sql storage a smart kitchen is to be implemented just like smart refrigerator which always gives reliable output.

VII. CONCLUSION

The conversion of traditional refrigerator to smart and intelligent is done using Arduino UNO and Python and the module detects the shortage of food items and notifies the user and uploads the data on sql server 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. Python opencv recognition software to detect what vegetables is inside / outside the fridge by mounting a camera and using python vegetables detection algorithms of the software which returns user the item name along with lot other details. Using Google API for object recognition which uses natural language processing algorithms and recognizes commands by strong neural networks and gives response. User Apps directly connected with server which shows real time contents of freeze also user suggested the recipes as per availability of vegetables. User can add and update any recipes as per availability of food which always gives reliable output..

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