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Smart Refrigerator with Specific Temperature Sensing Using Fuzzy Controller

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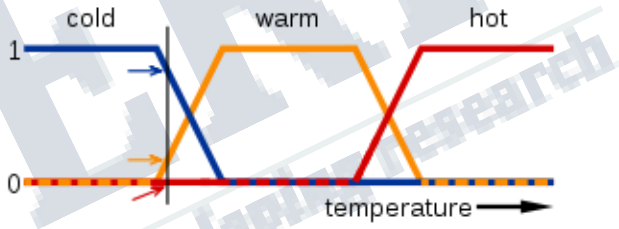
***Abstract*- — Refrigerator temperatures do not destroy pathogenic or spoilage microorganisms. The lower temperature does, however, slow the growth of microorganisms already in the food. Perishable food will deteriorate, even at refrigerator temperatures, due to spoilage microorganisms, enzymes and oxidation. Time and temperature are important factors in food quality. Proper storage conditions - temperature and humidity - are required to maximize storage life and maintain quality of harvested fruits and vegetables. Fresh fruit need low temperature and high relative humidity to reduce the respiration and slow down the metabolic processes. Some foods, including milk, meats and leftovers, should be kept colder than others. Food that is properly handled and stored in the freezer at 0° F (-18° C) will remain safe. Specific temperature is maintained at each segment of the fridge using optimum temperature control.**

***Index Terms*— object recognition, optimum temperature, pathogenic organisms ,**

I. INTRODUCTION

To preserve the vitamins and nutrients that they contain, you'll need to have the right storage environment at home. Food's shelf life is determined firstly by its freshness, and then by the temperature and humidity at which it's stored. Food that is properly frozen is preserved and prevented from growing of microorganism on it. It also slows down the enzyme activity that causes food to spoil. Humans and animals often operate using fuzzy evaluations in many everyday situations. In the case where someone is tossing an object into a container from a distance, the person does not compute exact values for the object weight, density, distance, direction, container height and width, and air resistance to determine the force and angle to toss the object. Instead the person instinctively applies quick "fuzzy" estimates, based upon previous experience, to determine what output values of force, direction and vertical angle to use to make the toss.

A basic application might characterize various sub-ranges of a continuous variable. For instance, a temperature measurement for anti lock brakes might have several separate membership functions defining particular temperature ranges needed to control the brakes properly. Each function maps the same temperature value to a truth value in the 0 to 1 range. These truth values can then be used to determine how the brakes should be controlled



In this image, the meanings of the expressions *cold*, *warm*, and *hot* are represented by functions mapping a temperature scale. A point on that scale has three "truth values"—one for each of the three functions. The vertical line in the image represents a particular temperature that the three arrows (truth values) gauge. Since the red arrow points to zero, this temperature may be interpreted as "not hot". The orange arrow (pointing at 0.2) may describe it as "slightly warm" and the blue arrow (pointing at 0.8) "fairly cold".

Food items have their specific temperature in which they can be preserved for long time. Using this fuzzy logic temperature, this can be achieved.Object recognition is another important aspect where machines have vision like humans and can recognise and predict the objects. There are many techniques for recognition of object, which depend on the type of application.

II. OBJECT RECOGNITION:

Every object class has its own special features that helps in classifying the class – for example all circles are

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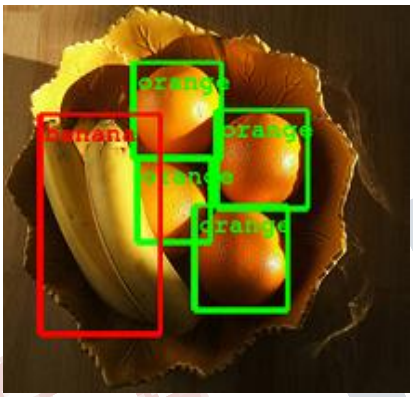
round. Object class detection uses these special features. For example, when looking for circles, objects that are at a particular distance from a point (i.e. the center) are sought. Similarly, when looking for squares, objects that are perpendicular at corners and have equal side lengths are needed. A similar approach is used for face identification where eyes, nose, and lips can be found and features like skin color and distance between eyes can be found. With the refrigerators, stored groceries can be monitored using internal cameras and object recognition technology. It can capture images for viewing and also recognise individual food items inside the refrigerator.



Like all machine-learning systems, neural networks try to identify features of training data that correlate with annotations performed by human beings — transcriptions of voice recordings, for instance, or scene or object labels associated with images. But unlike the machine-learning systems that produced, say, the voice-recognition software common in today's mobile phones, neural nets make no prior assumptions about what those features will look like.

That sounds like a recipe for disaster, as the system could end up churning away on irrelevant features in a vain hunt for correlations. But instead of deriving a sense of direction from human guidance, neural networks derive it from their structure. They're organized into layers: Banks of processing units — loosely modelled on neurons in the brain — in each layer perform random computations on the data they're fed. But they then feed their results to the next layer, and so on, until the outputs of the final layer are measured against the data annotations. As the network receives more data, it readjusts its internal settings to try to produce more accurate predictions.

III.OPTIMUM TEMPERATURE:

Fridge will have set of tiles accommodated in each rack .Items placed on the tiles will be monitored by the temperature sensor individually I.e, each item will be maintained at its optimum temperature .This will prolong the life of the life of food. This temperature is called optimum temperature. The Bio-Fresh app provides free information about foods and food storage, and is suitable for use on many smart phones and tablets. The app tells you everything you need to know about foods and their vitamin content, and gives shelf life comparisons for conventional refrigeration versus Bio-Fresh storage.

The detailed presentation allows you to quickly and easily access all kinds of information about fruits, vegetables, meat, fish and dairy products. We use this app to store information regarding optimum temperature The data sheet of optimum temperature of some products are

Product	Optimal Storage Temperature		Chill Point		Freezing Point
	(°F)	(°C)	(°F)	(°C)	(°F)
Apples	30-40	-1-4			29.3
Apricots	31-32	-1-0			30.1
Artichokes	32-35	0-2			
Artichokes, Jerusalem	31-32	0-2			28.0
Asparagus	32-35				30.9
Avocados, ripe	38-45	3-7	36	2	
Avocados, unripe	45-50	7-10	45	7	
Bananas, green	62-70	17-21	56	13	
Bananas, ripe	56-60	13-16	54	12	
Basil	52-59	11-15	50	10	
Beans, dry	40-50				
Beans, green or snap	40-45				30.7

IV. FUZZY LOGIC CONTROLLER:

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A fuzzy control system is a control system based on fuzzy logic—a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in contrast to classical or digital logic, which operates on discrete values of either 1 or 0 (true or false, respectively) The input variables in a fuzzy control system are in general mapped by sets of membership functions similar to this, known as "fuzzy sets". The process of converting a crisp input value to a fuzzy value is called "fuzzification".

A control system may also have various types of switch, or "ON-OFF", inputs along with its analog inputs, and such switch inputs of course will always have a truth value equal to either 1 or 0, but the scheme can deal with them as simplified fuzzy functions that happen to be either one value or another.

Given "mappings" of input variables into membership functions and truth values, the microcontroller then makes decisions for what action to take, based on a set of "rules", each of the form. Fuzzy controllers are very simple conceptually. They consist of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, thumbwheels, and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value.

The most common shape of membership functions is triangular, although trapezoidal and bell curves are also used, but the shape is generally less important than the number of curves and their placement. From three to seven curves are generally appropriate to cover the required range of an input value, or the "universe of discourse" in fuzzy jargon.

As discussed earlier, the processing stage is based on a collection of logic rules in the form of IF-THEN statements, where the IF part is called the "antecedent" and the THEN part is called the "consequent".For our refrigerator thefuzzy set wil be as follows:

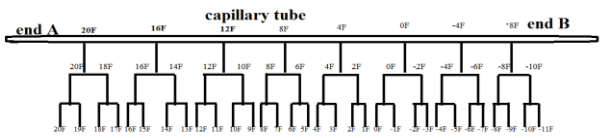
TABLE 1: GENERATION OF THE FUZZY INPUT SETS

S /N	Fuzzy Sets (Representing Temperature ranges in °C.)	Fuzzy State
1	Fuzzy set 1:{0,1, 2,3,...,10°C}	Very Cold
2	Fuzzy set 2:{11,12,13,...,21°C}	Cold
3	Fuzzy set 3: {22,23,24,...,32°C}	Warm
4	Fuzzy set 4:{33,34, 35,...,43°C}	Hot
5	Fuzzy set 5:{44,45,46,...,100°C}	Very Hot

V.INVENTION:

The challenge that we face here is defining 32 various temperatures simultaneously. We can do that by dividing the capillary tube into 32 various taps at different temperatures. It can be done in 3 steps .step 1 includes tapping of main capillary into 8 different temperature sessions.Step 2 involves further more dividingthis 8 tubes into 16 and the last step involves the obtaining of 32 different temperatures from 16 tubes.

These 32 are further connected to mux which is 32:1 where the multiplexers(mux) selects the 0ne gate that is signaled from the controller.The object placed in the segment is first recognized and then the data is sent to the data base where their respective optimum temperatures are saved.The controller thus decides the optimum temperature that has to be set and codes it into 5bit binary code which is the select line input for the mux.Then the mux will open only that gate and remaining 31 gates are kept closed.



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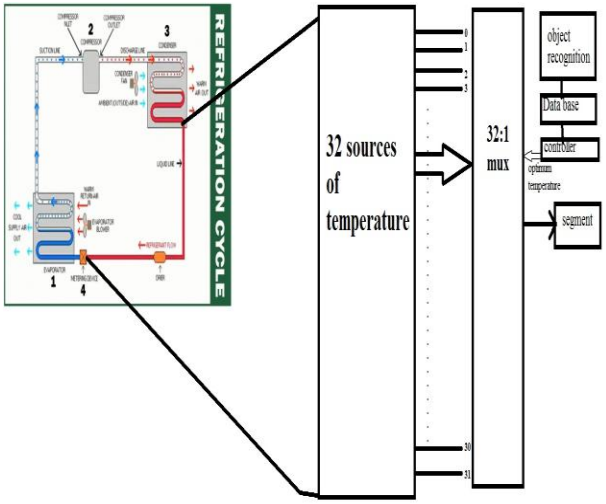
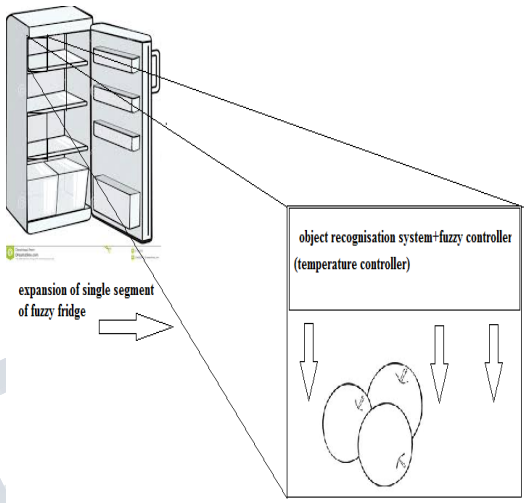


VI. WORKING:

The wired shelf or glass tray is replaced by a set of tile like structures in the chambers. Each chamber is provided by the object recognition system, fuzzy controller and temperature controller. The object recognition system is a camera that will recognize object and sends the information to fuzzy controller. The fuzzy controller based on the object recognized will decide the temperature that is to be set based on the optimum temperature table that is available in the data base. Data base consists of almost all eatable items and their optimum temperature. Now the temperature controller will maintain the optimum temperature through continuous sensing. When the object is removed from the particular tile, the object sensing device instructs the fuzzy controllers and the temperature is brought to reference temperature. Here, reference temperature is the temperature that is provided when tile is empty. This helps to maintain the temperature inside refrigerator so that the neighboring tiles are not disturbed due to the empty tile. Note that each chamber will be maintained at different temperatures as per the food item that is recognized in it.

Design of the refrigerator remains same as that of present generation models, but spacing and liter capacity will be high. Even on the doors, temperature controllers will be deployed to provide adequate temperature to the objects like eggs, soft drinks and water. Power consumption will be slightly less than the conventional refrigerator.

VII. PHYSICAL STRUCTURE:



LOGICAL CONTROL

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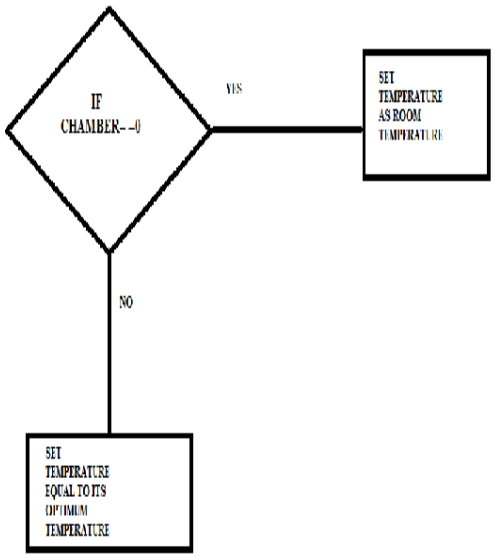

VIII. CONCLUSION:

As we are in 21st century we need to chase upon the new technologies, at the same time we should reduce wastage and protect our sources from depletion.Thus here we develop an automated fridge so as to maintain the individual optimum temperature that is fed into fridge .Our part of innovation is to combine fuzzy set and object recognition to fulfill this dream of futuristic technology. The main advantage is the restoration of food for longer duration and also not wasting the energy (as empty chambers are not maintained with temperature)

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