CS492 Project Report

ESTIMATION OF NUTRITIONAL VALUE OF FOOD IN REAL TIME

Submitted in partial fulfillment of
the requirements for the award of the degree of

Bachelor of Technology
in
Computer Science and Engineering

Submitted by

IDK16CS007 AKSHAY T
WYD16ME032 JISHNU VIJAYAN
KNR16CS030 JITHINRAJ P
KNR16CS037 MIDHUN PP

Under the guidance of
Prof. Shine S & Associate Professor

Department of Computer Science and Engineering
GOVERNMENT COLLEGE OF ENGINEERING KANNUR
Kannur, Kerala State, India – 670563

Department of Computer Science and Engineering

GOVERNMENT COLLEGE OF ENGINEERING KANNUR

Certificate

This is to certify that this is a bonafide record of the Project work done by the student whose name is given below in partial fulfillment of the requirements of the degree of Bachelor of Technology in Computer Science and Engineering under A.P.J.Abdul Kalam Technological University during the year 2019-2020.

Register No.	Name of Student
IDK16CS007	Akshay T

Prof. Shine S	Prof. Baburaj K.V.	Dr. Rafeeque P.C.
(Project Guide)	(Project Coordinator)	(Professor and H.o.D)

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Abstract

There has been a rapid increase in dietary ailments during the last few decades, caused by unhealthy food routine.If people become more aware about their food intake and its nutritional value, then the dietary diseases and allergies can be reduced. Dietary assessment systems that can record real-time images of the meal and analyze it for nutritional content can be very handy and improve the dietary habits and therefore result in a healthy life.This project proposes a novel system to automatically estimate food attributes such as ingredients and nutritional value by classifying the input image of food.

Contents

List of Figures

Chapter 1

Introduction

1.1 Background Information

High Calorie food intake can be harmful and result in obesity, which is a preventable medical condition that causes abnormal accumulation of fat in the body. It can result in numerous diseases such as obesity, diabetes, cholesterol, heart attacks,blood pressure and other diet-related ailments. In order to deal with such problems, people are inclined towards making a difference in their diet plans by paying more attention to what type of food they are consuming. Diet management is a key concern amongst individuals belonging to different age groups.If people become more aware about their food intake and its nutritional value, then the diseases mentioned above and allergies can be reduced.

1.2 Literature Survey

Kawano and Yanai[2] propose a real time mobile food recognition system, which continuously acquires frames of the image from the camera device. The user draws boxes around the food items on the screen and food recognition is carried out within the boxes. The graph cut based segmentation algorithm GrabCut is used for accurate food segmentation.Recognitions is performed using the linear kernel SVM (support vector machine). Camera position and viewing direction need to be maintained to obtain more reliable SVM classifications. Convolutional neural network have also been employed for the recognition task and as a result the recognition accuracy has improved significantly. To tackle the problem of recognizing objects one needs a properly structured engine with a strong capability of further learning and adapting to the specific stimuli with which it is expected to deal properly.

Convolutional neural networks (CNNs) constitute one such class of models. The CNN layers are directly inspired by the classic notions of simple cells and complex cells in visual neuroscience, which represent the prior knowledge injected in the network's structure. Their capacity of dealing with a large number of image categories and making strong and mostly correct assumptions about the nature of images can be controlled by varying their depth and width. [2]

A deep-learning architecture is a large multilayer stack of simple modules.Convo lutional and pooling layers in CNNs are the main building blocks of the architecture. Such building blocks (small trainable multilayer networks) can be trained by the backpropagation algorithm to extract specific features derived from the processing of training datasets [1].

The most straightforward way of improving the performance of (deep) neural networks is by increasing their size. This may be obtained by increasing its depth, i.e., the number of network layers, as well as its width, i.e., the number of units in each layer.However, if this principle is applied in the most straightforward way, e.g., by adding new large layers of neurons, fully connected to the neighboring ones as is usual, this simple solution comes with two major drawbacks.A larger size typically implies a larger number of parameters, which makes the network more prone to overfitting training data, especially if the number of examples in the training set is limited. The other drawback is the dramatic increase of the computational resources required for the task.

1.3 Outline of the Report

The content of the report is organized as follows:

- Chapter 1 deals with introductory concepts followed by the reference papers we studied for completion of the project.
- In chapter 2, the methodology used for the implementation of project is discussed.
- In Chapter 3, the system design is shown using flowcharts and data flow diagrams(level 0 and level 1)followed by some description
- In Chapter 4, the detailed design of the system is described using UML diagrams which includes Use case, Class diagrams, Sequence diagrams, Activity diagrams and finally the Component diagram with the purpose of visually representing a system.
- In Chapter 5,the data dictionary used for the project is discussed.
- In Chapter 6, experimental results and observations of the project are described.
- In Chapter 7, the project objectives and the importance are concluded with extended future scope.

Chapter 2

Methodology

The basic idea of our project is to develop Nutrition value analysis system that takes food images and predict its nutrition value using deep learning.

2.1 Phase 1: Data Set Creation

Data set has been created using Food11 dataset taken form kaggle which contains around 16000 images.The dataset has training , validation , and evaluation subsets.The data set was split into into 11 categories, Bread,Diary products,Dessert,Egg,Fried food,Meat,Noodels-Pasta,Rice,Seafood,Soup,Vegetable-Fruit.The dataset contains 10000 training images,3000 testing images,3000 evaluation images.

2.2 Phase 2: Model Training

The training phase can further be divided as:

- Create a validation set to examine the model
  To create a validation set we need to make sure that the distribution of each class is similar both in training and validation set.
- Define the architecture of model
  For this project, we used the Inception v3 , pre-trained model which was trained on a dataset that has millions of images. This model was fine tuned as per our requirement and extract features from it for training and validation images.
- Train the model and save it weights
  We train the model using the training images and validate the model

using validation images. We saved the weights of model so that we will not have to retrain the model again. The model was trained and weights obtained which can be used to make predictions for the new images.

2.3 Phase 3: Model Evaluation

Evaluation can also be divided as:

- Define the model architecture and load its weight This model is similar to trained model and is created for evaluation purpose using the same parameters as that of trained model.
- Create the test data
- Make predictions for the test images.
- Evaluate the model
  The actual tag and predicted tag are used to get the accuracy score.

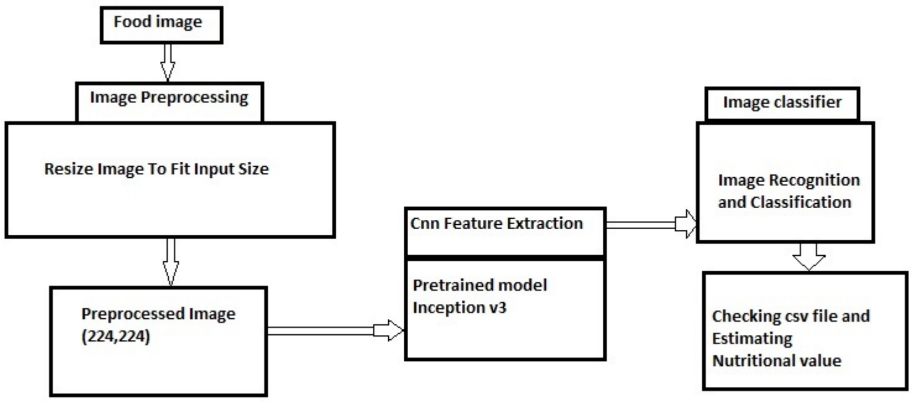


Figure 2.1: System architecture

Chapter 3

System Design

3.1 Flowcharts

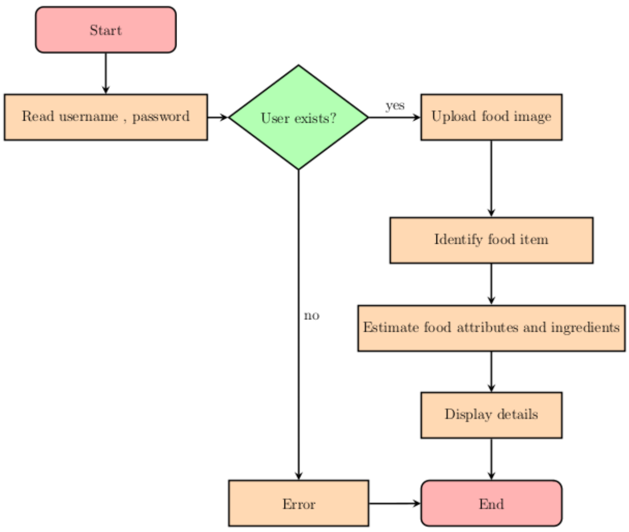


Figure 3.1: Flowchart

3.2 Data Flow Diagrams

3.2.1 Level 0 Data Flow Diagrams

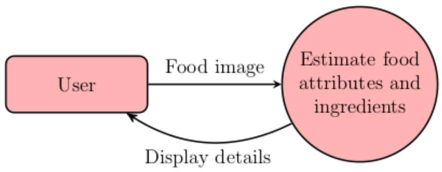


Figure 3.2: DF-0

3.2.2 Level 1 Data Flow Diagrams

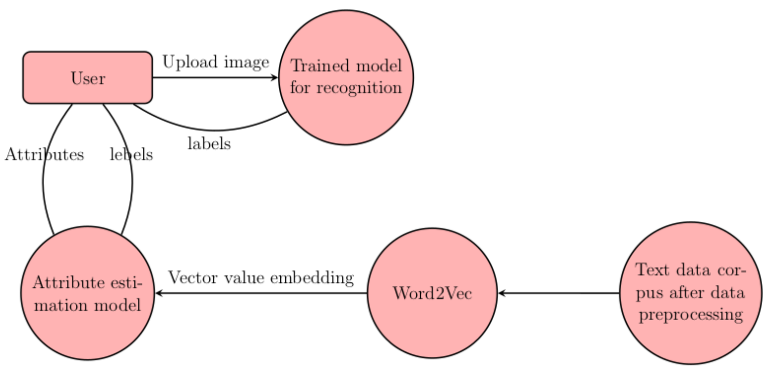


Figure 3.3: DF-1

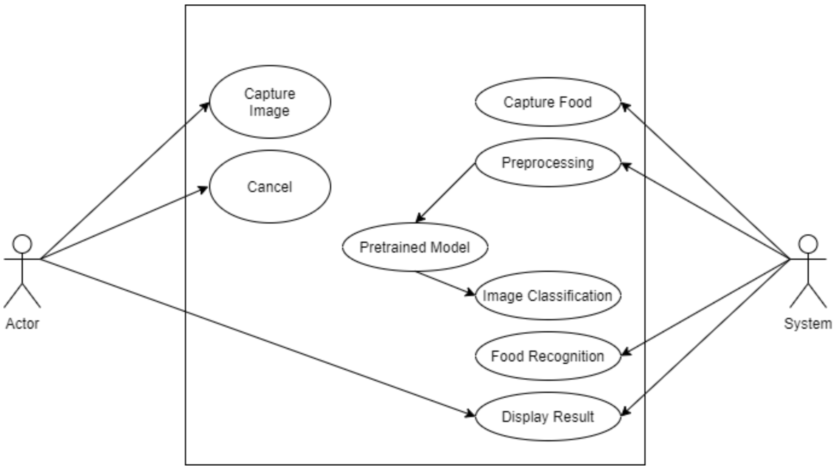
Chapter 4

Detailed Design

4.1 UML Diagrams

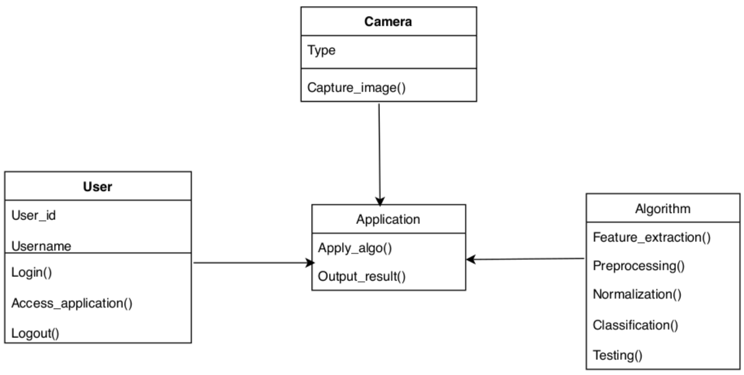
UML is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems. It is a simple modeling mechanism to model all possible practical systems in today's complex environment.The different UML diagrams of Nutrition value estimation system are discussed in this section.

4.1.1 Use Case Diagrams



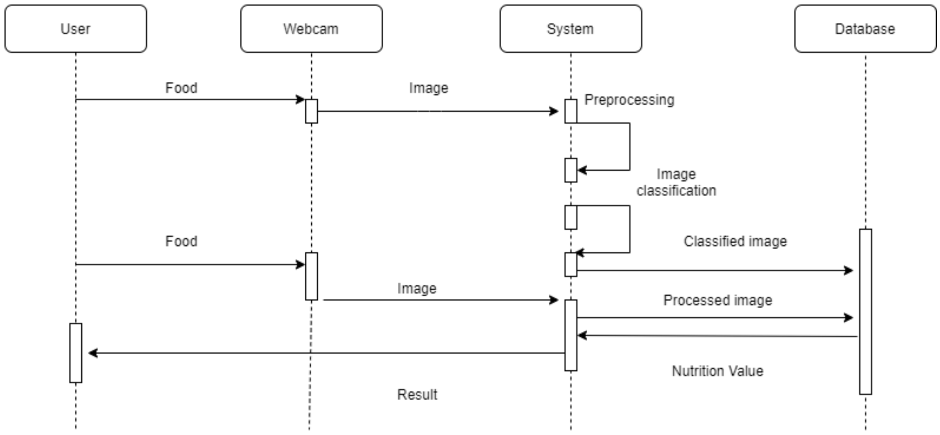
A use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. Use case diagram of Nutrition value estimation system is explained in Figure The actors involved in it are the user and the system.The food shown by the user is captured as image.The captured image is taken by the system for further processing.The preprocessed image is given to inception v3(pretrained model).The food item is recognized and nutrition value is displayed to the user.

4.1.2 Class Diagrams



Class diagram is a static structure diagram that describes the structure of a system by showing the system classes,their attributes,operations. Figure depicts the class diagram of our project.The classes used are Camera, User, Application and Algorithm .The class Camera has the method Capture image() which is used to capture the gestures. The class Algorithm has various methods that process the captured images. Preprocessing () and Normalisation() are used to process the image as desired. Classification () is used to classify the various image into particular classes that represents a food. The class Application outputs the result using the method Output result()

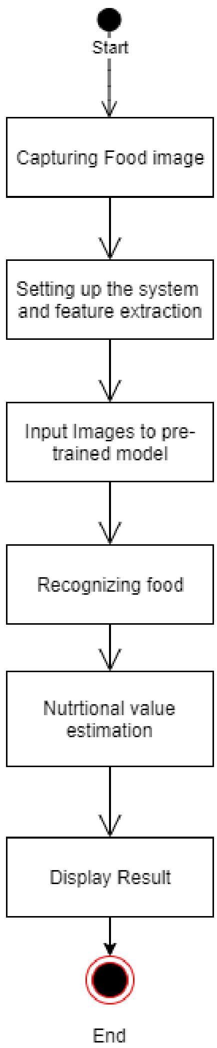
4.1.3 Sequence Diagrams



Sequence diagrams, commonly used by developers, model the interactions between objects in a single use case. They illustrate how the different parts of a system interact with each other to carry out a function, and the order in which the interactions occur when a particular use case is executed. In the sequence diagram of our system interaction takes place between user,webcam,system and data.

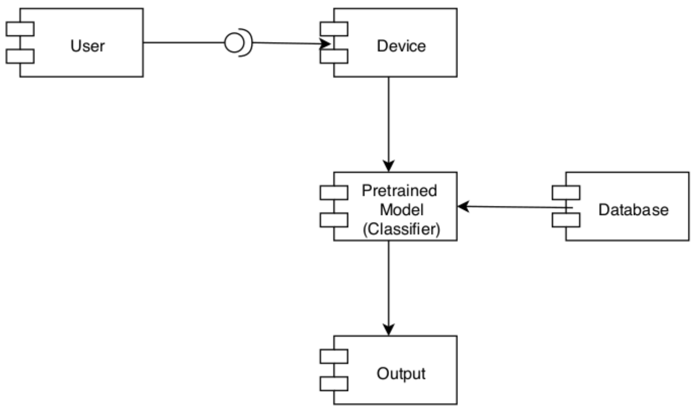
4.1.4 Activity Diagrams

Activity diagram is another important diagram in UML to describe the dynamic aspects of the system. It is basically a flowchart to represent the flow from one activity to another activity. The activity can be described as an operation of the system. The main activities involved in our continuous Nutrition value estimation system as per Figure starts with capturing the image of food given by user.After that transferring the preprocessed image to inception v3 our pretrained model.Then the nutrition value of the recognized image is displayed.



4.1.5 Component Diagrams

UML Component diagrams are used in modeling the physical aspects of object-oriented systems that are used for visualizing, specifying, and documenting component-based systems and also for constructing executable systems through forward and reverse engineering. Component diagrams are essentially class diagrams that focus on a system's components that often used to model the static implementation view of a system. Figure shows the com-



ponent diagram of the system.User,device,pretrained model,database are the components involved.The food shown by the user is captured through device camera and after several preprocessing steps,fed into the classifier and classification occurs in inception v3 .After recognising the food nutrition value is estimated by the system. As an output, nutrition value is displayed.

Chapter 5

Database Design

5.1 Data Dictionary

A data dictionary is a file or a set of files that contains a database's metadata. The only database that is used in the project is the data set to the Machine learning algorithm.Our data set contains multiple Images of various foods.These images are then divided into different categories.

Chapter 6

Experimental Results

6.1 Accuracy and Loss of training and validation set

Accuracy is the ratio of number of correct predictions to the total number of input samples.Loss is the number indicating how bad the model predicts.Accuracy and Loss on the training set show how the model is progressing in terms of its training,but the Accuracy and Loss on validation set show the measure of quality of the model. Figure 6.2 shows the plot of Accuracy and Loss of training as well as validation data against the number of epochs.Loss and Accuracy are measures of loss and accuracy on the training set,while Validation Accuracy and Validation Loss are measures of loss and accuracy on the validation set.

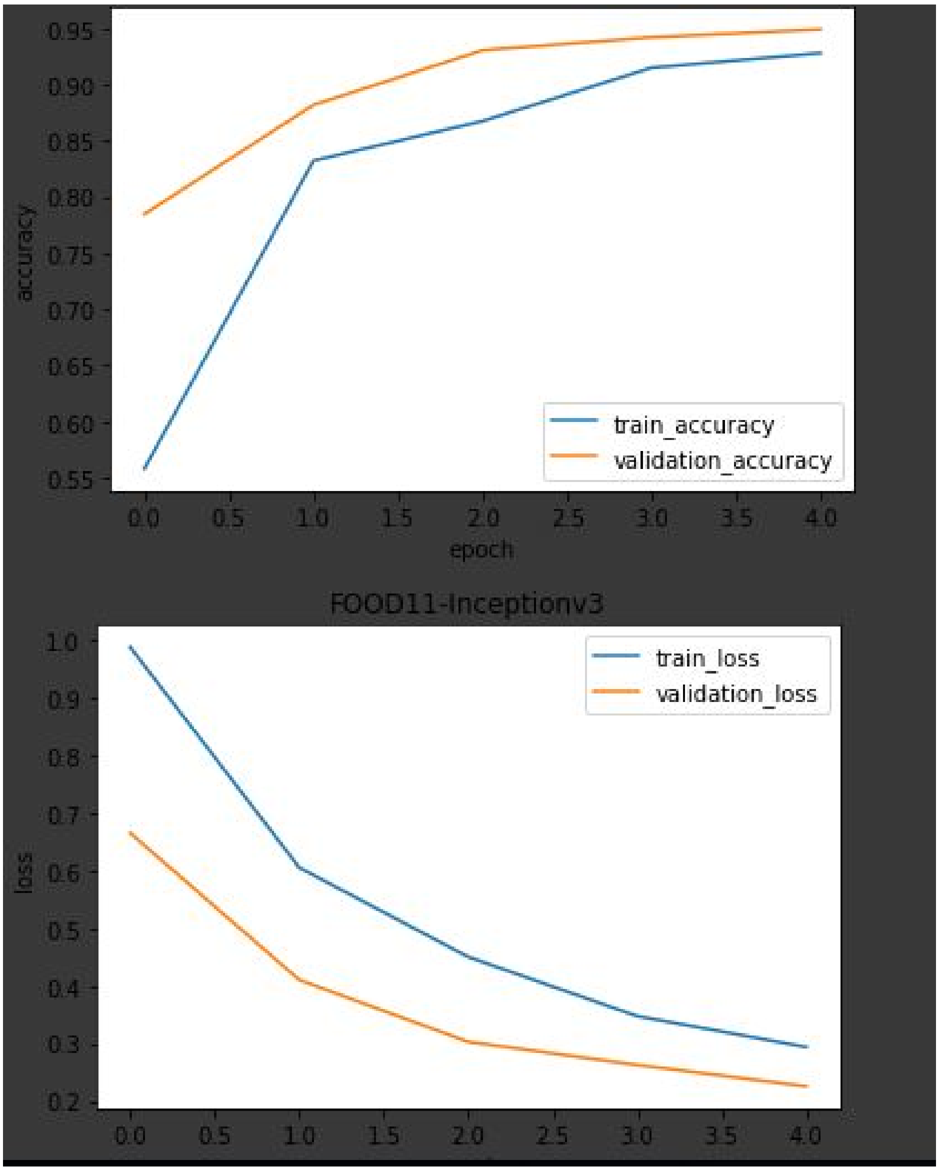


Figure 6.1: Accuracy and Loss

Chapter 7

Conclusions and Future Work

7.1 Conclusion

This project presents a system that exploits the extensive use of mobile devices to provide health information about the food we eat. The web-based app takes the image of the meal and presents approximate ingredients and nutritional values in food. A dataset is created that consists of common food items.We employed a fine tuned Inception model to recognize food items and propose a method to estimate attributes of the recognized food item. The results are improved via data augmentation and other similar techniques.90 percent accuracy is achieved on our dataset. Adaptive nature and accuracy of the system can be enhanced by using Artificial Neural Network (ANN) for classification and food recognition.Our proposed method for estimating attributes also achieved encouraging results. Future endeavors in this domain can include the practical application of this work and more improvements in the web application with advanced features to make it a complete guide for everyday meals.

References

[1] Guido Matrella Hamid Hassannejad. “Food Image Recognition Using Very Deep Convolutional Networks”. In: *ACM* 19.4 (July 2016), pp. 41–49.

[2] Y. Kawano and K. Yanai. “Real-time mobile food recognition system”. In: *IEEE* (June 2013), pp. 1–7.