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Android Application for Food Allergy Detection using Machine Learning Technique

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ABSTRACT : Food allergy is usually difficult to diagnose in early life, and the inability to diagnose patients with atopic diseases at an earsly age may lead to severe complications. Numerous studies have suggested an association between the infant gut microbiome and development of allergy. Here, we investigated the capacity of Long Short-Term Memory (LSTM) networks to predict food allergies in early life. This application will be helpful to predict composition of food using Machine Leaning Technique and will be able to predict the item in the composition that causes Allergy for the concerned person.

INDEX TERMS Food recognition,convolutional neural networks,vector embeddings,attribute estimation.

1.INTRODUCTION

Food is the basic necessity for all humans for survival. Some of the foods or some ingredients may cause allergy to our health. Most of the human population in the world are having some or the other food allergy. This application uses machine learning technique to identify the food and its composition (ingredients). Initially the user is provided to mention the foods items that are allergic to him/her. Once the food is recognized, the ingredients of the food is obtained. Ts process is done through image processing and machine learning technique. If the food ingredients are allergic to the user mentioned food items, this application will provide a message that this food is not safe to consume. So that the user can be saved from allergy caused by food.

In visual object recognizing task,convolution nueral networks are found great success and therefore CNNS are also employed for identifying food items present in an image in this work we adopt CNNS to aquire top one recognization accuracy rates of 85%.Another challenge is in the accurate computation of ingridients and nutritional value of the food.

Food allergy is defined as an immunological reaction resulting from consumption to other contact with food. It only affects susceptible people who are sensitive, or 'sensitized', to the specific food allergen, which would otherwise normally be well tolerated by the rest of the population. For those affected by food allergy, consumption of normally nutritious foodstuffs, even in small quantities, can produce life-threatening adverse reactions.Food allergens are usually proteins. Each allergenic protein can have multiple structural active sites or conformational epitopes that interact with the body ' s immune system.

The proposed system aims to be a step towards making attention based on healtn and fitnress concern so that people can eat and live a good life.The proposed method helps in finding the nutrional engredients of food automatically by making it easy for a person to learn about what food might contain how healthy it might be.The inherent theme is to automatically predict food items from an image of a platter and then estimate the respective food attributes ,such as the percentage of calcium,iron,etc.Along with the ingredients present in food our system provide nutrition facts related to packaged food items.The proposed system as its applications in health care industries and hospitals.

The proposed system consist of two components the first component uses CNNS to recognize the food items and image.The second component estimates food attributes using text retrival from internet archiever aswellas scrapping of data nutritional recipie website for ingredients and nutrient counts.This data is trained on a two layer nueral network,from which we can compute probabilities of existing ingridients in a particular food item.

The major contribution of the presented work are listed below.

- A food recognisation engine that is trained using convolution nueral networks.
- An extension of food-101 data set that covers the subcontienital cuisine, involving well defined training and validation classes.
- A real-time food attribute estimation using vector space embedding.This module is trained on data scraped from internet archieves of various nutritional and reciepe websites.

2.Literature Survey

A Literature survey is a type of review article where literature review is a scholarly paper which includes the current knowledge as well as the theoretical and methodological contributions to a particular topic.

T.Mikolov,k.chen[1] They have developed an Android-based application for recognition of Indonesian restaurant menus using convolution neural network. Food name is written on the restaurant menu can be read, but not really showing the information about the food, such as ingredients, how the food is prepared or a picture of the food itself. Hence, it is required to facilitate foreign travelers who want to find out information about Indonesian food based on restaurant menus. An Android-based application has been developed to show food information. The application captures a text on the restaurant menus, process and recognize the text using convolution neural network (CNN). The recognized text is then matched with predetermined database to show the information about the food. The application was able to recognize 100% of the menus when the menus use Sans Serif Font. However, the accuracy dropped into 56% when the menus use Times New Roman.

V. Vodopivec-Jamsek. [2] In this paper, they have successfully created a very large-scale image dataset for Chinese dish recognition, ChineseFoodNet. It contains 185,628 images of 208 food categories, in which the images are from not only web images but also real world. As a consequence, the models trained on our dataset should have covered most of food recognition applications. Also, they present the benchmarks of nine state-of-the-art CNNs models of four well-known CNNs architectures on ChineseFoodNet. Finally, they propose a novel two-step data fusion approach, "TastyNet". Based on experimental results, we select Resnet 152, Densenent 121, Densenet 169, Densenet 201 and VGG19+BN models. After voting the results of these model, we obtain final inference result.

G. Nasi, M. Cucciniello [3] In this paper, Food plate detection is the concept of identifying the food items on the plate.The HSV model used to determine the food item proves efficient method by detection of food objects. This technic is based on identifying the food items based on its hue. Identification of food item from the plate and background is improved by hue of plate and food hue. The technic can be used in food processing industry to identify proper mature condition of food item before food processing. This method can help service provider to prevent serving false food items to the customers.Methodologies used are image processing,MATLAB R2011aVersion,GUI Algorithms.This project is used to learn identification of food item from the plate and background is improved by hue of plate and food hue.

M. S. Marcolino [4] In this paper, Food intake assessment has been a popular research topic in biomedical and health related areas for years.The traditional method is food diaries and records where people need to record food types and estimate food volumes.Researchers have developed methods to monitor food in -takes inside human organs to address inaccuracy caused by human estimation.Typical methods include biological assessment e.g doubly labelled water,plasma carotene and chemical analysis.In computer vision ,food recognition is a specific case of category recognition.Part-based based recognition is an extension of template-based recognition method.Template-based methods are usually used in rigid shape object recognition exhibiting good performance for single object recognition.

S. A. Moorhead [5] In this paper, they present a real-time and robust diet monitoring system, especially for fast foods. The proposed method firstly locates the hand-held object by optical flow between adjacent frames, since the higher magnitude of the optical flow always represent moving object such as hands. Then, two cascaded stages of CNN classifiers are employed to recognize the handheld object. Even a variety of poses and occlusions, we still achieve 92.63% average precision rate among four categories in only 0.25 second, which includes hamburger category, drink category, french-fries category and not food category.

E. Hagg [6] The main purpose of this paper is on identifying the nutrients contained among the food images automatically. After taking a food picture, the system will show how much nutrients the food contained to users so they could learn of what kinds of and how much the nutrition they have absorbed. In this paper, we use of CNN network architectures to identify contents of each the six group food. Compare the architectures referred in this paper with other current technology, the CNN network architectures has a higher recognition rate so it would offer more precise results for users. In the future, we will gather more food images to increase the amount of training data and testing data, and optimize the methods and procedures we had proposed in order to reduce the time complexity for enhancing the recognition rate and performance.

J.-E. Lee,.[7] They have presented a food image description system based on joint recognition. Three schemes are proposed to join information from multiple factors in a learning framework. Based on recognition results. They generate verb-noun pairs that not only shows what food it is but also show how it was cooked. In the evaluation. They verify the effectiveness of joint models, and show that VNPs are more effective in describing food images, as compared to general-purposed image captioning. In the future, how to more tightly integrate different recognition results or intermediate representation in a learning framework is still an important issue.

M.-Y. Chen [8] In this paper, They proposed a new dataset for the evaluation of food recognition algorithms. The images have been acquired in a real canteen and depict a real canteen tray with foods arranged in different ways. Each tray contains multiple instances of food classes. We collected a set of 1,027 canteen trays for a total of 3,616 food instances belonging to 73 food classes. The tray images have been manually segmented using carefully drawn polygonal boundaries. They designed a suitable automatic tray analysis pipeline that takes a tray image as input, finds the regions of interest, and predicts for each region the corresponding food class. We evaluated three different classification strategies using several visual descriptors. The best performance has been obtained by using Convolutional-Neural-Networks-based features.

H.-C. Chen et [9] In this paper, They have presented their food log system and the evaluation of their web-based system. They also showed that a image pre-classification and a personalized estimator can contribute to improving the food balance estimation. By image pre-classification, the accuracy of each category improves by 3% and the online-training using user's own food images yielded an improvement of 4%. The overall accuracy with both techniques is 44%.The goal of this work is to extract information in order to provide

people beneficial information about their dietary habits. In order to achieve this goal, we need to correct a large number of food images with evaluation. In addition to this, we have to utilize users' manual inputs efficiently. They are going to research not only on analyzing the food images, but also on analyzing communities based on meals.

S. Fang, F. Zhu, C. J. Boushey, [10]In this paper, they have a tendency to apply a artificial neural network (ANN) to the tasks of detective work and recognizing food pictures. Be- explanation for the wide diversity of styles of food, image recognition of food things is usually terribly difficulties. Be that as it may, deep learning has been indicated as of late to be a truly intense image recognition system, and ANN could be a dynamic way to deal with deep learning. They tend to connected ANN to the errands of food location and recognition through parameter change. They tend to made a dataset of the preeminent incessant food things in a publically available food-logging framework, and utilized it to recognition execution.

A. Meyers et al., [11]To effectively track and trace food has become an extremely urgent global issue. Early warning of food safety can prevent food safety crisis. However, there is still very few automatic tracking systems for the entire food supply chain. In the paper we propose a data mining technique to predict food quality using back-propagation (BP) neural network. Some prediction errors could occur when predicted data are near threshold values. To reduce errors, data near the threshold values are selected to train our system. Special care of threshold values and performance of our proposed algorithm are discussed in the paper.

T. Ege and K. Yanai[12] In this paper, they have proposed a semi-supervised GANs based on deep convolutional neural network architecture approach to alleviate the shortcomings posed by lack of labeled images and also the classical image recognition problems in food datasets. We have performed experiments on the largest real-world food images ETH Food-101 dataset and the Indian Food dataset with partially labeled data. Experimental results show that the generative semi-supervised deep CNN approach proposed in this work outperforms the current state-of-the-art methodologies consistently for all the ranks for both the datasets even with partially labeled data. While GANs have the potential to improve the food recognition accuracy with partially labeled data, it is difficult to achieve stability and convergence during training. In future, we would try to improve the recognition accuracy with better and robust GAN architecture that could further reduce the usage of labeled training data.

T.Miyazaki,G.C.deSilva,andK.Aizawa, [13] In this paper, they analyze effectiveness of similarity learning for food image retrieval. For food application, recipe retrieval is an important task. However, many of them rely on only text query. Food image retrieval has relation to recipe retrieval so that similar food images are expected that they have similar recipes. Rising image retrieval performance is desired for recipe retrieval. On the other hand, to learn similarity by Siamese Network or Triplet Network are known as an effective method for image retrieval. We tested three types of CNN and it was turned out that Triplet Network was the most powerful network compared to others. They also showed the performance of Triplet Network can be improved by combining classification task.

3.RESEARCH METHODOLOGY

This section5describes the design5decisions and strategies5that affect the5overall organization of5the system and5the higher-level5structures. These5strategies will provide insight into the5key abstractions and5mechanisms used in5the system architecture.

Model phases in system development

- Requirement Analysis
- System Design
- Coding
- Implementation
- Testing Maintenance

3.1.1 Waterfall Model for Development Method:

The Waterfall model5is a sequential5development approach, in5which development is5seen as flowing5steadily downwards (like5a waterfall) through5the phases of5requirements analysis,5design, implementation,5testing (validation),5integration and maintenance.The basic principles5are

- Project is divided5into sequential phases,5with some5overlap5and splash ack5acceptable between5phases.
- Emphasis is on5planning, time schedules,5target dates, budgets5and implementation of5an entire system5at one time.
- Strict control5is sustained over the life of5the development via5extensive written documentation, formal reviews, and5approval/signoff by5the user and5information technology management occurring at the5end of most5phases before beginning the next phase.

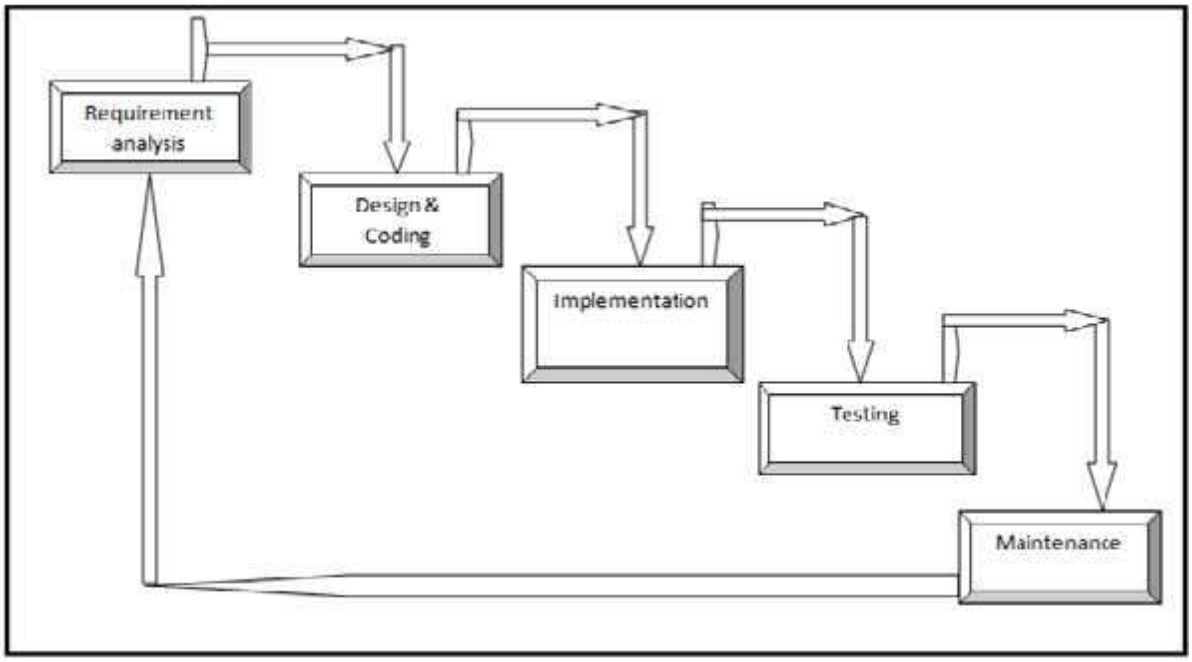

fig 3.1.1: waterfall model for development process

3.2High Level Design:

High Level Design (HDL) describes the relation between various modules and functions Of the system, data flow, flow chat and data structure are covered under HLD.

3.2.1System Architecture

System architecture is a conceptual model that defines the structure, behavior and more views of a system.

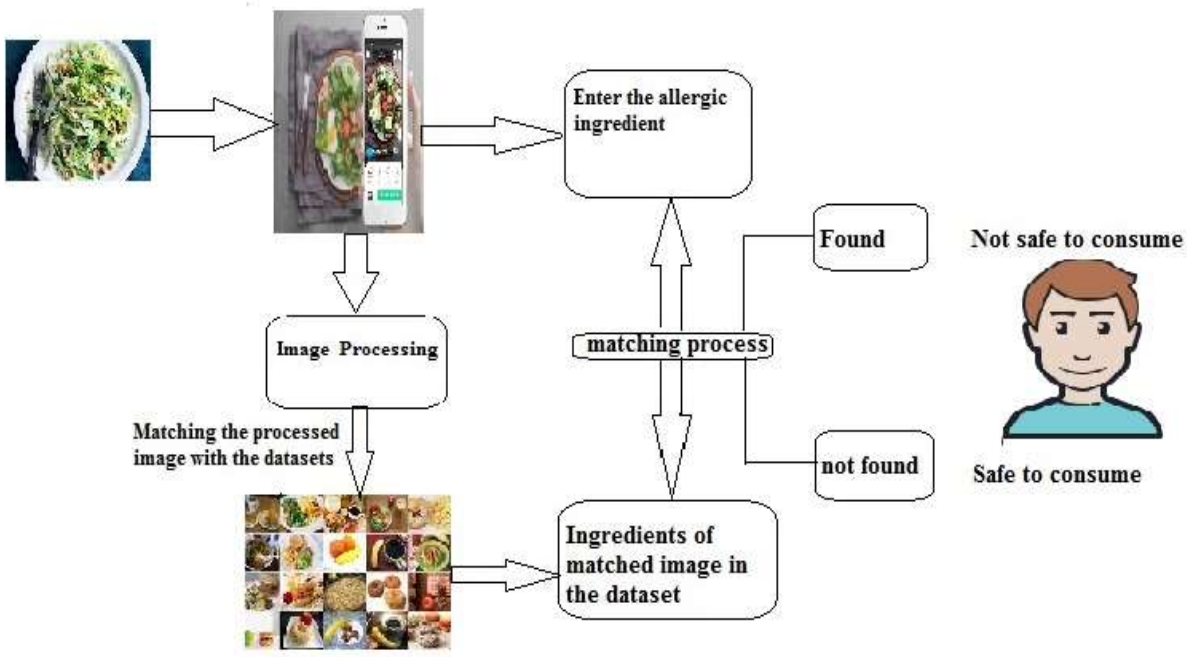

figure 3.2.1: system architecture

The system architecture includes graphical representation of concepts put together, which is a part of the architecture. It also includes principles and components. The system architecture of the proposed system is as shown in Figure 3.2.1.

The proposed system consists of the following Modules:

- The Camera API Module
- The Image Preprocessing Module
- The Dataset Analysis Module
- The Recognition and Output Module

3.2.2 Layered Architecture of Proposed System

An architecture in which data moves from one defined level of processing to another. Layered architecture patterns are n-tiered patterns where the components are organized in horizontal layers. This is the traditional method for designing most software and is meant to be self-independent. This means that all the components are interconnected but do not depend on each other.

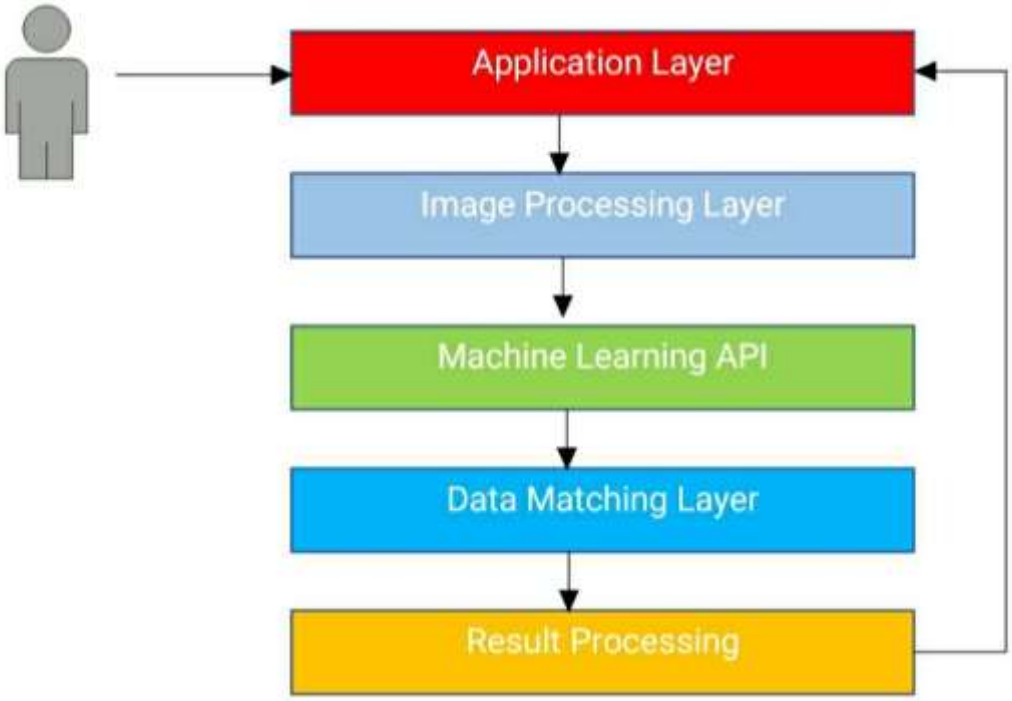

Figure 3.2.2 Layered Architecture

There are five layers in this architecture where each layer has a connection between modularity and component within them. From top to bottom, they are:

1. **Application Layer:**This is the initial layer where the process starts from this layer, the user inserts the ingredients which causes allergic symptoms so that it helps to recognize and give the result. The final result depends on this layer.
2. **Image Processing Layer:** In this layer, as we all know how image processing works so the given food will be captured by the android device. First the feature extraction is done then a model will be created. Further this created model goes under hypothesis formation such as candidate models and finally verification of the formatted model is done then this model will be sent to the next layer.
3. **Machine Learning API:** An application program interface (API) is a set of routine, protocols, and tools for building software applications. It enables to interact with current code snippet, interact with each other and of course interact with your user-base. This API will be connected to the android app by the best way to pull data from an API is by building a URL from existing API documentation.
4. **Data Matching Layer:** The created model which is sent from the image processing layer will be matched to the connected dataset to the android app. While matching process is done the confirmation of the object matched to the dataset will be verified.
5. **Result Processing:** Finally, after the verification of the matched dataset is done. By analyzing the verified process the result will be displayed in the form of a sentence. If the given food image is matched with given ingredient input is allergic then it displays as **"The given food is not safe to consume."** Else the given food is not matched with the given ingredient input then it displays as **"The given food is safe to consume."**Hence this is the result processing.

3.2.3 Tensor flow Architecture

The following diagram shows the architectural design of Tensor flow Lite:

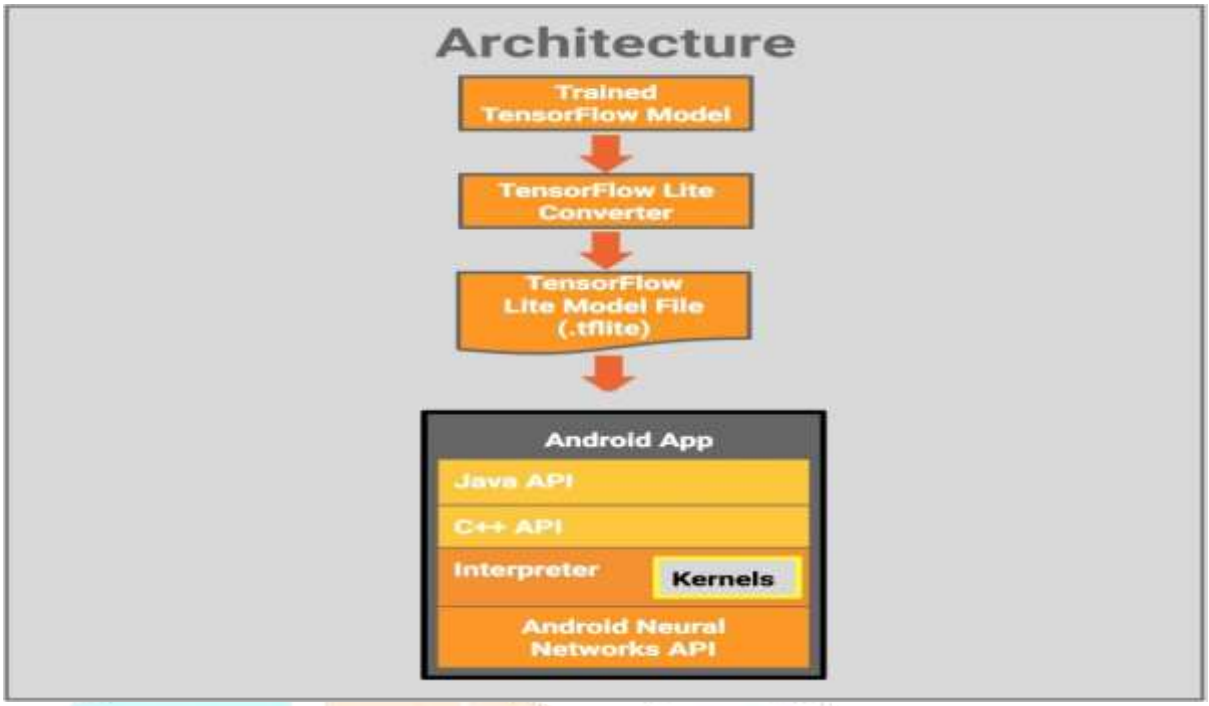

figure 3.2.3 tensorflow architecture

The individual components are:

- **TensorFlow Model:**A trained TensorFlow model saved on disk.
- **TensorFlow Lite Converter:** A program that converts the model to the Tensor Flow Lite file format.
- **TensorFlow Lite Model File:** A model file format based on FlatBuffers that has been optimized for maximum speed and minimum size.

The TensorFlow Lite Model File is then deployed within a Mobile App, where:

- **Java API**: A convenience wrapper around the c++ API on Android.
- **C++ API:** Loads the TensorFlow Lite Model File and invokes the interpreter. The same library is available on both Android and ios.
- **Interpreter:** Executes the model using a set of operators. The interpreter supports selective operator loading; without operations it is only 70KB, and 300KB with all the operators loaded. This is a significant reduction from the 1.5M required by TensorFlow Mobile.

3.2.4 Image Processing

An image is defined as an array of matrix of square pixels arranged in rows and columns. Image processing is a technique in which image is converted into digital form and performs some operations on that image to get helpful information. The process of analyzing digital image constitutes in the following phases

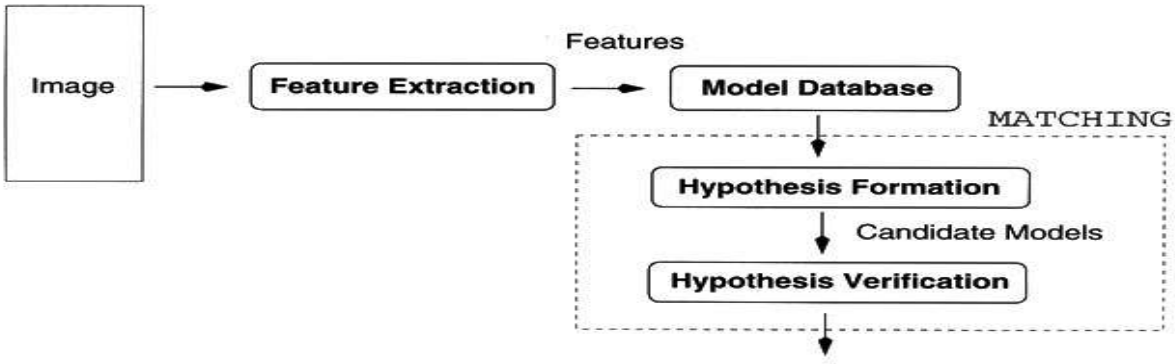

figure 3.2.4: image processing

1. **Image Acquisition:** This is the first step in image processing. Commonly this involves preprocessing such as scaling etc. The image can be taken as an input through scanner or digital camera. High resolution images helps in accurate image analysis.
2. **Feature extraction:** This step constitutes finding and extracting the features that can be used to determine the meaning of image. Features of an image are various attribute or characteristics of image field. Natural and artificial are the types of features. Visual appearance of an image followed in natural while artificial features is result from some manipulations of an image. Natural features include gray scale textural region, brightness of a region of pixel, edge outline of object etc. and artificial features include image amplitude histograms and special frequency spectra.
3. **Model database:** The output generated from the phase of feature extraction is compared with the database. The model database contains all the models known to the system. The information in the model database depends on the approach used for the recognition. It can vary from a qualitative or functional description to precise geometric surface information. In many cases, the models of objects are abstract

feature vectors, as discussed later in this section. A feature is some attribute of the object that is considered important in describing and recognizing the object in relation to other objects. Size, color, and shape are some commonly used features.

- **Hypothesis Formation:**The hypothesis formation step is basically a heuristic to reduce the size of the search space. This step uses knowledge of the application domain to assign some kind of probability or confidence measure to different objects in the domain. This measure reflects the likelihood of the presence of objects based on the detected features.
- **Hypothesis Verification:** How can object models be used to select the most likely object from the set of probable objects in a given image? The presence of each likely object can be verified by using their models. One must examine each plausible hypothesis to verify the presence of the object or ignore it. If the models are geometric , it is easy to precisely verify objects using camera location and other scene parameters. In other cases, it may not be possible to verify a hypothesis.

3.3 Low Level Design

Low Level Design (LLD) is a component-level design process that follows a step-by-step refinement process. This process can be used for designing data structure, required software architecture, source code and ultimately, performance algorithms.

3.3.1Use case diagram

Use case diagram is a graph of actors, a set of use cases enclosed by a system boundary, communication associations between the actor and the use case. The use case diagram describes how a system interacts with outside actors; each use case represents a piece of functionality that a system provides to its users. A use case is known as an ellipse containing the name of the use case and an actor is shown as a stick figure with the name of the actor below the figure.

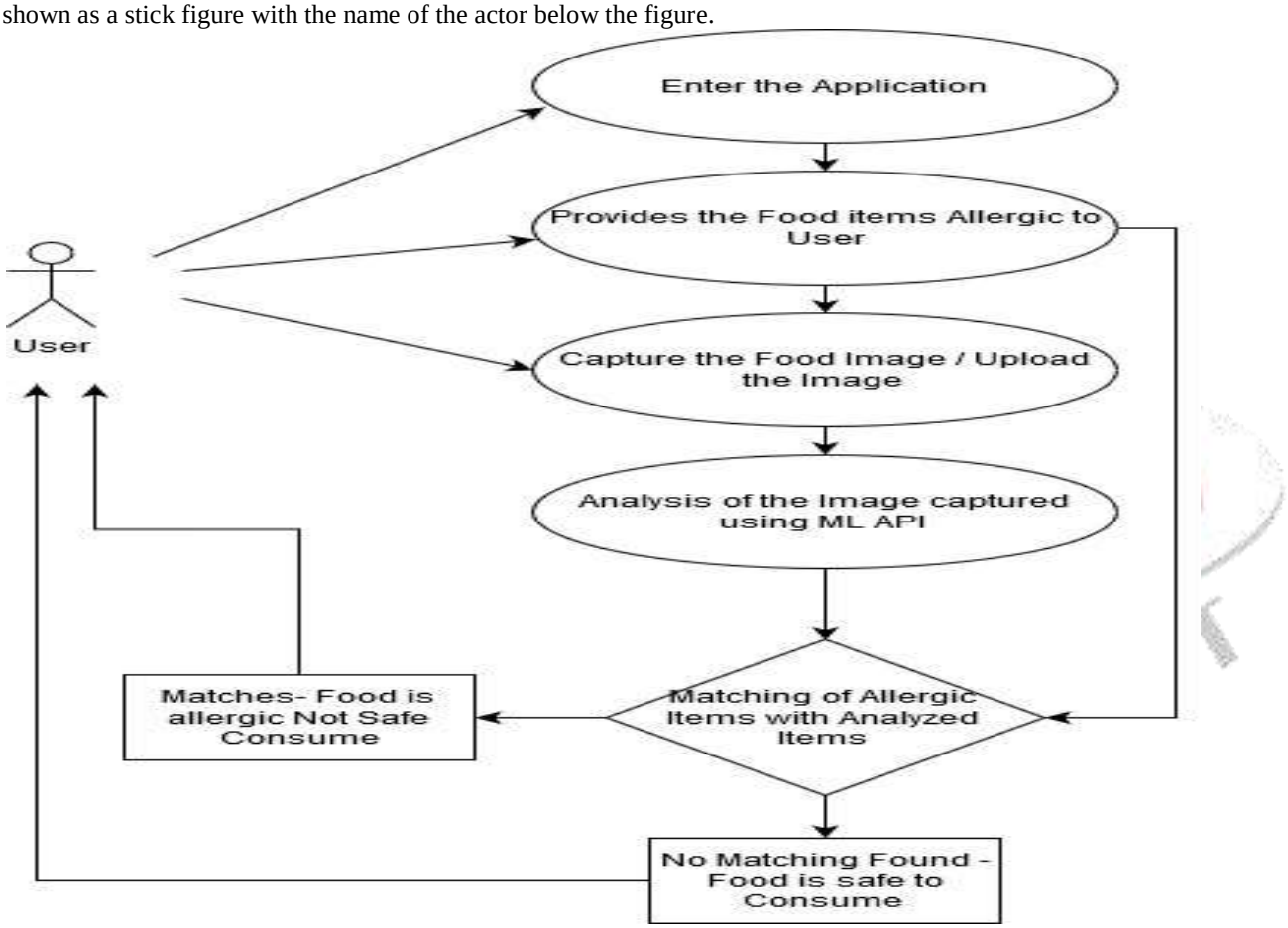

figure 3.3.1 use case diagram of user

The use case diagram in figure 3.3.1 describes the interaction of the user with the system. User once enter the application, he can take the picture of the food item or upload the image from the gallery. User can provide the food ingredient which are allergic to him. Analysis of the captured food image done through the machine learning API. If it is matched the allergic item with analyzed food item it will give a message to user that the food is not safe to consume.

3.3.2 Process Flow Diagram

A flow chart is a graphical or symbolic representation of a process. Each step in the process is represented by a different symbol and contains a short description of the process step. The flow chart symbols are linked together with arrows showing the process flow direction.The Process Flow chart provides a visual representation of the steps in a process. Flow charts are also referred to as Process Mapping or Flow Diagrams. Constructing a flow chart is often one of the first activities of a process improvement effort.

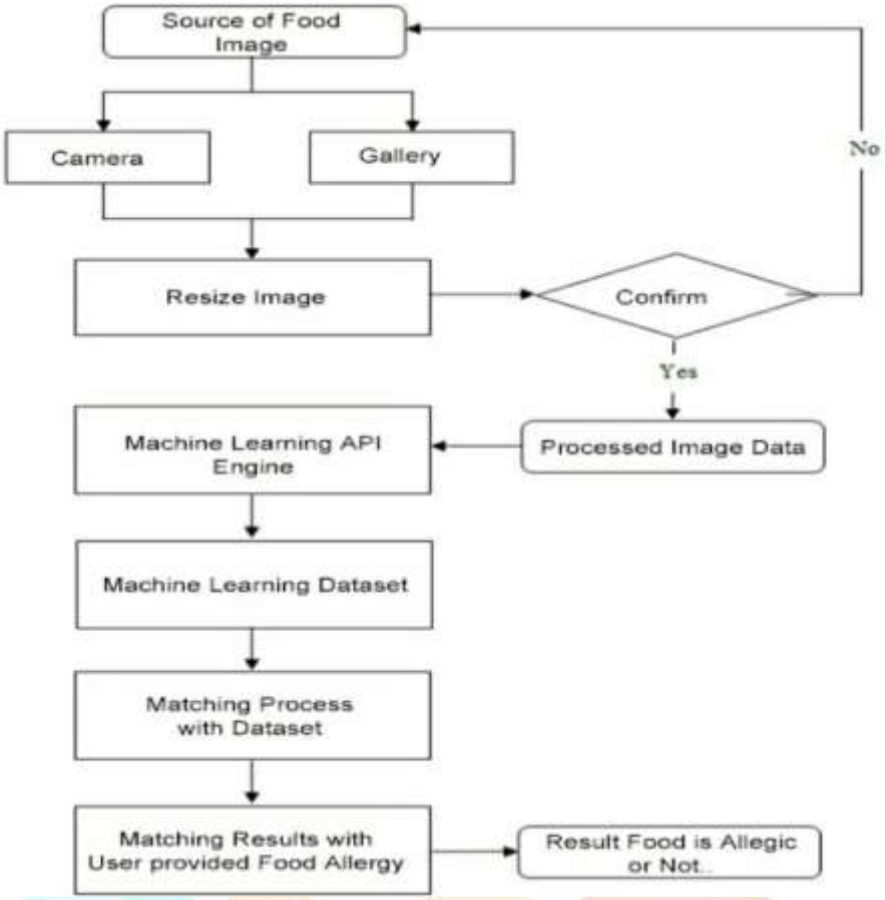

figure 3.3.2: process flow diagram

The process diagram in figure 3.3,2 describes the flow of our application. The user first capture the food item through camera api otherwise user can upload image from the gallery. After this image resizing will happen if the image captured is ok then send the image to next step of processing image data if it is no again user need to take the picture. After processing image data send to machine learning api it will identify food item and matching the analyzed food item data with the dataset food item. Finally output the result food is allergic or not.

4 CONCLUSIONS

Food is the basic necessity for all humans for survival. Some of the foods or some ingredients may cause allergy to our health. Most of the human population in the world are having some or the other food allergy. This application uses machine learning technique to identify the food and its composition (ingredients). Initially the user is provided to mention the foods items that are allergic to him/her. Once the food is recognized, the ingredients of the food is obtained. This process is done through image processing and machine learning technique. If the food ingredients are allergic to the user mentioned food items, this application will provide a message that this food is not safe to consume. So that the user can be saved from allergy caused by food.

This application will be able to identify the food and its composition (ingredients) before its consumption by the user and will provide the information about it which is safe or not for consumption. By the use of this application the users who are allergic and unknown about the composition of the food can be safe guarded from the allergies caused by the food products allergic to them.

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