Extended Abstract: *DEVELOPING AI ASSISTANT FOR GROCERY SHOPPING*

Asst. Professor NANDHINI C.S
SUPERVISOR

MOHAMED AJUMAL M
ABDUL HASEEF S
MOHAMED ATHIF HUSSAIN S

***Abstract*—This paper presents a system that integrates Artificial Intelligence (AI) methods with Augmented Reality (AR) techniques to enhance grocery shopping experience through the use of smart glasses. Our proposed framework deploys a Convolutional Neural Network (CNN) object detection model that allows for item identification. By simultaneously retrieving data from a large nutrition database, personal medical reports, and other grocery store related datasets, our intelligent system is able to provide user-centric nutrition facts, health and wellness tips, and unhealthy selection warnings that are augmented on a real time broadcasting of the smart glasses. Our state-of-the-art framework *CoShopper* demonstrates high accuracy in detecting grocery items, improves product selection, increases cost efficiency, and reduces the time spent in the process. Video demo of CoShopper can be viewed at [shorturl.at/mqIPX]**

Keywords—Augmented Reality, Artificial Intelligence, Deep Learning, Smart Grocery Shopping, Smart Glasses

I. INTRODUCTION

Globally, people are extremely eager to save time and money while maintaining healthy life choices, especially when performing essential activities such as in-store grocery shopping [1]. This research paper describes the architecture of *CoShopper*, a prototype of a system that employs AR as an intelligent guide to transform traditional grocery shopping into a personalized and rich user experience. CoShopper system adds a real-time digital layer to the traditional grocery store environment through the use of smart glasses. The main intention of our proposed system is to analyze the health status of the user, then help in making healthy food choices directly at the grocery store. Besides, CoShopper framework improves cost efficiency by featuring current discount deals offered by each individual grocery store.

As shown in Fig.1, our system involves several components that are collaboratively functioning to provide user-centric assistance while at the grocery store. These components are, first and foremost, the health organization that will be feeding our databases with up-to-date medical information including medical reports and lab results specific to every user of our system. Accessing such information allows CoShopper to become aware of the amount of each nutritional element that the user needs to maintain a healthy diet. Our intelligent system will also consider all the diagnosed food allergy data and use them to warn the user from purchasing certain products. In other words, when facing products at the grocery store, our state-of-the-art system has the ability to directly distinguish between healthy and unhealthy products based on the user's own health records. This feature is achieved through the integration between the user's medical database and Nutritionix [2], which is the second component of CoShopper and the largest verified database of nutrition information in the world. Saving money is another feature that we considered in the development process. The usefulness of our system extends to display weekly-deals applied on certain items in real-time while at the grocery store. The autonomous flow of such data is derived from the connection between our system and each individual store's up-to-date discount deals.

II. METHODOLOGY

A. CoShopper Dataset: Grocery Store Dataset

Due to the pandemic limitations, we were not able to have multiple visits to the grocery store to test our framework on the smart glasses. Therefore, we switched to the live video broadcasting as an alternative. We utilized the DUNet (Dense Upscaled Network) object recognition model to detect grocery store items in real-time [3]. To be able to recognize objects in the scene and predict their classes, our model needs to be trained on a large size visual dataset containing labeled and Bounding Box (BBX) annotated items. The visual dataset contained a list of 11 randomly selected grocery store items taking in consideration that these items have data in Nutritionix. To extend the flexibility of our framework, our shopping list contained items from different categories including food and non-food items. In addition, some of the items selected are placed on the store shelves individually, such as the dates, while others were placed as a group, such as the pineapples.

Training and testing videos were all filmed using a smartphone camera which was held from a height that mimics the experience of the user wearing a pair of smart glasses with a mounted frontal camera. Our dataset contains a training video for each item individually while the testing videos were filmed for each item individually, then they were all combined into one two-minutes video. With the training videos, each video focuses on the appearance of one item per frame in different locations. The testing videos on the other hand, focused on filming the actual shopping experience of the user facing the item, grabbing it, and placing it in the shopping cart. Images from the collected videos are extracted every nine frames to have more variations between the image samples for the item's objects and backgrounds. Manually

labeling the frames of the collected videos is a hard task. Therefore, we employed a tracker [4] to facilitate labeling our object instances. Some coordinates are manually adjusted in order to build a precise ground truth dataset.

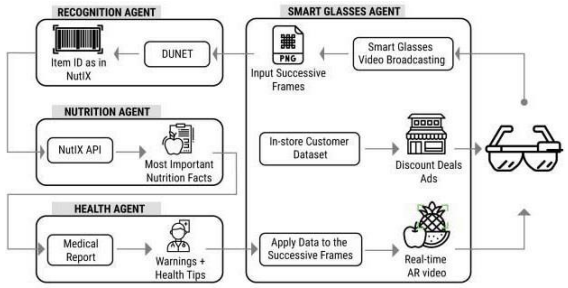

Fig.1. The architecture of the CoShopper framework

B. Object Detection Agent

Now that we have our database ready, we pass it through the other components of our framework. We deploy our Object Detection Agent to predict the object's labels and bounding boxes through Supervised Learning (SL) on the collected dataset. Object recognition models contain two loss functions, one for classification and one for regression that by minimizing their values the model learns to localize object instances with a BBX and identify their labels by analyzing visual representations in the live video broadcasting feed that is coming from the glass's camera. These tasks are done through extracting visual features and applying the multi-box procedure on different scales and offsets of the training samples. However, in order to make our framework able to perform on a live streaming, we need a fast object detection model that has the ability to provide the item label in real-time in addition to the ability to perform adequately on a small dataset with a limited number of samples. For the aforementioned reasons, we employ the DUNet object detection model. After the training phase, the learned weights that are used in the inference on a full video version in the store with different item categories.

C. Nutrition Data Analysis Agent

Our Nutrition Data Analysis Agent takes the predicted labels from the object recognition agent and passes it as a query to the online Nutritionix dataset through the provided API and our framework credentials. We want to assist the users of our system in understanding the nutrition facts of every item they see at the grocery store. Therefore, we created a CSV file containing a list of nutrients that are most important for the user's health condition along with their threshold values which represents the amount that user need of each one of them. These values were used to color code the key nutrition elements. The colors range from white to orange and from white to green. Nutrition elements colored in the range between white and orange represent healthy and unhealthy items, white being healthy while orange being unhealthy. Other nutrition elements colored in the range between white and green represent healthy and essential items, white being healthy while green being essential. For instance, Welsh Cheddar Cheese contains Carbohydrate, Calories, and Sodium that are color coded with white, light orange and orange respectively.

D. Health and Wellness Agent

This agent is responsible for retrieving information from the user's recent medical report. Based on a hypothetical individual with certain medical conditions and specific dietary needs, a sample medical report has been created for our agent which lists every grocery item (food and non-food) that the user must be avoiding. Our sample medical report also includes warning messages that will be augmented for the user upon the detection of any of the mentioned unhealthy items. The report also included healthy alternatives for each of the unhealthy items and they will be augmented to encourage our user to switch to the healthy alternative.

E. Grocery Store Weekly Discount Deals

CoShopper offers the user a cost-efficient shopping experience through the augmentation of current discount deals offered by each individual store. We created a CSV file representing the weekly discount deals of the grocery store. The list contained categories, brand, item, original price and discount deal. For example, while the user is holding a pack of Whole Wheat Loaf, discount deals applied on other types of loaf will be displayed.

III. Conclusion

Our system demonstrates high accuracy in the detection of each grocery store item on our shopping list. CoShopper has the ability to simultaneously retrieve all data relate to the detected item. Our deployed agents are also successful in analysing the retrieved data based on the user's current health condition. User-centric nutrition facts, health and wellness tips, and unhealthy selection warnings are all augmented on the live video broadcasting. The development of CoShopper framework with all of the capabilities it offers could open the door for further research on the deployment of AI- powered AR smart glasses to enhance the grocery shopping experience for customers.

Acknowledgment

The authors wish to thank Dr. Richard Lachman for his contribution to this paper through his insightful suggestions. Extended appreciation to Dr. Ahmed Alhamdan and Dr. Nasir Alhamdan for sharing their extensive medical knowledge that helped in the health and wellness elements of this project.

References

[1] Singh, R. Why do online grocery shoppers switch or stay? An exploratory analysis of consumers' response to online grocery shopping experience. *International Journal of Retail & Distribution Management*, 2019.

[2] Nutritionix, Grocery Foods, United States. Accessed on: 2020. [online]. Available: https://www.nutritionix.com/brands/grocery

[3] Alabachi, S., Sukthankar, G., & Sukthankar, R. Customizing object detectors for indoor robots. In 2019 *International Conference on Robotics and Automation (ICRA)(pp. 8318-8324). IEEE.*

[4] Farhadi, D. G. A., & Fox, D. Re 3: Real-Time Recurrent Regression Networks for Visual Tracking of Generic Objects. *IEEE Robot. Autom. Lett., 3(2), 788-795*, 2018