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An AI driven approach for Smart refrigerator to enhance family diet and sustainability

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An AI driven approach for Smart refrigerator to enhance family diet and sustainability

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Abstract- With smart homes changing the way of life of people, a smart refrigerator is an addition to their family. The fast pace of our life has led to an alarming consumption of junk food, expired products or vegetables at homes. In this paper, we are introducing a novel concept of a smart refrigerator which is content aware and focuses on personalization for each of its users, which, in the long-term, would help to tackle the problem of effective waste management. It is an AI-driven solution, aiming at resolving the problems faced by the current generation and also has various other salient features like health data analysis, framing nutrient plans, recipes, dishes, etc. Various sensors like cameras, bar code scanners and weight gauge help to calculate the nutrients present. AI and ML continuously evolve, adapt and help to better understand the users' tastes and preferences. Analysis of the consumption pattern will lead to the generation of what all items are to be bought and in what quantity to be stored in the refrigerator. This would lead to healthier homes and a healthier planet.

Index Terms- Artificial Intelligence (AI), barcode scanners, cameras, machine learning (ML), smart refrigerator.

I. INTRODUCTION

The advances in AI and ML powered by Cloud-based computing has revolutionized the home appliance industry, whether it is a good old coffee maker, or a virtual assist. There is no segment that has been unexplored. Integration of technology with homes has made smart living possible and is taking us towards the future. With the rising advancements, demands and expectations are also rising at a tremendous pace. Consumers are becoming more tech-savvy and want the next big thing in the market for their homes.

There have been many efforts in developing a smart refrigerator in the industry. A smart refrigerator that has both personalization and sustainability-driven holds its own USP. The traditional notion of a refrigerator has changed, from a storage unit, to keep food cold, to a device that integrates with the internet and the cloud, giving it capabilities to develop data and applications, focusing on a healthier lifestyle.

In this project, we aim at developing a smart refrigerator that driven by both, personalization and sustainability. Interweaving itself into this complex system of devices talking to each other, making routine tasks simpler [1]. Using these intelligent devices in the kitchen, which is the heart of every home, would help to bring in a range of products and appliances to tackle the various problems faced by homemakers. With weighing scales and image sensors, it would be easy to identify which product is going to consumed the most and at the earliest. Most of the existing smart refrigerators do not provide a solution for these problems. Smart refrigerators are the next evolutionary step in home appliances. The refrigerator would have sensors that would monitor the products kept inside, and accordingly would pan out recipes which can be viewed with a feed of the demo, by linking it to the internet for real-time content. Also, with the help of smart wearable technology, access to health related data of the people living in the house would be possible. This way, the refrigerators can be in constant touch with their users, letting them know if any product has to be bought, or if a product was about to get over and has to be replenished.

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There has been a drastic change in people's lifestyle, which is a result of the developments taking place in the technological sector. This lifestyle has reduced the level exercise and lead to the consumption of unhealthy food [2]. The eating pattern of an individual can cause diet related illnesses during later stages of our lives [3]. Changing lifestyle has led to an unhealthy dietary pattern and the lack of exercise has given rise to obesity, which is becoming a major health hazard. From this perspective, the smart refrigerator would be focusing on the nutrition and health habits of its users. Refrigerators are a part of the majority of households. As results play an important role in the user's consumption pattern, smart refrigerators will make it ideally suitable to tackle the problem of family healthcare.

II. PRESENT SCENARIO AND RESEARCH GAP

A. Present Scenario

The smart refrigerator industry has seen a lot of changes in the recent times, with some of the market leaders in the e-commerce sector venturing into the industry as well. Some of the popular ones area Kenmore Smart sold on Amazon, which is the best match for Alexa lovers, Samsung RF28JBE, LG InstaView Door-to-Door, all unique in their own ways. However, all of them have various shortfalls, mainly:

- Most of these companies don't give a guarantee on software updation which eventually leads on to issues, such as unable to connect to the server, making it vulnerable and unintelligent in due course. Considering refrigerators are part of a household for a long period of time, this is a major issue. Once the refrigerator becomes vulnerable it is prone to DDoS attacks which can leak sensitive information of the users.
- The price of these refrigerators is generally high, making buying a high-end refrigerator with any of these features a sweeter deal. These refrigerators would last longer and also don't have a software updation issue.
- There isn't a standardised system to record bar code information, for instance, the expiry, or the quantity of the product.
- There aren't any functions helping with nutrient and dietary control, which would pose to be a very attractive feature in any refrigerator.

B. Research Gap

The global smart appliance market is believed to grow at a CAGR of 23.48% during 2016-2020 [4]. Businesses are starting to intensely focus of this sector, trying to come up with numerous advancements and digital technologies that can be integrated into the daily lives of their customers. The present scenario gives insight into the fact that the existing refrigerators are made with advanced technology and are more concentrated on the combination of intelligent sensor [5][6] networks and information. However, most companies overlook the fact that they can deliver more to their customers by integrating personal factors like their health, building a stronger brand loyalty. This segment has a lot of potential and further exploration would lead to more opportunities to bring the development of the same.

III. PROPOSED MODEL

A. Proposed Model

The project is focused around developing a smart refrigerator which enables their customers to enhance their diet, including more nutritious content and endorsing a healthier dietary plan. The system is built around cloud computing and AI, eventually branching out into ML. The system has a database of its users and a locally built database which has nutrient information [7]. This goes in accordance to the user's tastes and preferences and helps to achieve the maximum level of satisfaction from the customer's point of view. The database contains information about the user's age, weight, height, medical record, allergies etc [8]. The in-built sensors scan the bar code and also scan an image of the product every time it passes the door. This way, the refrigerator is able to record what food item it is and with the help of the weighing scales it will be able to have a clearer idea of how much of the

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product is consumed, enabling it to identify the consumption pattern. This would let it generate grocery lists and enable it to find recipes and dietary plans which fit the same [9]. Also, it would be able to let the user know when a particular product is about to expire. Notifying them regarding the same when they are near a store or when they go shopping would make their life easier. The screen on the door of the refrigerator displays all this information and gives out warning signals to know if the user still wants the product or not.

B. USP of the model

The USP of our prototype is the cameras, bar code scanners and weight gauge which helps to calculate nutrients, giving a clear picture of the contents present inside the refrigerator. By integrating ML and AI, we are able to better understand the customer's tastes and preferences. It analyses the consumption pattern and notifies the user not only what to buy, but also how much to buy. The cloud-based system tracks the nutrition intake and identifies which nutrients are lacking in the user's diet, which is based on the intake. It also develops customised recipes based on the number of members in the house to improve taste and reduce waste. It calculates the BMI of its users when the information is fed in, which leads to more efficient nutrient suggestions.

C. System Design

The smart refrigerator application requires the usage of Python for its implementation. The users interact with the interface of the smart refrigerator. The database design is vital for the system design. Below is the entity-relation diagram of the smart refrigerator. In order to explain the working of our model we have devised an architectural design of the entire process subdivided into 3 parts. The first is wearables and smart phones, next by the smart refrigerator and the last being cloud. The Fig 1.1 explains the entire architectural framework.

C.1. Smart wearables and smart phones

Smart wearables record the day to day activities such as exercise, physical fitness, sleep cycle, heart rate, calories burnt etc. This health data is gathered and sent to the users' smart phones. Smartphones nowadays have in-built health applications which are equipped with a Medical ID. This Medial ID is unique to its user, containing all the information generated from these smart wearables and also has its own input on the same, for instance, the previous medical records which include user's BMI, allergies, medical condition and other issues. When the smart phone is connected to the smart refrigerator it can transfer this data to the refrigerator.

C.2. Smart refrigerator

Each smart refrigerator is assigned with a unique ID and has in-built cameras which have a 360° view which recognise what comes in and goes out of the refrigerator. There is also a bar code scanner which scans the codes of packed goodss. The weight gauge measures the weight distribution and the consumption of the what is kept in the refrigerator. Combining these two helps to track the consumption pattern of the users, leading to higher accuracy in predictability of dishes and generation of grocery list. The data obtained from the smart refrigerator is sent to the cloud.

C.3. Cloud

Cloud serves two important functions, the first one being, it has a database of all the recipes and the unique smart refrigerator ID. The second is that it has the AI and ML based algorithms. Cloud has database of recipes which is stored on it. It further segregates data with reference to certain keywords and hashtags. For example, if the users use certain hashtags like #spicy, #south Indian, etc., the system will match these words with recipes, which would enable the users to relive the same.

Once this data is sent, the customer is able to view customised dishes, which is made available with the help of cloud. These dishes are orientated around the user's health condition. With the help of these devices, it will be capable to monitor the customer's health more accurately. If the user is an active gym user, then it would also pick out those dishes which would complement their work-out pattern.

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A separate database is maintained in cloud for each smart refrigerator based on its unique ID. The user's information such as the medical records and the inventory present in the refrigerator are sent to the cloud and based on this, coupled with his/her preferences, it will select the best recipe.

D. Working Process

A separate database is maintained in cloud for each smart refrigerator based on its unique ID. In Fig 1.2 the smart refrigerator with the help of the in-built camera, would scan what comes inside the refrigerator. For instance, if it is a fruit, vegetable or dairy product, it would classify this on the bases of certain predetermined criteria in case it is a packed product and has a bar code. Then, the bar code scanner present would scan the code, getting all information regarding what item it is, when it would expire and lastly, the weight gauge would let us know what all is being consumed and how much of it is being consumed. All this information is derived from the smart refrigerator, and combined with the information with the data obtained from the smart phone which tells us regarding the medical records, sleeping patterns etc. In the end, the final information that is sent to the processing unit is the user's medical records. The inventory present in the refrigerator are sent to the cloud. Based on this and his preferences, it will select the best recipe.

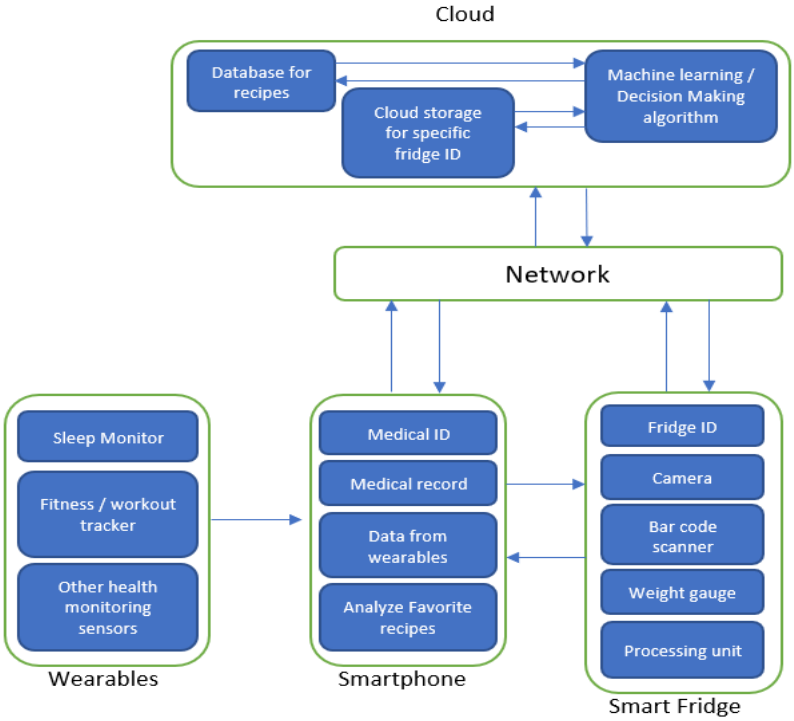

Fig 1.1 System design and Components of smart refrigerator

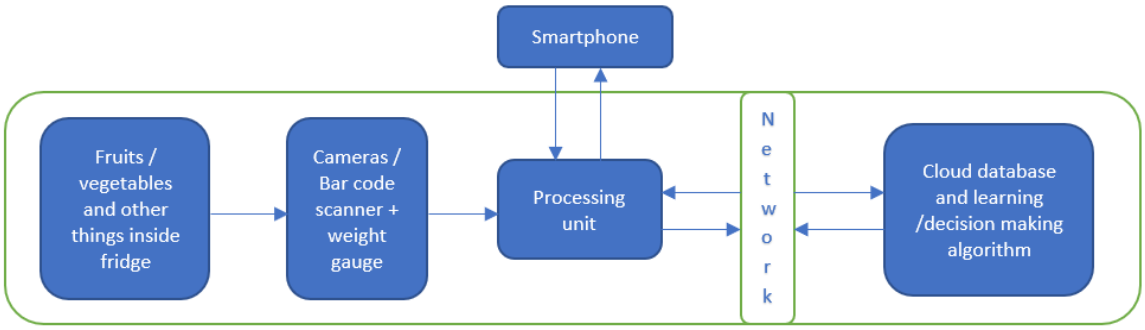

Fig1.2 Working process of Smart Refrigerator

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The processing unit, where with the help of the cloud database, which contains millions of recipes, an algorithm is created after careful assessment of keywords. A proper match is made with the database, helping to achieve a personalised experience for the user. It gives recipes based on what is available inside the refrigerator which it is able to perceive with the help of the consumption pattern. This also enables it to give out suggestions regarding what is to be bought. The ML mechanism present would help the machine to predict on its own in the future, without requiring access to all this information and after rectifying past errors. If the customers refrigerator has meat stored in it previously, then it would be able to detect that the user is a non-vegetarian and would recommend in accordance to that. Based on the previous consumption pattern of the user, the machine would be able to detect more accurately what to recommend its customer. The consumption pattern of the user would also enable the system to tell the users which all products are to be bought and in what quantity. This would help in waste management as the system would know which all products are not being consumed and is going to be wasted. So, by avoiding purchase of those products, or reducing its quantity, it will be help to minimize the waste. The final recipe or ingredients required would be displayed on the screen in the refrigerator, or on the user's phone, which is even more convenient to the user. The user would be notified if a product has expired, when it should be removed from the smart refrigerator and when it should be bought to replace it as well.

E. Sustainability

The smart refrigerator would continuously analyse and monitor consumption, due to which it becomes easy to predict the future consumption. This estimation would enable in reducing the waste emission from households as people would be aware what quantity is apt for the user and buy goods in accordance to that. This would lead to waste minimisation and installing these refrigerators in an apartment complex, proceeding into a locality, which would help in waste minimisation at a greater level. Its further expansion can help to reach this at a global scale.

F. Example

In order to comprehend the application of this smart refrigerator, we were given a problem along with how we would tackle this issue.

Problem –Jenny who is a 40-year old female who has early onset of Type 2 diabetes. With her hectic lifestyle she was barely able to manage her health and the lack of unawareness had made Google her virtual dietician. As most of the information was not personalised it left her dissatisfied. For instance, being South Indian, she preferred South Indian cuisine, however the options made available to her are mostly bland and tasteless. And more often, she found that she did not have the ingredients in the refrigerator for the dishes she liked. The unreliability of the information of these websites was extremely high. She was persistently looking for a way out of this.

Solution **-** With the help of our concept we believe we would be able to address her problem. The first step would be accessing her medical data from her smartphone. With most of smartphones having Medical ID and day to day activity through her fitness tracker, it would be easier to get information that is required to assess her medical condition and recommend dishes to her in accordance to that. Based on the contents inside the smart refrigerator we would be able to analyse and recommend dishes which would be customised to her taste. Giving preference mainly to the dishes which she would be able to cook based on what is available in the refrigerator.

IV. FUTURE WORK

The future is smart living and it begins at home. The smart refrigerator sector is growing rapidly and we believe our product has tremendous potential and, in the future, it can be integrated with super markets to supply the products at the user's door step. It can predict the demand for products and automatically notify the user enabling him to place the order. The proposed model is still in an infant stage and therefore, still has scope of improvement. With access to the user's medical record and their consumption pattern it would be possible to develop nutrition chart for their users. Upon following this chart by the user, the system would recommend the dishes and workout plans they can use to

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make it more effective as well. The ultimate aim is to achieve a smart home which is driven towards making our lives easier, and at in the long term not harm our planet.

Energy conservation is becoming a vital part of sustainability, so in future scope we can include an energy conservation system. For this, we would initially connect the smart refrigerator with a smart energy meter which receives load scheduling data from the smart grid. This would help us to monitor and analyse the peak hours enabling us to conserve the energy by automatically managing the temperature inside the smart refrigerator. This can reduce power consumption of household appliances, helping to cut down on expenses and also reducing the carbon footprints as well.

V. CONCLUSION

This novel concept which is an integration of AI, ML and cloud-based computing. It has a bright future and is bound to branch out into various other dimensions of kitchen appliances, especially with smart homes becoming more common. The refrigerator would enable the users to have a better nutrient consumption, in turn improving their health. The design is in a manner wherein the items stored are used for advising the users dishes that can be made by guiding them step by step. It can also track the consumption pattern of the customers and do a health data analysis based on this.

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