Image Processing for Recipe Generation

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***Abstract*—With the improvements in image processing techniques and tools, classifying images has become an efficient process. We aimed to solve the problem of classifying food images using various technologies available to create a seamless Recipe AI iOS app that can capture images of ingredients and come up with recipes that uses the classified ingredients. This project consists of using a camera to capture images of ingredients, image processing to determine the ingredient, and filtering through recipes to find the closest matching for the user.**

Keywords—**iOS Development, Machine Learning, TensorFlow, TFLite, Firebase, APIs, Food2Fork, Recipes**

I. Introduction

This document is a final report for Enterprise Software Platforms course in the Fall semester of 2018 under the guidance of Professor Rakesh Ranjan. The course project focused on the development of a iOS application for recipe generation based on user selected ingredients.

The application aims to help solve two problems: reduce the amount of food wasted due to it getting soiled, and to help users save money by making food at home rather than ordering take-out or going to a restaurant. The end user can utilize the produce they have on hand to get new recipes to try and save recipes to try at a later time.

The application is developed using Apple XCode with Swift which is connected to Google Firebase. A custom trained machine learning model using TensorFlow is hosted on firebase to perform the image classification of ingredients. The recipes are retrieved from a free-to-use recipe database Food2Fork using their specified API. This allows the application to query Food2Fork for recipes based on specific ingredients.

II. Implementation

A. iOS Deployment

Apple controls a large majority of the mobile device market. In order to cater to the largest audience possible, iOS was selected for our deployment platform. RecipeAi was constructed in XCode using Swift 4.0 programming language. Google Firebase was connected via Cocoapods.

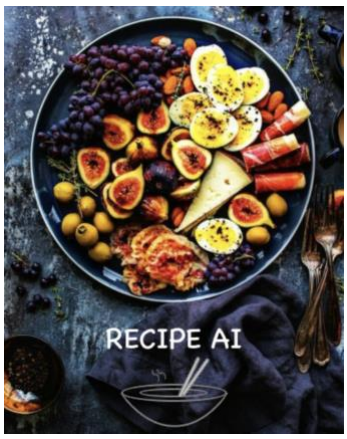

Figure 1: RecipeAi Launch Screen

B. Machine Learning – TensorFlow and Firebase

Machine learning was used to classify the ingredients selected by users. Rather than inputting ingredients manually via the application, a new approach of automatically identifying ingredients was selected. Google TensorFlow was selected as the machine learning platform. Users can also select photos from their photo library rather than capturing ingredients they have on hand.

[avocado, bell pepper, broccoli, cabbage, carrot, cauliflower, celery, corn, cucumber, eggplant, garlic, ginger, green beans, kale, lettuce, onion, peas, potato, pumpkin, spinach, tomato]

Figure 2: Training Data Categories

Machine learning was implemented using TensorFlow by Google. TensorFlow is an open source library for dataflow programming developed by Google which can be used for machine learning applications.[1] For this application, the transfer learning technique was used to generate a trained model for produce identification. A base model provided by TensorFlow is trained using our custom dataset. With a lack of a complete dataset for produce, a web crawl for vegetables was done to gather training data. 21 common household vegetables were selected to train the model using the GoogleImageDownload script[2]. This limits the ingredients the model is able to classify but can be improved by retraining the model with a more complete model.

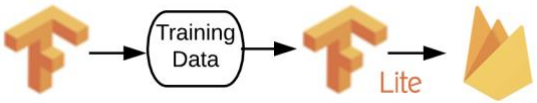

Figure 3: Deployment of Custom TensorFlow Model

The custom trained model is converted to .tflite format by the provided TFLiteConverter and hosted on Google Firebase. The decision to host the trained model on Firebase instead of bundling it with the application allows the model to be further trained and improved without having to update the iOS application. Whenever the model is re-trained and updated, the application would automatically have the newest trained model.

III. Functionality

A. Application

The basic recipe application allows users to take photographs of ingredients they have on hand and provides them with recipe ideas. Users can also create an account in the application and save recipes for later reference. The application requires access to the camera so users are first prompted to allow permissions for camera access. Users can take a picture and the application will identify the vegetable in the picture and provide recipe suggestions queries from Food2Fork database.

Figure 4: RecipeAi Home Screen

B. TensorFlow Model – Classification

The custom training TF model is able to successfully identify the specified produce shown in Figure 2. In order to show the functionality of the model, a test image of a vegetable was passed to the untrained standard model and the trained model. The figure below shows the image classification output for each model. The trained model can clearly identify the potato in the picture while the untrained model identifies the potato as a French loaf with a confidence score of 0.579.

Untrained model output:

```
French loaf (score = 0.57979)
dough (score = 0.04374)
dugong, Dugong dugon (score = 0.00977)
spaghetti squash (score = 0.00768)
burrito (score = 0.00610)
```

Trained Model Output:

```
Evaluation time (1-image): 0.203s

potato (score=0.99995)
```

Figure 5: Comparison of untrained vs untrained model

Using the trained model, the iOS app calls the Firebase API to input the user selected image and outputs the produce name and the appropriate confidence value. This output is then used by the application to query Food2Fork for recipes.

C. Food2Fork API

To create recipes from the ingredients that the user gathers we used the website Food2Fork which contains recipes acquired from various sources on the internet. This is a great place to start since its usage is simple as it allows developers to search and get recipes with Food2Fork API [3]. To connect it to our app we created an account with the website so that we can get an API key using which we can make API calls.

```
Query: eggs,bellpeppers,tomatoes,salt

Recipe:

1-1/2 pound Ground Beef
1 pound Hot Breakfast Sausage
2 cloves Garlic, Minced
2 cans (14.5 Ounce) Whole Tomatoes
2 cans (6 Ounce) Tomato Paste
2 Tablespoons Dried Parsley
2 Tablespoons Dried Basil
1 teaspoon Salt
3 cups Lowfat Cottage Cheese
2 whole Beaten Eggs
1/2 cup Grated (not Shredded) Parmesan Cheese
2 Tablespoons Dried Parsley
1 teaspoon Salt
1 pound Sliced Mozzarella Cheese
1 package (10 Ounce) Lasagna Noodles
(add 1/2 Teaspoon Salt And 1 Tablespoon Olive Oil To Pasta Water)


Recipe Link: http://thepioneerwoman.com/cooking/2007/06/the_best_lasagn/
```

Figure 6: API call to Food2Fork

To create a complete recipe we had to make two API calls within our app. The first call uses the list of ingredients from the user and creates a query which results in a list of recipes and their IDs that contain our list of ingredients. This list of recipes can be sorted by ratings or by their trending status, we chose to sort it by ratings and pick the first recipe from the list. The second API call uses this recipe's ID to get the actual recipe to create a dish with a complete set of directions and a link to where recipe originated from. This helps users connect to new recipes with a complete visual guide.

IV. Conclusion

The iOS application allows users to come up with new and creative ideas with the ingredients on hand. Due to the model being hosted on Firebase, rather than being bundled with the application, future improvements can easily be made. By updating the model and retraining for more vegetables and even accounting for fruits, the application's potential users can increase easily. This allows users to save money by not going out to eat and also reduces the amount of food thrown away due to spoilage.

V. Acknowledgement

We would like to thank Professor Ranjan for allowing us to create this application. Thru this design project, we were able to explore the technologies in machine learning, mobile application development and working with APIs.

VI. References

[1]https://en.wikipedia.org/wiki/TensorFlow#Machine_Learning_Crash_Course_(MLCC)
[2] https://github.com/hardikvasa/google-images-download
[3] https://www.food2fork.com/about/api
Git: https://github.com/SJSU272LabF18/Project-Team-1