A Preliminary Project Report On

"Food calorie estimations Using Deep Learning And Computer Vision"

Submitted to

Savitribai Phule Pune University

In Partial Fulfilment of the Requirement for the Award of

B.E. COMPUTER ENGINEERING
SEM VIII

BY

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UNDER THE GUIDANCE OF
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2021-2022

AFFILIATED TO

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CERTIFICATE

This is to certify that the project entitled

“Food calorie estimations Using **Deep Learning And Computer Vision** “

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is a record of bonafide work carried out by them, in the partial fulfillment of the requirement for the award of Degree of Bachelor of Engineering (Computer Engineering) at JSPMs Jayawantrao Sawant College of Engineering, Pune under the

The University of Pune. This work is done during the year 2021-2022

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Acknowledgements

I am profoundly grateful to Prof. Darshana Patil for his expert guidance and continuous encouragement throughout to see that this project rights its target since its commencement to its completion.

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chapter 1

Synopsis

1.1 Group ID : 01

1.2 Group Member : 1.Chetan Jarande

2.Diya Ukirde

3.Mukta Bhagwat

4.Vishakha Patil

1.3 Title of the Project

"FOOD CALORIE ESTIMATION USING DEEP LEARNING AND COMPUTER VISION"

1.4 Internal Guide :

Dr Aarti Dandavate

1.5 Technical Keywords :

Jupyter , YOLO v4 , object detecion , image segmentation ,image processing, food image recognition,food calorie estimation; computer vision, deep learning

1.6 Problem Statement

The reason behind this project is that as the sugar level is rapidly increasing in the human body , there is a need to keep a track on the amount of calorie intake. The calorie intake depends on the person if he/she wants to reduce the obesity or to gain the weight . Using this system , people can estimate the approximate amount of calorie intake from the foods just by clicking a single image of the food.

1.7 Abstract

Nowadays, people are more concerned about their health due to COVID-19. Number of diseases are increasing day-by-day such as heart diseases, high blood pressure, diabetes, etc. These diseases are increasing due to over consumption of oily food, high sugary contents, junk food and many more which leads to obesity.Even COVID-19 has proved the importance of intake of sufficient nutrients to build a strong immune system.So, in order to keep a track of intake of necessary nutrients and to avoid over consumption of fatty and high cholesterolic foods , we are proposing this system . It is not just for the fatty people or the people who are suffering from any disease but can also work for the persons who want to gain weight. In this paper, we proposed an image based calorie estimationsystem which can run on desktop system without any use of external servers. The proposed system consists of various steps such as food classification, detection, segmentation and calorie calculation.

1.8 Goals and Objectives

1.Detection of the type of food especially fruits.
2.Estimation of approximate amount of calories present in the food (fruits).

1.9 Name of Conference/ Journals where papers can be published

1.Journal of Emerging Technologies and Innovative Research (JETIR)
2.International Journal of Innovative Research in Science and Engineering Technologies (IJIRSET)
3.International Engineering and Research Journal (IERJ)

Chapter 2

Introduction

2.1 Background

People are generally considered obese when their Body Mass Index (BMI) is over 30 kg/m2. High BMI is associated with the increased risk of diseases, such as heart disease. Unfortunately, more and more people will meet criteria for obesity. The main cause of obesity is the imbalance between the amount of food intake and energy consumed by the individuals. Obesity treatment requires the patients to eat healthy food and decrease the amount of daily calorie intake, which needs patients to calculate and record calorie from foods every day. While computer vision-based measurement methods were introduced to estimate calorie from images directly according to the calibration object and foods information, obese patients have benefited a lot from these methods.And as todays' young generation is more careless about their diet. They don't look after what are they eating. And as the world is getting faster, people don't consider what they are eating, they are just busy in their work and consume whatever looks attractive even if it is highly fatty. Every time the attractive foods are not healthy . For this we need to keep control on ourselves and keep a watch on what we are eating and how does it is going to affect our body. Especially the people who are suffering from diabetes should take care of the calorie intake. For them even consuming a single fruit can make a huge difference in the sugar level. So, to keep a track of the amount of calories we consume, we have proposed a system which will provide the user with the calorie content present in the food by clicking its picture. The people who need to gain weight or even the people who are having less number of white platelets i.e less than 1,50,000 can use this system to increase the calorie content by consuming high amount of calorie content foods. The condition having less than 1,50,000 number of platelets is known as thrombocytopenia. A normal platelet count ranges from 150,000 to 450,000 platelets per microliter of blood.In this paper we proposed a system which can run on any browser.To estimate the calorie present in the food, the user first of all needs to register a standard reference object whose size is known . Then the user needs to click a picture of the food as well as the reference object which is Image Acquisition . In this system we are using thumb as a reference object. After Image Acquisition , the next step is Image Detection the system will detect the objects by creating bounding boxes around the food and the reference object. Then all objects in the image will get detected. After this, each object image is separately cropped and saved in the system for segmentation. After segmentation. We get Contour Areas, this Contour Areas will help us to find the volume of fruit. Dataset will provide the standard value of densities. By using standard formulas of volume estimation and calorie estimation we get the final output, that is calorie in the particular food items. In recent years, there are a lot of methods based on computer vision proposed to estimate calories. Among these methods, the accuracy of estimation result is determined by two main factors: object detection algorithm and volume estimation method. In this project, we studied the application of deep learning for food classification and recognition. Deep learning is an emerging approach from machine learning, and has been proposed in recent years to move machine learning systems towards the discovery of multiple

levels of representation.

The main contributions of this project are listed as follows:

1. Proposing the first recognition system for food.

2. Proposing a complete and effective calorie estimation method

2.2 Relevance

In recent years ,object detection has been the biggest accomplishments of deep learning and image processing.One of the common approaches to creating localizations for objects is with the help of bounding boxes. You can train an object detection model to identify and detect more than one specific object, so it’s versatile. Object detection models are usually trained to detect the presence of specific objects.The constructed models can be used in images, videos, or realtime operations. Today , it is also used for detecting the presence of animals in the farms , detecting the features in healthcare , etc.

2.3 Project Undertaken

A lot more people calculate their Body Mass Index (BMI) to check whether they are completely healthy or having a perfect body structure , but using the Food Calorie Estimation System the user will get to know the presence exact calorie content in the specific food .The proposed system can also detect multiple food items at a time.

2.4 Methodologies Of Problem Solving

Python :

Python and OpenCV we are using some function which provides the functionality to read neural networks from the weight files so we are using those function to parse our weight file for object detection purpose we are using it anyway for our segmentation and file parsing yolov4 model weight file

OpenCV

OpenCV (Open Source Computer Vision Library) is used to filter images taken from either a video stream, video files or image files. While using a supported programming language ,you can create a program to use a camera, as a sensor, to detect and track elements within an image. If you can isolate elements within an image, you can detect and track the elements within video OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize fruits, faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stitch images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 18 million. The library is used extensively in companies, research groups and by the governmental bodies.

2.5 Literature Survey

Analysis of Literature Survey

1. Automatic calorie estimation system for food images on smartphones

Koichi Okamoto, Keiji Yanai ,The Faculty of Informatics, Nihon Telecommunications University proposes a food calorie estimation system displayed on smartphones for consumers using this method.

This includes the following steps:

1.1 Take the Meal photo with the reference object here reference object which they have used is the food plate.

1.2 Gathered the Required data of objects from Image using Colour Pixel-based K means clustering and grab cut.

1.3 CNN algorithm is used to Identify the category of food objects.

1.4 Calculate the actual food size and food calories using a pre-trained relationship between size (volume and shape) and standard calories

2. Calories Estimating from Food Image openCV

Meghana M. Reddy , Github Repository, May 2016 This system used an SVM (Support Vector Machine) algorithm to classify photos.If the data is not too large, there is no problem. However, the SVM algorithm won’t give good results on a large amount of data and the system proposed by Meghana, must Require the 3 objects which are reference object, food and Food plate in ascending order of size. And the author also used the thresholding methods.

3.YOLO for Real-Time Food Detection

Benny Cheung in blog has proposed a system in which he has detected the food objects. Here he has used UEC FOOD 100 dataset which contains 100 - classes of food photos. Each food object in this dataset has a bounding box around it indicating the location of the food item in the image.Most of the food classes in the dataset are from Japanese culture. In this paper , he have used Darknet's YOLO algorithm for object detection

4. Real-Time Pear Fruit Detection and Counting Using YOLOv4 Models and Deep SORT chevalier cheval The authors, Ira Borja Parico and Tofael Ahamed,have created a system that identifies pear fruits and counts the total quantity of them. They employed the YOLO technique for both Object Detection and Fruit Counting.

5.YOLO-based models for fruit detection have been used in several studies. On an NVIDIA GeForce GTX 1070 Ti GPU, Koirala et al.completed real-time mango fruit recognition with their MangoYOLO model, which achieved an F1 score of 0.968, an AP of 98.3%, and an inference speed of 14 FPS. Only one study used YOLO in conjunction with a multiple object tracking algorithm to count fruits.

6. Only one study used YOLO in conjunction with a multiple object tracking algorithm to count fruits. Itakura etal. used YOLOv2 and the Kalman filter to count pear fruits in a video, achieving an AP of 97 percent in detection and an F1 score of 0.972 in counting. However, their counting system did not have a high frame rate. Because a depth camera is uncommon and mentioned. Because consumer smartphones lack depth cameras,implementing the method on mobile devices proved difficult.

7.Measuring calorie and nutrition from food image

P. Pouladzadeh, S. Shirmohammadi, and R. Almaghrabi, IEEE , Transactions on Instrumentation and Measurement, pp. 1947–1956, 2014.The author have divided the food into six groups according to similar nutritional properties. The UNICT-FD889 dataset with the UECFoodl00 dataset was used for training and testing in deep learning. The system can classify and identify the nutrient according to their groups, but performance is a major issue due to less training and testing. Moreover, it works well for a limited dataset.

8.Deep Learning-Based Food Calorie Estimation Method in Dietary Assessment

A. Meyers, N. Johnston, V. Rathod, A. Korattikara, A. Gorban, N. Silberman, S. Guadarrama, G. Papandreou, J. Huang, and K. P. Murphy, “Im2Calories:Towards an automated mobile vision food diary,” in Proc. of IEEE International Conference on Computer Vision (ICCV), 2015 Faster R-CNN is used to detect the food and calibration object. GrabCut algorithm is used for object extraction of each food's contour. Then the volume is estimated with the food and corresponding object. Here multiple Objection detection is possible also we need to take 2 photos of food one from a top view (due to reference object used as coin and for better recognition purpose) and another is from a side view.We are going to use similar pipelines

in our structure of a system.

2.6 Applications

1. This proposed system can help in Healthcare
2. In order to classify the kind of food we can use for this system
3. Can predict the approximate amount of calories present in the food
4. We also can measure the approximate area of that food object

CHAPTER 3

SOFTWARE REQUIREMENT SPECIFICATION

3.1 PROJECT SCOPE

- To develop prototype model for food calorie estimation using python.
- This model will be run using python programming language.
- The system will be a windows based application which will run on browser.

3.2 ASSUMPTIONS AND DEPENDENCIES

This document will provide a general description of project, including user requirements, product perspective, and overview of requirements, general constraints. In addition, it will also provide the specific requirements and functionality needed for this project such as interface, functional requirements and performance requirements.

3.2.1 User Classes and Characteristics

Find the different user classes that you anticipate will use this product. Any common user who suffer from obesity or any kind of diseases that is related to diet.

That user can definitely use this system. To use this system, user does not require technical knowledge. It also describe the pertinent behaviour or characteristics of each user class. Few requirements may be limited only to specific user classes. Differentiate the very most important or useful user classes for this item or product from those who are less significant to satisfy.

3.2.2 Basic Requirement

To use our system there are some requirements that we expect from user :

- We assume that the image should be taken from an appropriate distance where the reference object and food object are clearly visible inside of images and light intensity should be balanced as well not too dark and not too bright.
- For better results user should consider the background of the food object, if the background is uniform and have the same place color the system performance would be on top. For background, the user can use the white plane plate and out the food object inside of that food plate.
- For this current system we have only included a few food objects and reference objects as the thumb and the detection system is trained on the fresh or standard food object appearance. And currently, we have trained the detection algorithm to specifically detect fruits.

3.3 FUNCTIONAL REQUIREMENTS

Functional user requirements are nothing but very high-level statements about what the system should and also it should describe clearly an overview of system
services in detail.

3.4 EXTERNAL INTERFACE REQUIREMENTS

3.4.1 User Interfaces

The user interface or UI for the system should be compatible to be used by any standard browser such as IE, Mozilla or Google chrome. Using this UI user can have access to the system.

3.4.2 Hardware Interfaces

A hardware interface is needed to run the software. Python IDLE and other necessary libraries is required which is minimal requirement.

3.4.3 Software Interfaces

It uses Python as the programming tool. Latest version of python anything higher than 3.7 can be used.

3.5 NON FUNCTIONAL REQUIREMENTS

3.5.1 Performance Requirements

- System can work optimal or faster on 4 GB or more of RAM.
- The system is targeted to be available all time. Once there is a fatal error or system down, the system will provide understandable feedback to the user.

3.5.2 Safety Requirements

- The system is designed in modules where errors can be detected.

3.5.3 Security Requirements

- The system is designed in modules where errors can be detected and fixed easily.

3.5.4 Software Quality Attributes

- Usability:

  This relates to how easily people can use system. A measure of usability could be the time it takes for end users to become familiar with my system functions, without training or help.

- Reliability:

This can be defined as the available time or UP time of software.

- Performance:

  This is essentially how fast system works. A performance requirement for the system could be start in less than 20 seconds. It will give output in less than 10 seconds

- Security :

  Say that system saves all the previous code and lets you reuse a saved code.

3.6 SYSTEM REQUIREMENTS

3.6.1 Database Requirements

Database is not the required in our system, user just need to pass image as a input to the system.

3.6.2 Software Requirements

1. Operating System: Microsoft Windows 7 and Above

2. Programming Language: Python

3. IDE: Python IDLE

4. Platform : Jupyter notebook

3.6.3 Hardware Requirements

1. Processor: Intel Core I3 or Higher

2. RAM: 4 GB or Higher

3. Hard Disk: 100 GB (min)

3.7 ANALYSIS MODELS: SDLC MODEL TO BE APPLIED

SDLC model to be applied

Agile Model

Agile Model is a combination of the Iterative and incremental model. This model focuses more on flexibility while developing a product rather than on the requirement.

In Agile, a product is broken into small incremental builds. It is not developed as a complete product in one go. Each build increments in terms of features. The next build is built on previous functionality. In agile iterations are termed as sprints. Each sprint lasts for2-4 weeks. At the end of each sprint, the product owner verifies the product and after his approval, it is delivered to the customer. Customer feedback is taken for improvement and his suggestions and enhancement are worked on in the next sprint. Testing is done in each sprint to minimize the risk of any failures. In this project we have used agile model. It helps us to done work in efficient way.

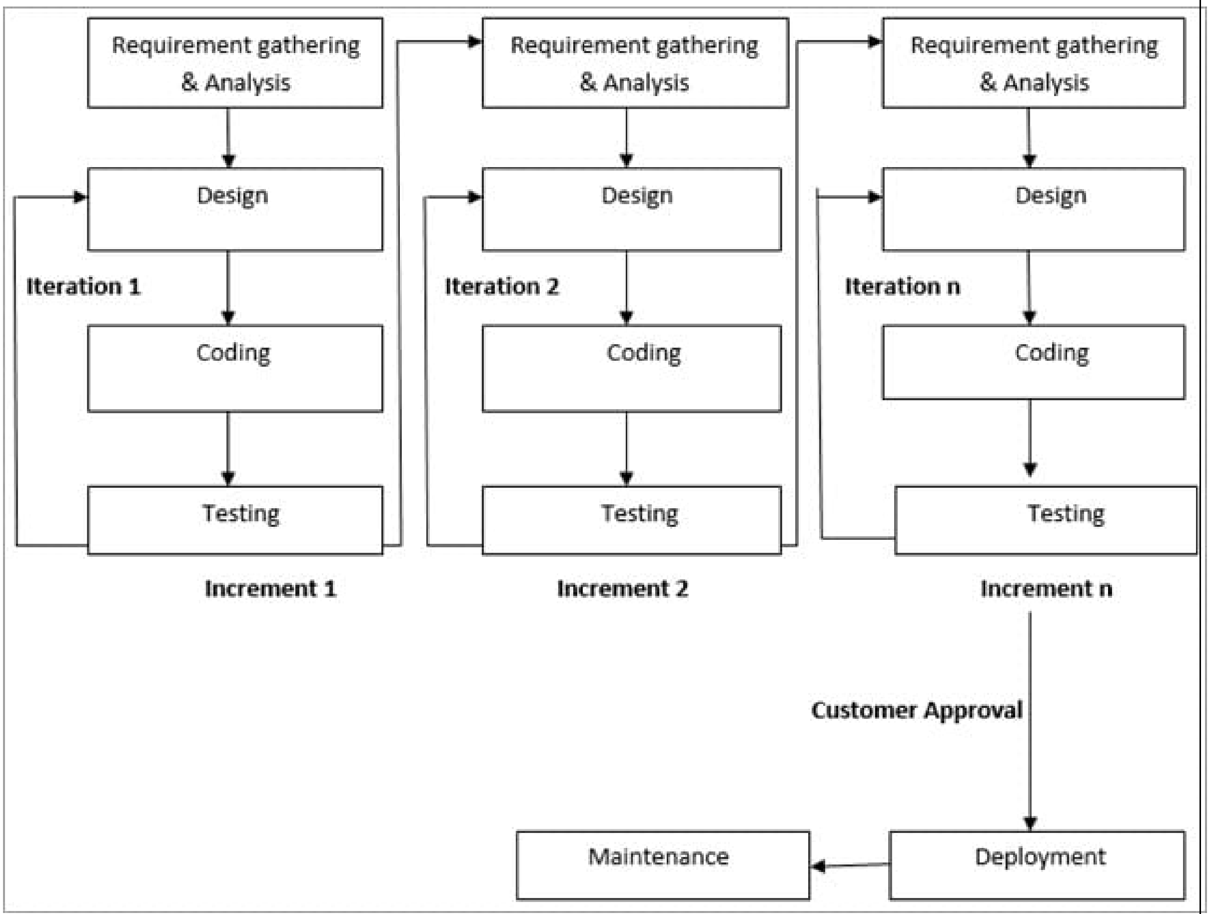


Figure 3.1: agile Model

CHAPTER 4

SYSTEM DESIGN

4.1 SYSTEM ARCHITECTURE-

Here we are proposing a food calorie estimation system that can run on a user's smartphone on the web or on through cloud support or it can be also used on a PC or on the Web. In this proposed system user needs to take a photo of food items from their smartphone or need to provide it with the pre-registered Reference object. The system will then categorize those food items into pre-defined food item categories before estimating the number of calories in each of the food items observed.

4.2 MATHEMATICAL MODEL-

Let

S be Closed system defined as, S = Ip, Op, A

To select the input from the system and perform various actions from the set of actions A so that Op can be achieved state can be attained.

S=Ip,Op ,A

Where,

Ip= Image

Set of actions=A=F1,F2,F3,F4,F5

Where

F1= Image Capture

F2= Detection

F3= Segmentation

F4= Volume Estimation

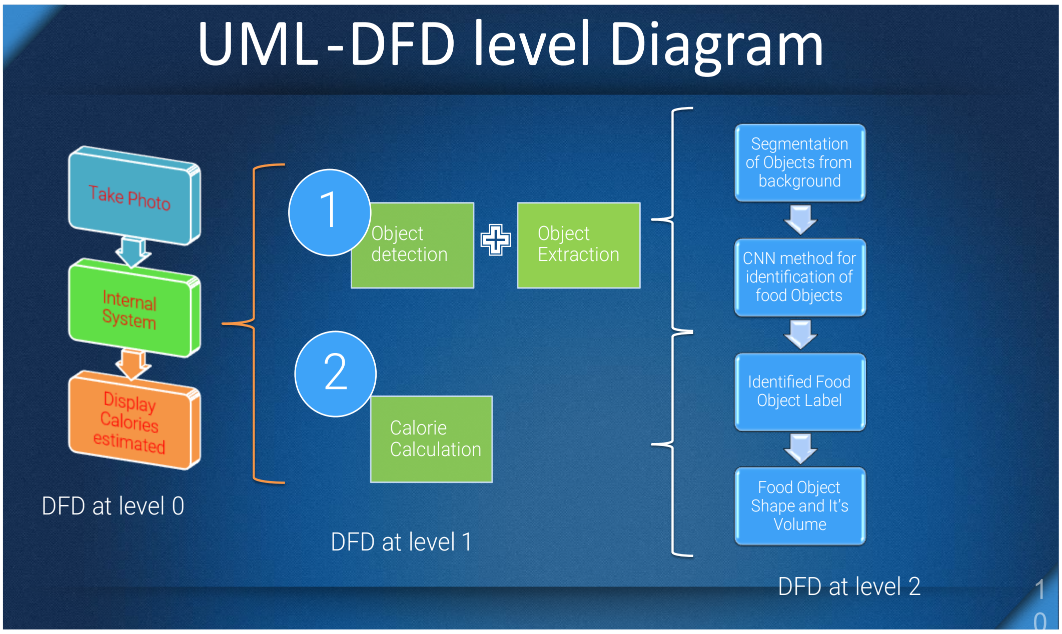
F5- Calorie Calculation

OUTPUT-

Op=Calorie value in digits

4.3 DATA FLOW DIAGRAMS –

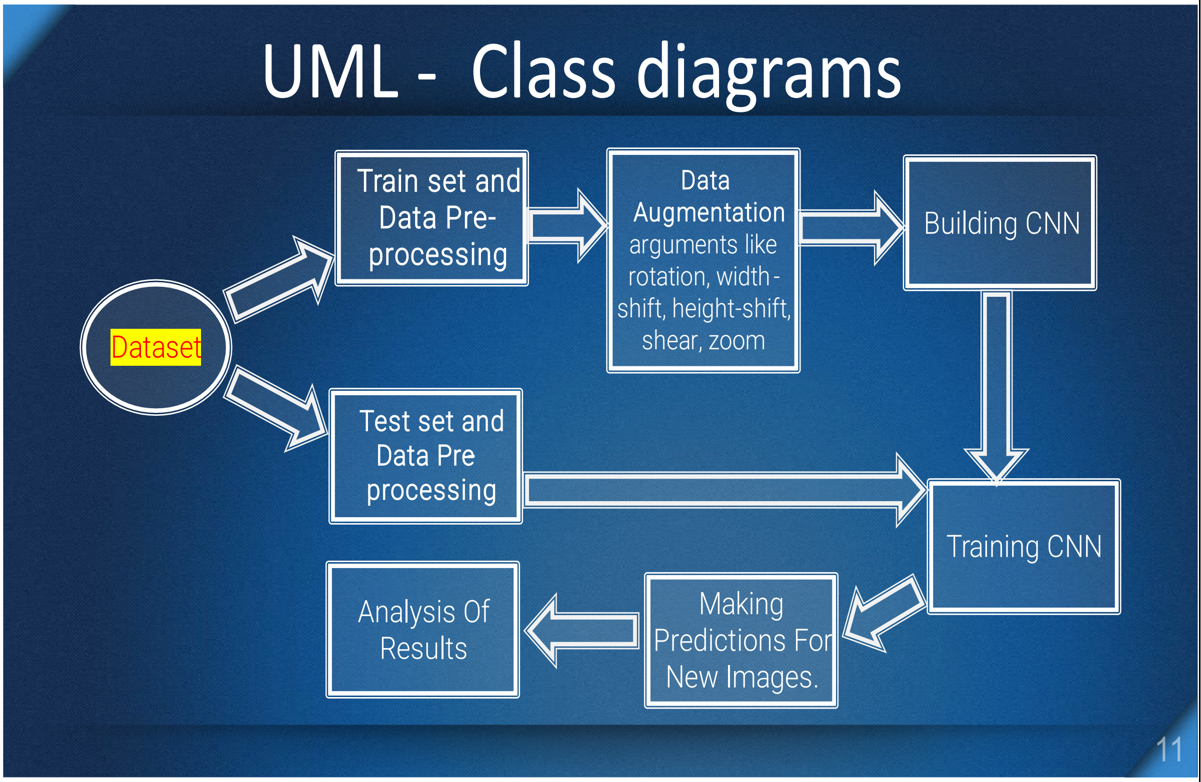
A data flow diagram (DFD) is a graphical representation of the “flow” of data through an information system, modeling its process aspects. A DFD is often used as a preliminary step to create an overview of the system, which can later be elaborated. DFDs can also be used for the visualization of data processing.



4.4 UML DIAGRAMS

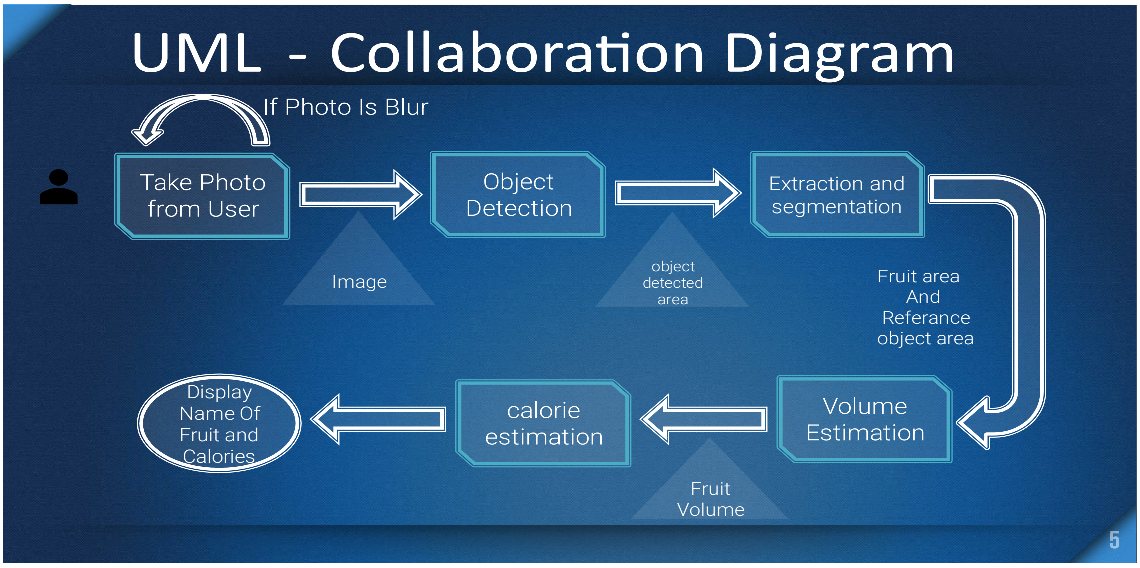
4.4.1 Class Diagram

A class diagram in the world of Unified Modeling Language or UML can be defined as a type of static structure diagram which mainly defines the structure of a system. It works by showing the system's classes and their attributes and operations or methods also the relationships among objects.



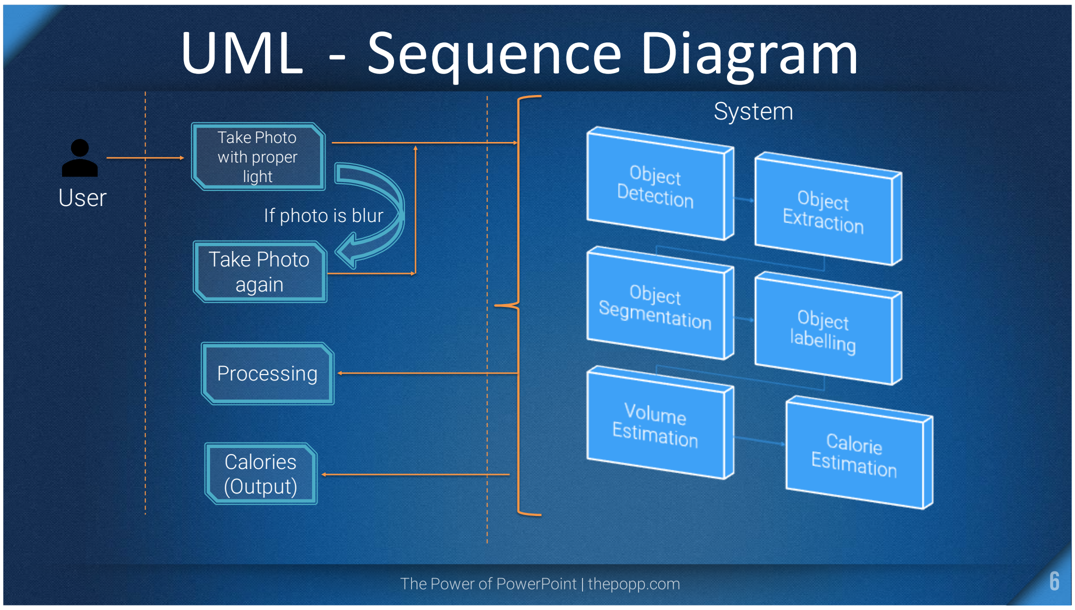
4.4.2 Collaboration Diagram

The collaboration diagram is used to show the relationship between the objects in a system. Both the sequence and the collaboration diagrams represent the same information but differently. Instead of showing the flow of messages, it depicts the architecture of the object residing in the system as it is based on object-oriented programming. The collaboration diagram, which is also known as a communication diagram, is used to portray the object's architecture in the system.



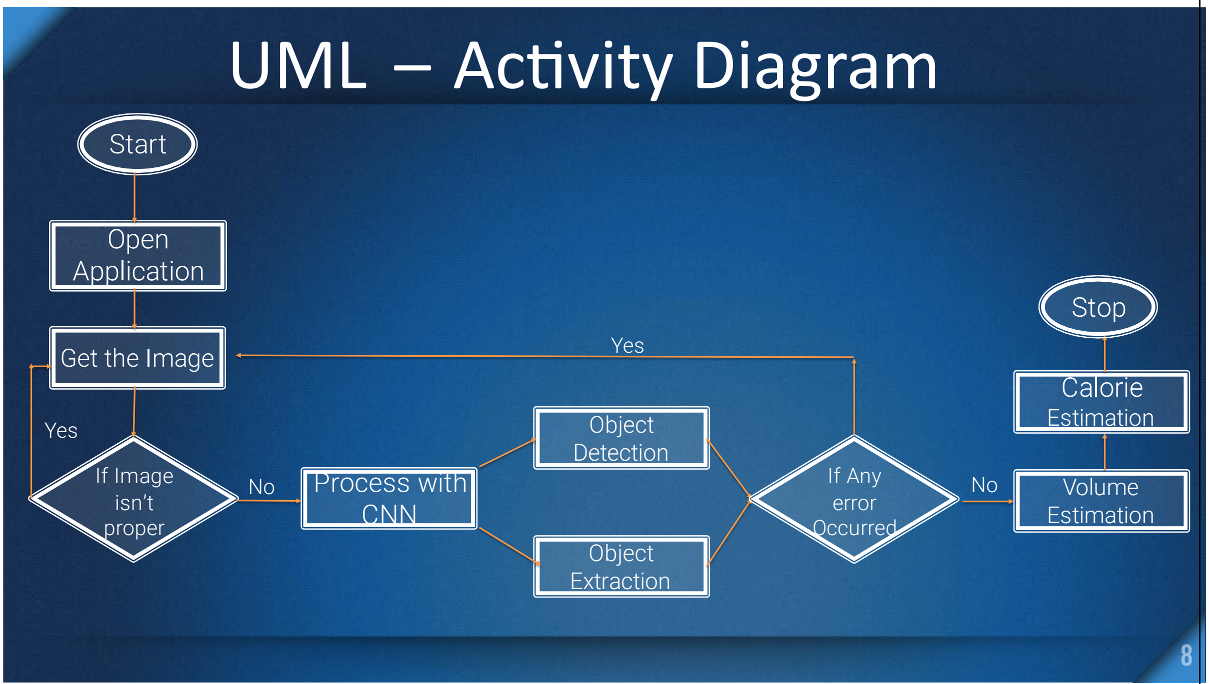
4.4.3 Sequence Diagram

Sequence diagrams can be used to provide a graphical representation of object interactions or object coordination over the time. These basically displays a actor or user, and the objects and components they interact with in the execution of a use case. The sequence diagrams displays the own of messages from one object to another object, and as such correspond to the methods and event supported by a class/object



4.4.4 Activity Diagram

Activity diagram can be defined as a flowchart to display the flow from one activity to another activity. These activities could be described as an operation of the system. The control flow usually is drawn from one operation of application to another. This can be branched or sequential, or concurrent also. Activity diagrams can deal with all or many type of flow control and used different elements such as join or fork.



CHAPTER 5

System Architecture & Details of the Method.

5.1 System Architecture

In this report, we propose a food calorie estimation system that can run on a user’s smartphone on the web or on through cloud support or it can be also used on a PC or on the Web. In this proposed system user needs to take a photo of food items from their smartphone or need to provide it with the pre-registered Reference object. The system will then categorize those food items into pre-defined food item categories before estimating the number of calories in each of the food items observed.

Our main processing steps of the proposed system are as follows:

1. Acquisition of images as input to the system.
2. Object Detection and identification and cropping of those desired and detected objects.
3. Images Segmentation of Objects
4. Find the approximate Volume, Density, and Calories using a predefined reference object if the reference object is present inside the image else shows only detection.
5. Display the result estimated calories with the detected object name.

We presume that a meal photo is taken from the object's Front View in our mobile system. To make segmentation easier, we assume that the background of food dishes is uniform rather than textured. Furthermore, we presume that the reference object's size is known. In fact, in the system we are implementing, a user can record the size of a reference object that is anticipated to be in their own possession, such as a coin, or the user can register their Thumb as their reference object.

Here As we are planning to create a system that detects the objects out from the complete picture and that enables us to be more flexible in sense of we can use more than 1 pre-defined reference object and also multiple food object detection will be easy but for better results, we assume that user will use background surface as uniform such as dish plate, then food should be present and picture should be taken a good exposure of light and at least 1 pre-defined reference object should be present in the picture which is going to be provided as input to the system.

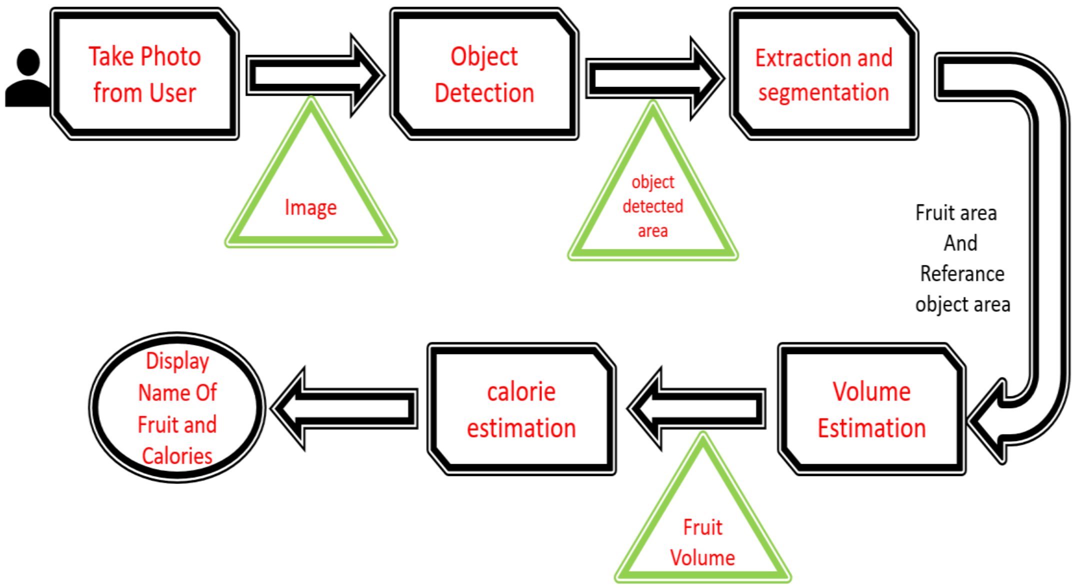
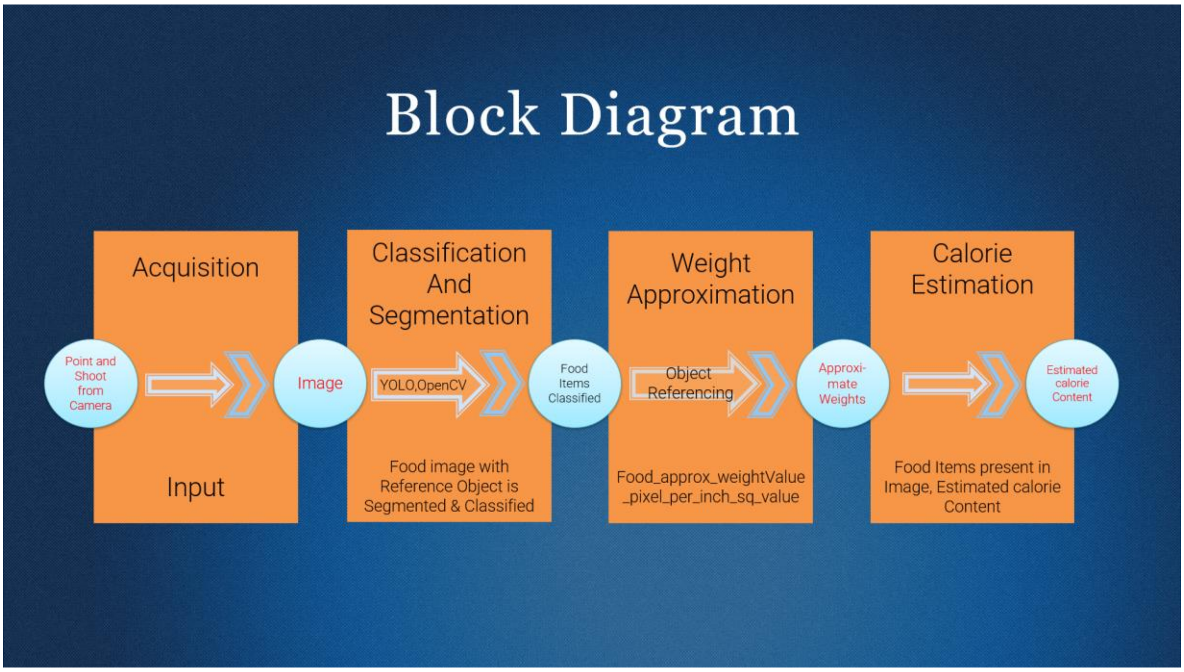


Fig 1: Diagram of system



5.2 DETAILS OF METHOD

5.2.1 **Image Acquisition**

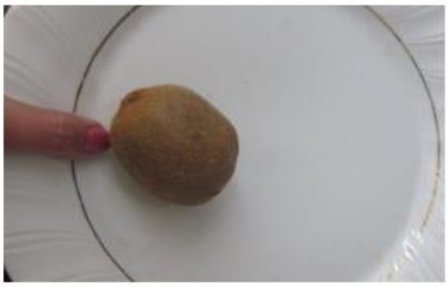
Here for the 1st step, we are acquiring the images users can click the image, and then they can pass that image to our system and get desired results out of it.

Like below example we expect to be input in this format:







5.2.2 Detection

For the **Detection** phase, we are using the YOLO-V4 algorithm, which are give very fast object detection localization and classification of objects on which it has been trained on. It almost takes less than 0.5 seconds on average image size to process and provides the detection result in a single pass. We have used the Darknet YOLO-V4 framework to train our model on those fruit categories and reference objects. It is a state-of-art algorithm now which has been a champion for object detection completions.

As the users are mostly going to use this app in real-time scenarios, so For training purposes, we need a Dataset so we created our own dataset which contains the almost 800 images of 7 different fruits categories, which have created this dataset with the help of roboflow platform where we added necessary annotations to our dataset which are the application for YOLO object detection format.

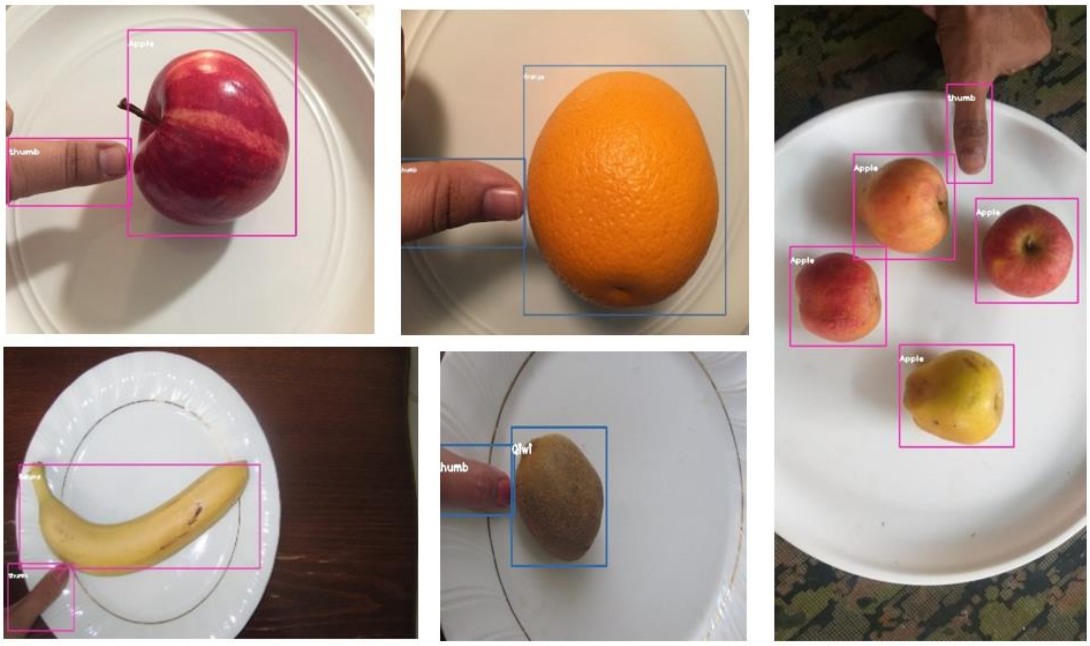
- we also augmented the data in the following dimensions.

Flip: Horizontal, Vertical

90° Rotate: Clockwise, Counter-Clockwise, Upside Down

Brightness: Between -20% and +20% and we have resized the data in 896x896.

The results are



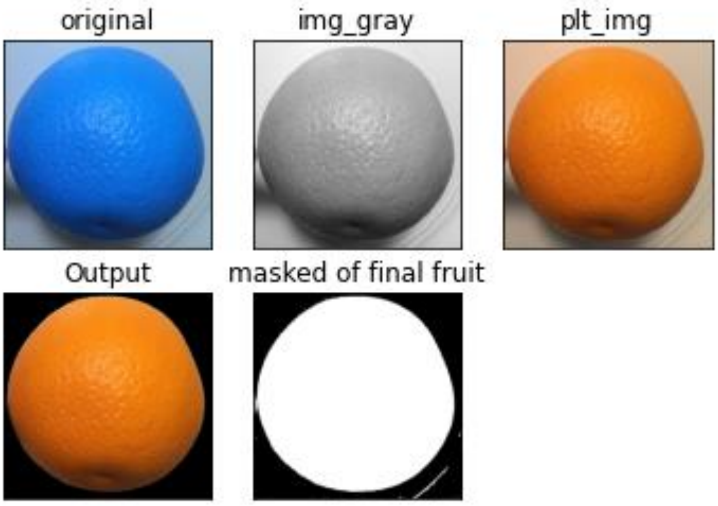
5.2.3 **<u>Image Segmentation</u>**:

In the Segmentation phase we will separate the object area from the parent picture which is been detected in the previous phase. By doing cropping we will extract those desired objects that we want to process for this step, here we have used the Utsu method and global thresholding techniques and a few filtrations present in computer vision which makes our work quite easy to find contours and do the rest of the processing. The same goes for reference objects.

The segmentation for cropped object will look like this one

For Apple :

For Orange:



The last image from each example represents the mask of an object which we have got from our segmentation algorithm.

5.2.4 **Volume Estimation**:

After we get the segmented pixel area and the required things such as Food Object Area using Food Contours, Reference object Pixel height, and predefined reference object multiplier we will get used the main following things which are mentioned below:

We have 3 factors from image segmentation

1. Foods pixel area
2. Skin pixel area
3. Actual skin area (skin multiplier)

From these factors food estimated area is given below:

Estimated Food Area = Foods Pixel Area $*$ Actual Skin Area of Skin Pixel Area

We have two types of shapes of foods

1. Sphere - like apple, orange, tomato, onion
2. Cylinder – like banana, cucumber, carrot

Volume estimation for Sphere :

Estimated Radius =ER

ER =$\sqrt{(\text{Estimated Food Area } / \ \Pi)}$

And Estimated Volume = EV

EV = 4 /3 $*$ Π $*$ ER^3

5.2.5 Calories Estimation:

For the calorie estimation, we are going to make use of a pre-defined table having the value of labels and standard density, and also with that respect, we have calorie values.

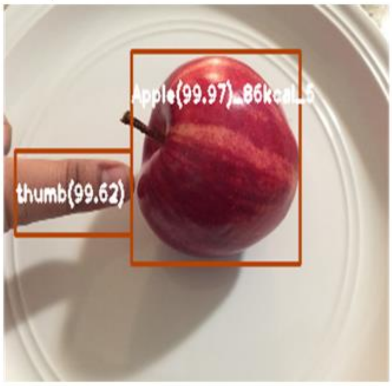
Foods	Density (g/cm^3)	Calorie (kcal/g)	Label	Shape
Apple	0.609	0.52	1	Sphere
Banana	0.94	0.89	2	Cylinder
Carrot	0.641	0.41	3	Cylinder
Cucumber	0.641	0.16	4	Cylinder
Onion	0.513	0.40	5	Sphere
Orange	0.482	0.47	6	Sphere
Tomato	0.481	0.18	7	Sphere

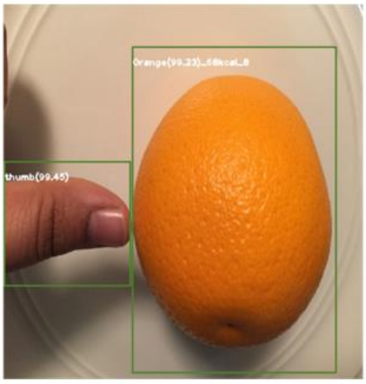
Estimated Weight = Actual Density of food $*$ Estimated Volume

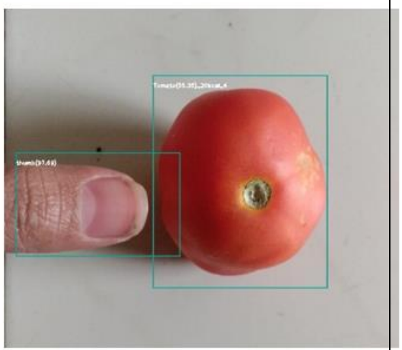
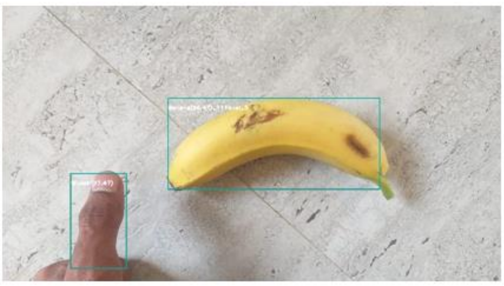
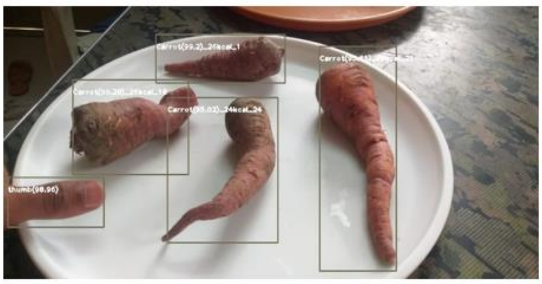
Estimated Calories = Estimated Weight $*$ Calories Per 100 gm / 100

Once the result is generated by using this simple mathematical formula

We will write our result on image back and will present it to the user in the following format.





CHAPTER 6

SOFTWARETESTING

6.1 TYPES OF TESTING

6.1.1 Unit Testing

Unit testing is the testing of an individual unit or group of related units. It falls under the class of white box testing. It is often done by the programmer to test that the unit he/she has implemented is producing expected output against given input.

6.1.2 Alpha Testing

It is the most common type of testing used in the Software industry. The objective of this testing is to identify all possible issues or defects before releasing it into the market or to the user. Alpha testing is carried out at the end of the software development phase but before the Beta Testing. Still, minor design changes may be made as a result of such testing. Alpha testing is conducted at the developer's site.
In-house virtual user environment can be created for this type of testing.

6.1.3 Beta Testing

Beta Testing is a formal type of software testing which is carried out by the customer. It is performed in the Real Environment before releasing the product to the market for the actual end users. Beta testing is carried out to ensure that there are no major failures in the software or product and it satisfies the business requirements from an end-user perspective. Beta testing is successful when the customer accepts the software. Usually, this testing is typically done by end-users or others. It is the final testing done before releasing an application for commercial purpose. Usually, the Beta version of the software or product released is limited to a certain number of users in a specific area. So end user actually uses the software and shares the feedback to the company. Company then takes necessary action before releasing the software to the worldwide.

6.1.4 Performance Testing

This term is often used interchangeably with 'stress' and 'load' testing. Performance

Testing is done to check whether the system meets the performance requirements.

6.1.5 White Box Testing

White Box testing is based on the knowledge about the internal logic of an application's code. It is also known as Glass box Testing. Internal software and code

working should be known for performing this type of testing. Under these tests are based on the coverage of code statements, branches, paths, conditions etc.

6.1.6 Black Box Testing

Black Box testing also known as Behavioural testing, is a software testing method in which the internal structure or design or implementation of the item being tested is not known to the tester. These tests can be functional or non-functional, through usually functional. This method is named as so because the software program, in the eyes of the tester, is like a black box, inside which one cannot see.

This method attempts to find error like incorrect or missing functions, interface error, behaviour or performance error etc.

6.1.7 System Testing

Under System Testing technique, the entire system is tested as per the requirements. It is a Black-box type testing that is based on overall requirement specifications and covers all the combined parts of a system.

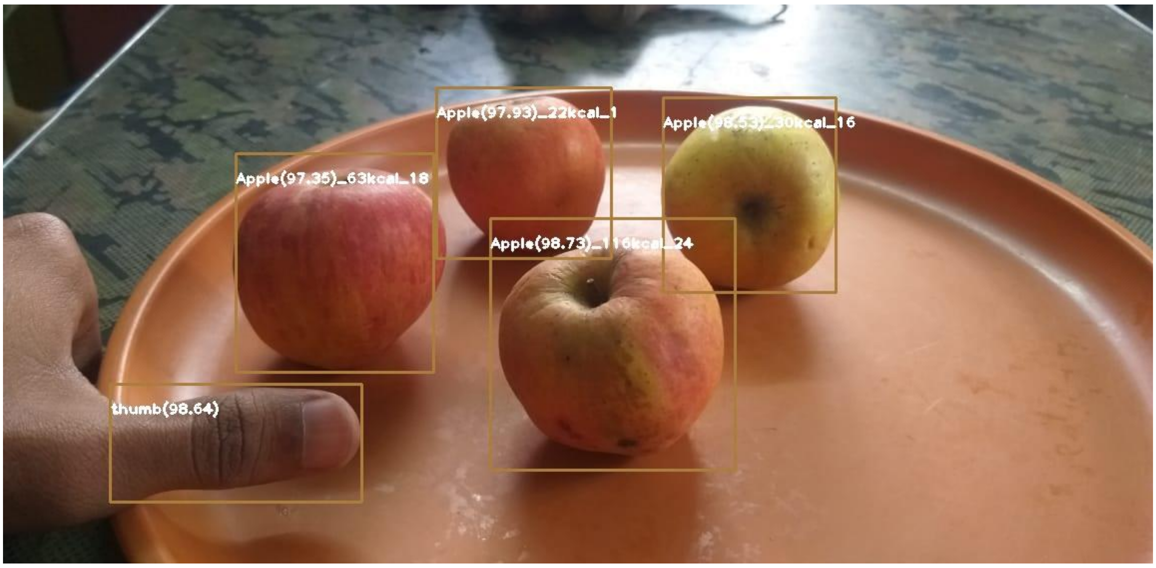
Chapter 7

Result and Analysis

As it is mentioned in the proposed system part that to get the calories user needs to include the predefined reference object inside the input image so that calorie calculation can be done well.

In this model, we have the validation of the reference object. if the reference object is not there in the image our model will not show the calories, it will only show the detection of objects. So reference objects should be present in the image that users are passing. Also, we insist people use white plates or white backgrounds to get better results or any common uniform surface.

TEST CASE 1 with reference object



Like for these photos in the 1st picture we have the reference object present so it as per the requirement to get the calories we need at least 1 predefined reference object. So as we can see the calories are successfully calculated for each image, here are the results that are going to be printed at users side at the end

Apple(97.93)_22kcal_1 [434, 83, 175, 171]
Calorie estimation done for--> Apple and Calorie is 22.21 kcal/g

Apple(98.53)_30kcal_16 [661, 93, 173, 195]
Calorie estimation done for--> Apple and Calorie is 29.657 kcal/g

Apple(97.35)_63kcal_18 [233, 149, 198, 219]
Calorie estimation done for--> Apple and Calorie is 62.728 kcal/g

Apple(98.73)_116kcal_24 [488, 214, 245, 252]
Calorie estimation done for--> Apple and Calorie is 116.468 kcal/g

Drawn and detection part done for--> thumb(98.64)
Drawn and detection part done for--> Apple(97.93)_22kcal_1
Drawn and detection part done for--> Apple(98.53)_30kcal_16
Drawn and detection part done for--> Apple(97.35)_63kcal_18
Drawn and detection part done for--> Apple(98.73)_116kcal_24

Display and detection part done in 3.409546136856079 Seconds

The format of printing the name for fruits is:

ObjectName_(Confidence)_Calories_BBNumber

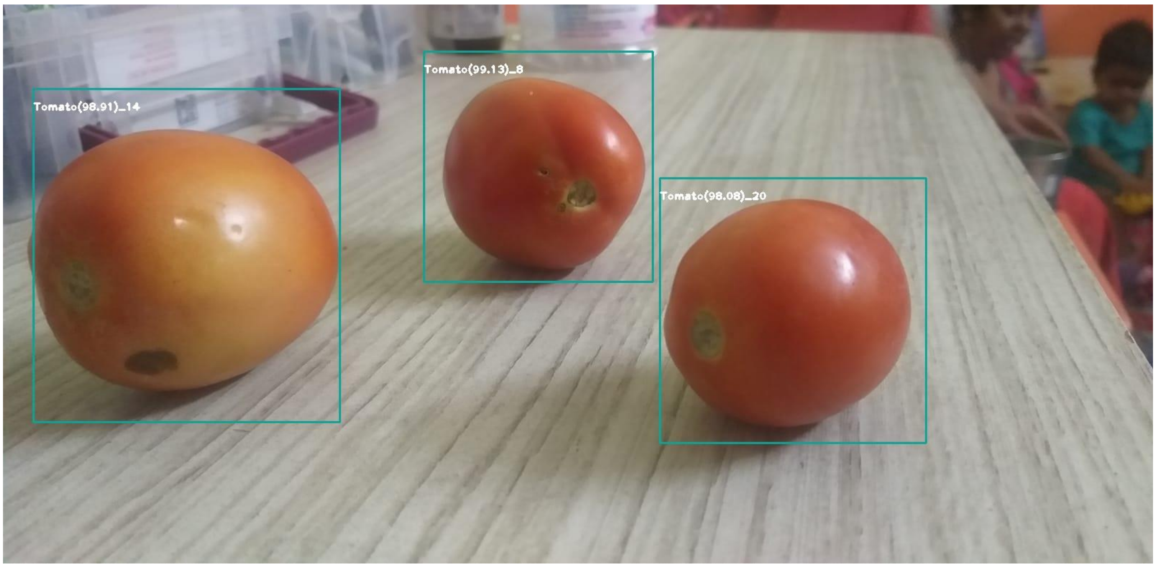
And for the reference object it is :

ReferanceObjectName_(confidence)_BBNumber

As we can see that light intensity and background near the object can impact the results also it is necessary to keep reference object near the food objects. Because user needs to take care of this because we do use the properties of images which it holds.

And the overall procedure took around 3.5 seconds to complete the whole process, this time range can vary depending on the type of hardware the user is using and also a number of processes along with this one running on that computer.

For the validation part, it won't show any calories generated at the end but it will do its detection part and will print the note for the user as "the reference object isn't there in the image, so please provide one picture which contains at least one reference object inside of it."



Test Case 2 :without reference object

********______|***|______********
Reference Object is not present in the image please provide one to move ahead for calories
********______|***|______********

CHAPTER 8

CONCLUSION

In this paper, we proposed an image-based calorie estimation system that runs on a desktop computer without the use of any external servers. The system automatically estimates food calories by taking a photo of the food from the top or side with a pre-registered reference object.

We have used the YOLO-V4 algorithm for object detection. To recognize and localize each of the food regions we have used the YOLO-V4 darknet which has many convolution neural networks layers inside it in this system, we have used the simple segmentation methods from computer vision therefore it is difficult sometimes to treat a food image with not sufficient light intensity, the non-uniform background behind the food object

We plan to incorporate more sophisticated segmentation algorithms in the future, hopefully, state-of-art region-based with CNN methods for this process we can conclude that our Computer vision which is used for segmentation deals with the image really quick, and calories calculation is fast enough for object detection model YOLO-V4 which we have used is highly accurate and give really faster detection result.

CHAPTER 9

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CHAPTER 10

10.1 survey on food calorie estimation using deep learning and computer vision

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JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

SURVEY ON FOOD CALORIE ESTIMATION USING DEEP LEARNING AND COMPUTER VISION

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Abstract : Nowadays, people are more concerned about their diet due to COVID-19. A number of diseases are increasing day-byday such as heart diseases, high blood pressure, diabetes, etc. These diseases are increasing due to over consumption of oily food, high sugary contents, junk food, many more which leads to obesity. Even COVID-19 has proved the importance of intake of sufficient nutrients to build a strong immune system. So, in order to keep a track of the intake of necessary nutrients and to avoid over consumption of fatty and high cholesterol foods, we have proposed a system that will estimate the approximate amount of calories present in the food. This system can run on mobile as an application as well as on a desktop as a system. The system carries out image acquisition, object detection, and calorie estimation as some of the processes.

IndexTerms - Image processing, food image recognition, food calorie estimation, convolutional neural network , Computer vision , Deep learning.

I. INTRODUCTION

Todays' young generation is more careless about their diet. They don't look after what are they eating. And as the world is getting faster , people don't consider what they are eating, they are just busy in their work and consume whatever looks attractive even if it is highly fatty. Every time the attractive foods are not healthy. For this, we need to keep control of ourselves and keep a watch on what we are eating and how does it is going to affect our body. So, to keep a track of the number of calories we consume, we have tried to propose a system of mobile application which will provide the user with the calorie content present in the food by clicking its picture. In this paper, we propose a System for food calorie estimation from a single photo that runs on an Android smartphone or on the web or a desktop system as well. We are implementing a system as a stand-alone mobile application that can be used even on an airline or in the subway (underground) where an Internet connection is not accessible, taking into account its usability and mobility. Once the user downloaded and installs the application, even if an Internet connection is not there it will work. So, it is also useful for people living in remote areas.To estimate the calories present in the food, the user, first of all, needs to register a standard reference object whose size is known. Then the user needs to click a picture of the food as well as the reference object which is Image Acquisition. As a reference object user can use anything which he/she carries with him/her always like a thumb, wallet, etc. After taking the picture, the system will segment the objects by creating bounding boxes around the food and the reference object, and then it will compare the images with the images in the dataset by giving the volume of the food. And then after the calculation of the volume, the system will insert the value of the volume in a standard formula and then the user will get the output

II. LITERATURE SURVEY OR RELATED WORK-

Despite this, a variety of approaches for automatically estimating food calories have been developed. In this portion of the article, we go over them in detail. Koichi Okamoto, Keiji Yanai [1] "An Automatic Calorie Estimation System of Food Images on a Smartphone " Department of Informatics, The University of Electro-Communications, Tokyo, Japan - In this method, they offer a meal calorie estimating system that runs on a consumer smartphone and includes the following components:

1. Take a meal photo from the top with a reference object, reference object which was used in this system was a food plate of a predefined size. **2**. Extraction of the food item and reference object regions. Using K-means clustering and grab cut methods. **3**. Recognize food categories of the detected food items. Using CNN algorithm **4**. Calculate the real sizes of the foods items present in images and food calories based on the pre-trained relations between sizes (volume and shape) and standard calories. These are 4 main steps that were included in the system where accuracy was quite high and also the recognition speed was also high. But this system process image containing only one food item at a time and multiple food item processing were not possible here. Chen et al. [2] so here in his proposed system, an image-based food calorie estimation method was using RGB-D images which were captured by depth cameras such as Kinect. It was challenging to execute the technology on mobile devices since depth cameras are uncommon and consumer cell phones lack them.

Meghana M Reddy, [3] "Calorie-estimation-from food images openCV", GitHub repository, May 2016. Here in this system what they have done is that they used SVM (support vector machine) algorithm in other to classify the images which are quite good if data is not big but it currently gives not good enough results on big data containing a large number of images. Another thing is that for object extraction and segmentation they have used too many filters of OpenCV which decreases the speed of processing. Also, the system needs to have 3 objects must in it, those are 1 big plate, only 1 fruit and 3rd is reference object in this case they used the thumb as a reference object. Nowadays the popular method which is closely used for object detection techniques and one of the best in object detection and object recognition techniques is Regions based Convolutional Neural Networks (R-CNN) Which further have 2 more advanced versions namely Fast R-CNN and Faster R-CNN. The Faster R-CNN technique is much faster than many methods available out there but it is also costly to train the model on a machine because it needs much more GPU power.

R-CNN method by y Girshick et al. [4] R-CNN divides the overall detection issue into two subproblems: using low-level signals like color and texture to produce category-agnostic item placement suggestions (RPN – Region Proposal Network) and using CNN classifiers to identify object categories at those locations. The precision of bounding box segmentation with low-level signals, as well as the incredibly potent classification capacity of state-of-the-art CNNs, are combined in this two-stage technique. In our detection approaches, we used a similar pipeline, although we looked at improvements in both phases, such as multiboxing.

Author Chiun-Li Chin et al. [5] have divided the food into six groups according to similar nutritional properties. The UNICTFD889 dataset with the UECFoodl00 dataset was used for training and testing in deep learning. The system can classify and identify the nutrient according to their groups, but performance is a major issue due to less training and testing. Moreover, it works well for a limited dataset.

PROPOSED SYSTEM -

In this paper, we propose a food calorie estimation system running on a user's smartphone or it can be also used on a PC or on the Web. In this proposed system user needs to take a photo of food items from their smartphone with the pre-registered Reference object. The system will then categories those food items into pre-defined food item categories before estimating the number of calories in each of the food items observed.

Our main processing steps of the proposed system are as follows:

1. Image Acquisition.
2. Object Detect for the food items as well as the required reference object.
3. Image Segmentation of objects from step 2.
4. labeling of Objects and Volume Estimation.

5. Calorie Estimation.

We presume that a meal photo is taken from the object's Front View in our mobile system. To make segmentation easier, we assume that the background of food dishes is uniform rather than textured. Furthermore, we presume that the reference object's size is known. In fact, in the system we are implementing, a user can record the size of a reference object that is anticipated to be in their own possession, such as a coin, or the user can register their Thumb as their reference object.

Here As we are planning to create a system that detects the objects out from the complete picture and that enables us to be more flexible in sense of we can use more than 1 pre-defined reference object and also multiple food object detection will be easy but for better results, we assume that user will use background surface as uniform such as dish plate, then food should be present and picture should be taken a good exposure of light and at least 1 pre-defined reference object should be present in the picture which is going to be provided as input to the system..

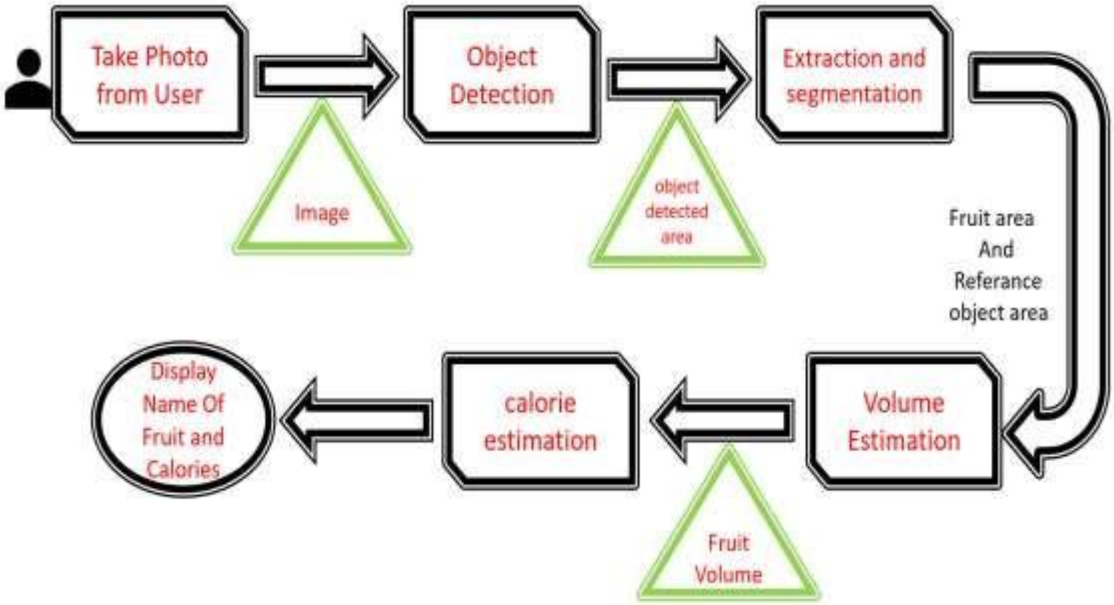

Fig 1: Diagram of system

DETAIL OF THE METHODS

1. **Image Acquisitions**:

For datasets, we gathered many food images in order to train our model and there are food datasets available at Kaggle like Food_360 and other FooDD dataset

We assume that users will take a photo from their smartphone or supply the image having good light intensity present in it and the background should be uniform.

2. **Object Detection**:

here is an example Here suppose this is the input Image that the user supplied then the system will detect the object out of it considering basic edge detection methods are used.

3. Segmentation:

Here in the left image, you can see that object is region is separated from the rest of the image then using segmentation for object extraction techniques such as grab cut or Utsu method of thresholding techniques present in computer vision which makes our work quite easy to do. The same goes for reference objects.

Table: the standard value of density & calories and labels.

Foods	Density (g/cm^3)	Calorie (kcal/g)	Label	Shape
Apple	0.609	0.52	1	Sphere
Banana	0.94	0.89	2	Cylinder
Carrot	0.641	0.41	3	Cylinder
Cucumber	0.641	0.16	4	Cylinder
Onion	0.513	0.40	5	Sphere
Orange	0.482	0.47	6	Sphere
Tomato	0.481	0.18	7	Sphere

4. Volume Estimation:

We have 3 factors from image segmentation

1. Foods pixel area
2. Skin pixel area
3. Actual skin area (skin multiplier)

From these factors food estimated area is given below:

Estimated Food Area = Foods Pixel Area ∗ Actual Skin Area of Skin Pixel Area

We have two types of shapes of foods

1. Sphere - like apple, orange, tomato, onion
2. Cylinder – like banana, cucumber, carrot

Volume estimation for Sphere :

Estimated Radius =ER

$$ER = \sqrt{(\text{Estimated Food Area} / \Pi)}$$

And Estimated Volume = EV

$$EV = 4/3 * \Pi * ER^3$$

5. Calorie Estimation:

For the calorie estimation, we are going to make use of a pre-defined table having the value of labels and standard density, and also with that respect, we have calories values.

Estimated Weight = Actual Density of food ∗ Estimated Volume

Estimated Calories = Estimated Weight ∗ Calories Per 100 gm / 100

CONCLUSION :

From this survey paper, it's seen that we can implement an image-based calorie estimation system that runs on a user's smartphone without the need for external recognition servers. By just taking a photo of a meal from the front using a preregistered reference object, the system estimates food calories automatically.

For this process, we can conclude that computer vision algorithms for Segmentation and object extraction and Strong CNN algorithms are best suited for the identification of food and estimating calories of food present in the image.

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JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

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FOOD CALORIE ESTIMATION USING DEEP LEARNING AND COMPUTER VISION

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JSPM's Jayawantrao Sawant College of Engineering,
Pune, India

***Abstract**:* Nowadays, people are more concerned about their health due to COVID-19. A number of diseases is increasing day by day such as heart diseases, high blood pressure, diabetes, etc. These diseases are increasing due to over consumption of oily food, high sugary contents, junk food and many more which leads to obesity. Even COVID-19 has proved the importance of intake of sufficient nutrients to build a strong immune system. So, in order to keep a track of intake of necessary nutrients and to avoid over consumption of fatty and high cholesterol foods, we are proposing this system. In this paper, we proposed an image based calorie estimation system which can run on desktop system without any use of external servers. The proposed system consists of various steps such as food classification, detection, segmentation and calorie Estimation.

***IndexTerms**: image processing, food image recognition, food calorie estimation, Yolo v4 Darknet, computer vision, deep learning.*

I. INTRODUCTION

Today's young generation is more careless about their diet. They don't look after what are they eating. And as the world is getting faster, people don't consider what they are eating,
they are just busy in their work and consume whatever looks attractive even if it is highly fatty. Every time the attractive foods are not healthy. For this, we need to keep control of ourselves and keep a watch on what we are eating and how it is going to affect our bodies. Especially the people who are suffering from diabetes and obesity should take care of their calories intake. So, to keep a track of the number of calories we consume, we have tried to propose a system that will provide the calorie content present in the food by clicking its picture. In this paper, we proposed a system that can run on any browser. It can also work on localhost without internet.
To estimate the calories, present in the food, the user, first of all, needs to register a standard reference object whose size is known. Then the user needs to click a picture of the food as well as the reference object which is Image Acquisition. In this system, we are using the thumb as a reference object. After image Acquisition, the next step is image detection the system will detect the objects by creating bounding boxes around the food and the reference object. Then all objects in the image will get detected. After this, each object image is separately cropped and saved in the system for segmentation. After segmentation. We get Contour Areas, this Contour

Areas will help us to find the volume of fruit. Dataset will provide the standard value of densities. By using standard formulas of volume estimation and calorie estimation we get the final output, that is calories in the particular food items.

II. LITERATURE SURVEY OR RELATED WORK-

Nevertheless, various approaches have been developed to automatically estimate the calories of food. This article will discuss them in detail.

1.We also have published the survey paper regarding this study [1] "SURVEY ON FOOD CALORIE ESTIMATION USING DEEP LEARNING AND COMPUTER VISION"

2.Koichi Okamoto, Keiji Yanai [2] "Automatic calorie estimation system for food images on smartphones" The Faculty of Informatics, Nihon Telecommunications University proposes a food calorie estimation system displayed on smartphones for consumers using this method. This includes the following steps:

2.1Take the Meal photo with the reference object here reference object which they have used is the food plate.

2.2Gathered the Required data of objects from Image using Colour Pixel-based K means clustering and grab cut.

2.3CNN algorithm is used to Identify the category of food objects.

2.4Calculate the actual food size and food calories using a pre-trained relationship between size (volume and shape) and standard calories and display them on consumer's smartphone

The system has good enough Accuracy and speed but it processes only 1 meal item at a time, the multiple food item recognition wasn't possible here.

3.Meghana M. Reddy, [3] "Calories Estimating from Food Image openCV", Github Repository, May 2016 This system used an SVM (Support Vector Machine) algorithm to classify photos. If the data is not too large, there is no problem. However, the SVM algorithm won't give good results on a large amount of data and the system proposed by Meghana, must Require the 3 objects which are reference object, food and Food plate in ascending order of size.And the author also used the thresholding methods from the OpenCV library which provides supports the segmentation of food objects.

4. Region-based convolutional neural The Network (RCNN) also features two more advanced variants of the, the Fast RCNN and the Faster RCNN, which are now widely used in object localization or detection and since it's a region-based technique is also considered to be a good choice for detection and segmentation purposes. The faster RCNN method is significantly faster than many other methods which are out there, but it also costs because it requires more GPU power to train the model on a machine. Girshicketal. [4] has developed the RCNN approach. Common detection problems are divided into two sub-problems by RCNN. Using low-level signals such as colors and textures to provide category-agnostic suggestions for object placement (RPN-Region Proposal Network) and using CNN classifiers to identify object categories... Those places to identify. This two-step approach combines the accuracy of bounding box segmentation with low-level signals with the most powerful classification capabilities of state-of-the-art CNNs. We used a similar pipeline in our detection approach but looked for improvements in both phases, such as: B. Multi-boxing.

5.Benny Cheung in blog [9] titled "YOLO for Real-Time Food Detection" has proposed a system in which he has detected the food objects. Here he has used UEC FOOD 100 dataset which contains 100 - classes of food photos. Each food object in this dataset has a bounding box around it indicating the location of the food item in the image. Most of the food classes in the dataset are from Japanese culture. In this paper , he have used Darknet's YOLO algorithm for object detection

6.According to Addie's paper [14] Real-Time Pear Fruit Detection and Counting Using YOLOv4 Models and Deep SORT, chevalier cheval The authors, Ira Borja Parico and Tofael Ahamed, have created a system that identifies pear fruits and counts the total quantity of them. They employed the YOLO technique for both Object Detection and Fruit Counting.

7.YOLO-based models for fruit detection have been used in several studies. On an NVIDIA GeForce GTX 1070 Ti GPU, Koirala et al. [17] completed real-time mango fruit recognition with their MangoYOLO model, which achieved an F1 score of 0.968, an AP of 98.3%, and an inference speed of 14 FPS. Only one study used YOLO in conjunction with a multiple object tracking algorithm to count fruits

8. Only one study used YOLO in conjunction with a multiple object tracking algorithm to count fruits. Itakura etal. [18] used YOLOv2 and the Kalman filter to count pear fruits in a video, achieving an AP of 97 percent in detection and an F1 score of 0.972 in counting. However, their counting system did not have a high frame rate. Because a depth camera is uncommon and mentioned. Because consumer smartphones lack depth cameras, implementing the method on mobile devices proved difficult

9.For Over the time YOLO algorithm Has suppressed the many object detection model which was proposed over the time and also it is a state of art and have class of its own for object detection purposes YOLO (You Only Look Once) algorithm have many versions like PP-YOLO , YOLO-V4, YOLO-V5 which are one of the most popular object detection models who is out there right now and also we have YOLO-V4 Darknet Framework and YOLO-V5 PyTorch Framework which are really popular now a days, and we can say that YOLO-Vx is currently in the development phase. So we are going to use some similar methods which we have seen above in our system.

III .PROPOSED SYSTEM

In this paper, we are proposing the Food Calorie Estimation System Using Deep Learning and Computer Vision Techniques, our system can run on a consumer's PC locally, on the web as well as providing the cloud hosting support for it, so it can run on Cloud and provide the support on users end so that the application we be lightweight and fast.

At the user's end, we expect that the user should have some graphical support inside their system with a sufficient amount of RAM and ROM at-least we expect 4GB of RAM and general integrated GPU support.

Our proposed system consists of the following phases:

1. Acquisition of images as input to the system.
2. Object Detection and identification and cropping of those desired and detected objects.
3. Images Segmentation of Objects
4. Find the approximate Volume, Density, and Calories using a predefined reference object if the reference object is present inside the image else shows only detection.
5. Display the result estimated calories with the detected object name.

* **Guidelines For Using this system:**

Since we are going to use the properties which images have

- We assume that the image should be taken from an appropriate distance where the reference object and food object are clearly visible inside of images and light intensity should be balanced as well not too dark and not too bright.
- For better results user should consider the background of the food object, if the background is uniform and have the same place color the system performance would be on top. For background, the user can use the white plane plate and out the food object inside of that food plate.
- For this current system we have only included a few food objects and reference objects as the thumb and the detection system is trained on the fresh or standard food object appearance. And currently, we have trained the detection algorithm to specifically detect fruits.

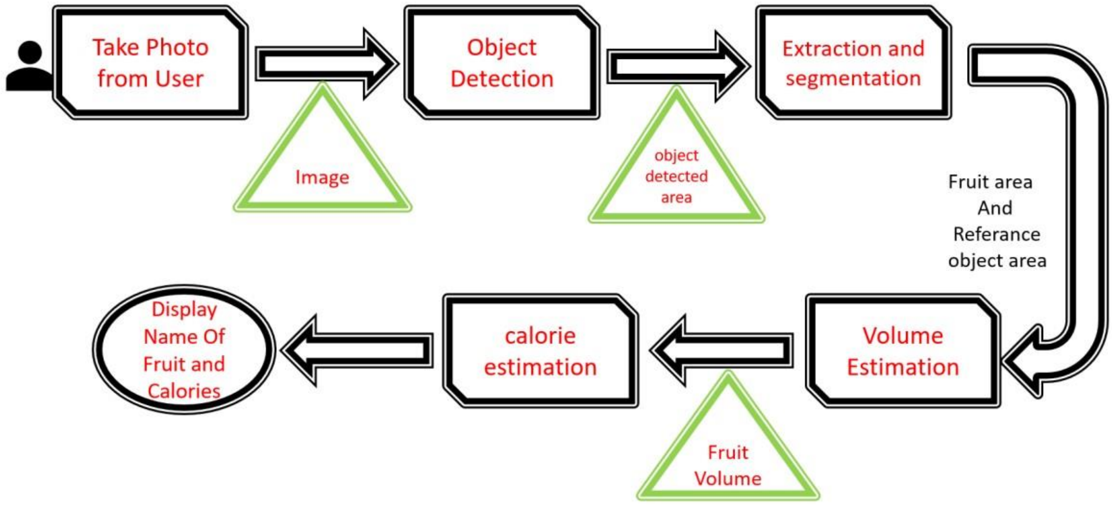


Fig 1: Flow Diagram of system

IV.DETAIL OF THE METHODS

1.Image Acquisitions:

- As the users are mostly going to use this app in real-time scenarios, so For training purposes, we need a Dataset so we created our own dataset which contains the almost 800 images of 7 different fruits categories, which have created this dataset with the help of roboflow platform where we added necessary annotations to our dataset which are the application for YOLO object detection format.
- we also augmented the data in the following dimensions. Flip: Horizontal, Vertical

90° Rotate: Clockwise, Counter-Clockwise, Upside Down

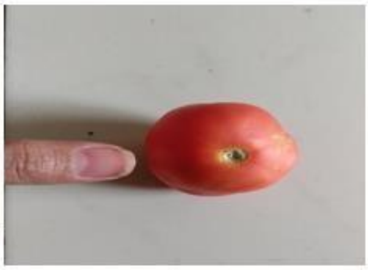
Brightness: Between -20% and +20% and we have resized the data in 896x896.

We assume that users will take photos from their smartphone or supply an image having good light intensity present in it and the background should be uniform.

For the Input we are expecting Image acquisition in following format or similar format:






2.Object Detection:

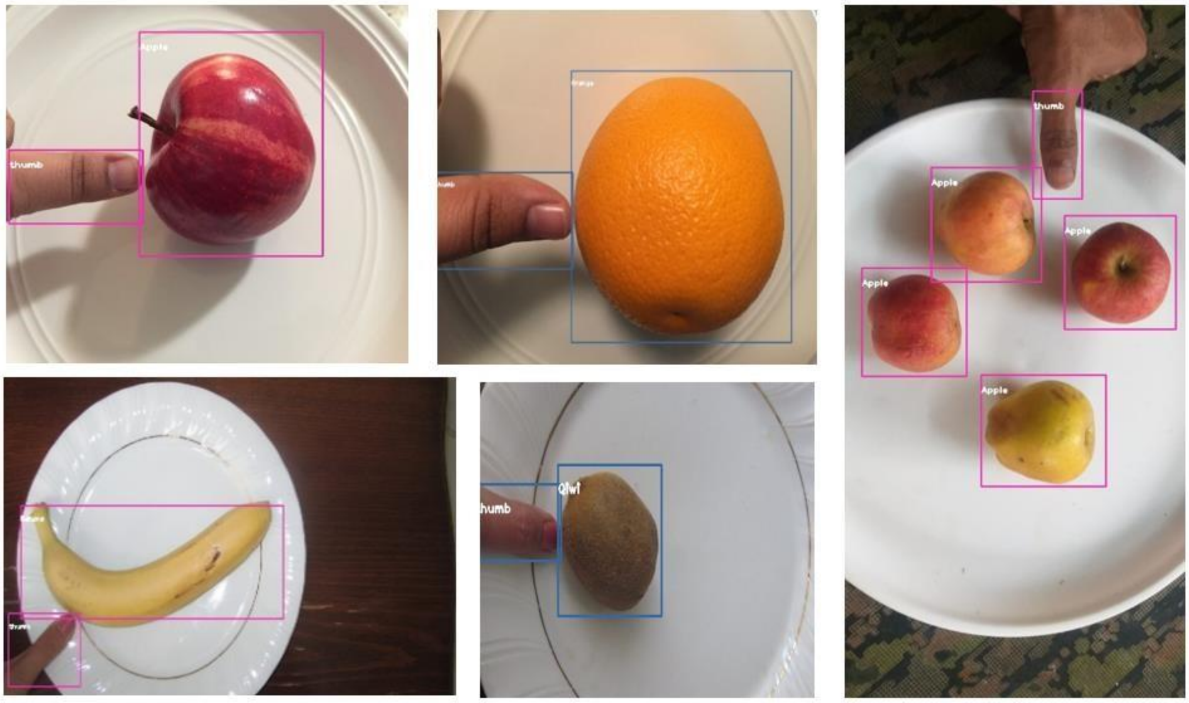
In this step, the user will pass the image, and from that image, our system will find out the given fruit. From all the previously proposed models (e.g. [2] Meghna reddy's paper), we improve our model to give the result on multiple objects data. As we can see in the image acquisition step, we have also taken the multiple fruits data. As we are doing the supervised learning method, we have already annotated the data so our model gives the result accordingly.

Here are the classes that we have used in the model.

1.-thumb, 2.-Tomato, 3.-Qiwi, 4.-Onion, 5.-Carrot, 6.-Banana, 7.-Apple, 8.-Orange We have to use the thumb as a reference object so we have added that too.

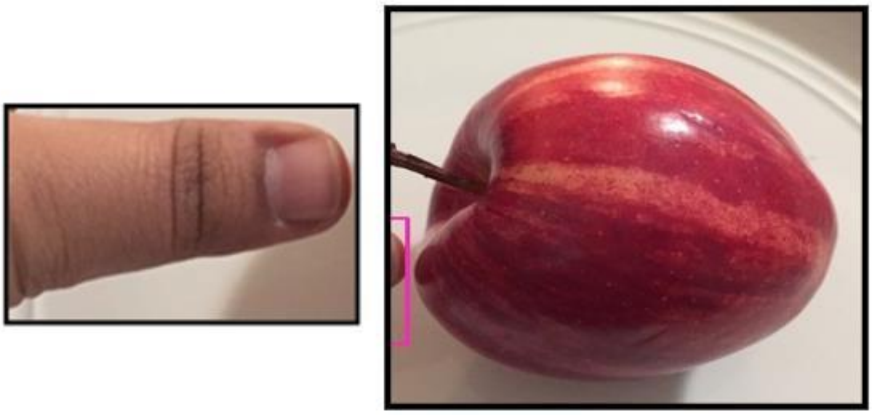
We have used the YOLO-V4 Darknet to give better object detection results. As its one of the fastest and beast object detection algorithms which are out there.

In our case it gives the following results:



3.Cropping of images:

As we have detected the object next we have to crop the image. each object from the image will be cropped and then save as an individual image in the folder. then next step segmentation of images will be done.
As we have seen in the image above, in this step the thumb and apple get cropped separately. all other images will get cropped in same manner.



4.Segmentation:

After cropping images, next step is segmentation. In the segmentation of images, various steps are carried out. Gray scaling, thresholding of image, finding of contours, masking of image. In this step, we get the largest contour area which will help to get calories.
As we have seen the apple image above, now we will see the stepwise segmentation

5.Volume estimation:

We have 3 factors for the image segmentation

1. Foods pixel area
2. Skin pixel area
3. Actual skin area (skin multiplier)

From these factors food estimated area is given below:

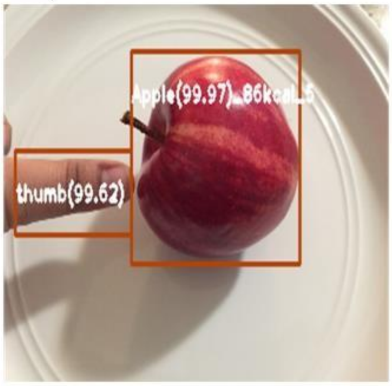
1. Estimated Food Area = Foods Pixel Area ∗ Actual Skin Area of Skin Pixel Area We have two types of shapes of foods 1. Sphere - like apple, orange, tomato, onion Cylinder – like banana, cucumber, carrot Volume estimation for Sphere:
2. Estimated Radius = $\sqrt{(\text{Estimated Food Area} / \Pi}$

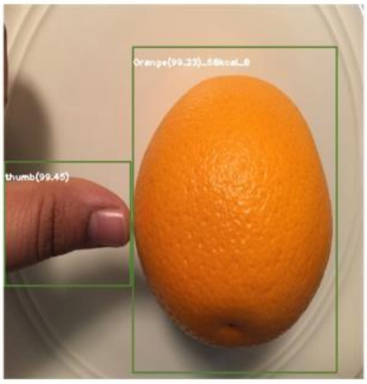
Estimated Volume = 4 /3 ∗ Π ∗ Estimated Radius^3

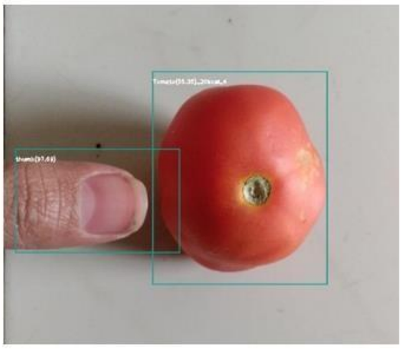
6.Calorie Estimation:

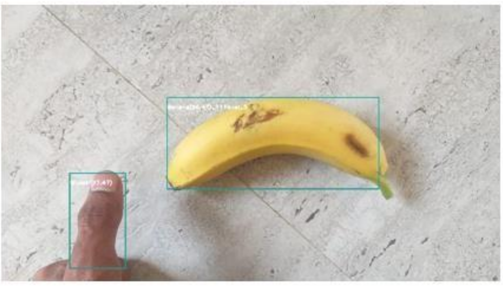
For the calorie estimation, we are going to make use of a pre-defined table having the value of labels and standard density, and also with that respect we have calorie values. Estimated Weight = Actual Density of food ∗ Estimated Volume
Estimated Calories = Estimated Weight ∗ Calories Per 100 gm / 100

By doing all this process, we have calculated the calories, here are some results from our model









V. RESULT AND ANALYSIS

As it is mentioned in the proposed system part that to get the calories user needs to include the predefined reference object inside the input image so that calorie calculation can be done well.

In this model, we have the validation of the reference object. if the reference object is not there in the image our model will not show the calories, it will only show the detection of objects. So reference objects should be present in the image that users are passing. Also, we insist people to use white plates or white backgrounds to get better results or any common uniform surface.

- Here is the standard the Density, Calorie table which we are using In our system Note: thumb is a reference object.

Foods and food labels	Density g/cm3	Calories (kcal/g)	Shape
Tomato	0.47	22	sphere
Qiwi	0.575	44	oval
Onion	0.97	63	sphere
Carrot	1.04	30	cylindrical
Banana	1.14	110	cylindrical
Apple	0.96	95	sphere
Orange	0.814	60	sphere

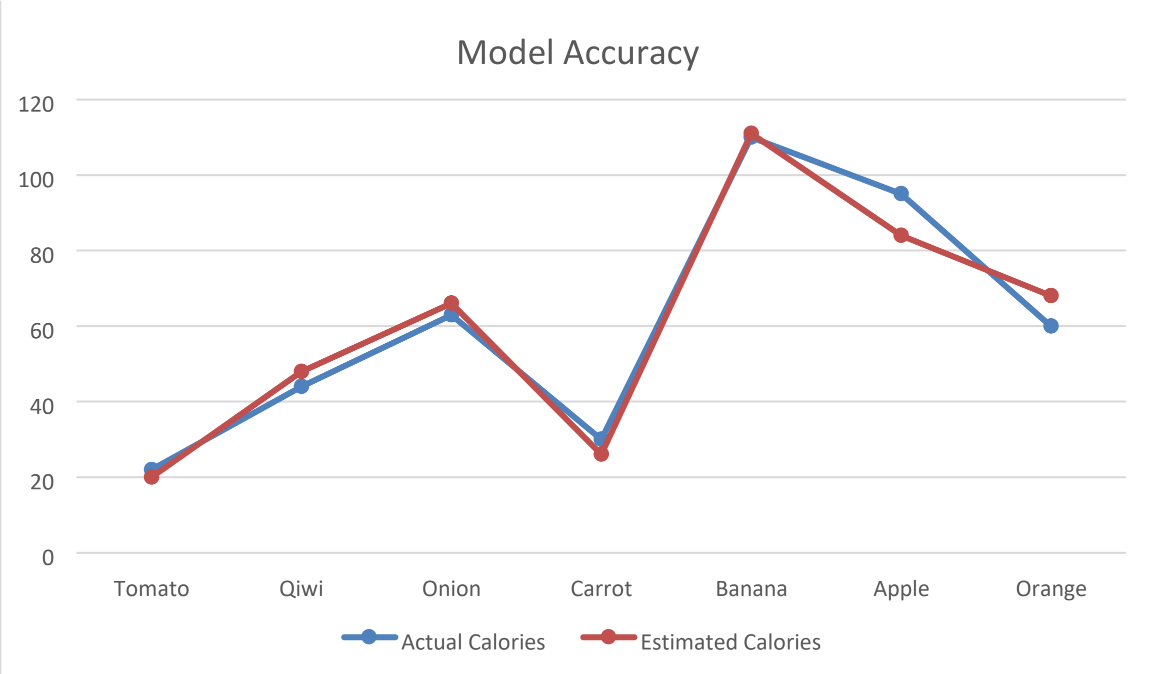
- Here is the below Table for the Estimated calories which we got in our best-case scenarios

The ‘Accuracy’ column values show the % of Accuracy calculating as Accuracy = (Estimated Calories by system / Actual Calories) 100.

Items	Actual calories	Estimated calories	Accuracy(%)
Tomato	22	20	90.90
Qiwi	44	48	90.90
Onion	63	66	95.20
Carrot	30	26	86.66

Banana	110	111	99.00
Apple	95	86	90.52
Orange	60	68	86.60

• Line graph that shows the plotuing of Estimated calories Vs Acutal calories of food items.



VI. CONCLUSION

In this paper, we proposed an image-based calorie estimation system that runs on a desktop computer without the use of any external servers. The system automatically estimates food calories by taking a photo of the food from the top or side with a pre-registered reference object.

We have used the YOLO-V4 algorithm for object detection. To recognize and localize each of the food regions we have used the YOLO-V4 darknet which has many convolution neural networks layers inside it in this system, we have used the simple segmentation methods from computer vision therefore it is difficult sometimes to treat a food image with not sufficient light intensity, the non-uniform background behind the food object

We plan to incorporate more sophisticated segmentation algorithms in the future, hopefully, state-of-art region-based with CNN methods for this process we can conclude that our Computer vision which is used for segmentation deals with the image really quick, and calories calculation is fast enough for object detection model YOLO-V4 which we have used is highly accurate and give really faster detection result.

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