**CHAPTER 6**

**SYSTEM IMPLEMENTATION**

System Implementation is the stage where the theoretical design is converted into a working system, the new system may be totally new, replacing an existing manual, or automated system or it may be a major modification to an existing system. The system is implemented using MATLAB and data set.

**MATLAB**

The name MATLAB stands for MATrix LABoratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATAB is a high-performance language for technical computing.

It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. MATLAB has many advantages compared to conventional computer languages (e.g., C, FORTRAN) for solving technical problems.

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. The software package has been commercially available since 1984 and is now considered as a standard tool at most universities and industries worldwide. MATLAB is a fourth-generation programming language and numerically analysis environment. Uses for MATLAB include matrix calculations, developing and running algorithms, creating user interfaces (UI) and data visualization. The multiparadigm numerical computing environment allows developers to interface with programs developed in different languages, which makes it possible to harness the unique strengths of each language for various purposes.

MATLAB is used by engineers and scientists in many fields such as the image and the signal processing, the communications, the smart grid design, robotics as well as computational finance. It has powerful built-in routines that enable a very wide variety of computations. It also has easy to use graphics commands that make the visualization of results immediately available. Specific applications are collected in packages referred to as toolbox. There are toolboxes for signal processing, symbolic computation, control theory, simulation, optimization, and several other fields of applied science and engineering.

**IP Webcam**

IP Webcam turns your phone into a network camera with multiple viewing options. View your camera on any platform with VLC player or web browser. Stream video inside Wi-Fi network without internet access.

IP Webcam offers a pretty straightforward and functional layout. The setup is very easy and there are a few options in the main menu, such as which camera to use, and whether sound will be streaming or not. IP Webcam is an Android app that lets you transform your phone into a network camera which will let you remotely view videos that are captured real-time.

**6.1 Methods for Fruit recognition**

**RGB**

It is also referred to as true color image which defines Red, Green and Blue color components for each individual pixel. This RGB array is of class double where each color component is a value between 0 and 1. This can be stored along the third dimension of data array.

**GLCM (Gray Level Co-occurrence Matrix)**

It is statistical method that examines the texture that considering the pairs of pixels with specific values. It mainly consists of statistic feature like contrast which measure the local variation, correlation which measure the joint probability, energy which provides the sum of squared elements and homogeneity which measures the closeness of the distribution.

**Color Histogram**

It controls the appearance and behavior of image. It converts color image into HSV image and preserves the hue and saturation components. The values are extracted and plotted in the graph. The intensity matrix is obtained from the HSI image matrix. This matrix is updated with histogram equalized intensity matrix.

**Color moments**

Color moments are very much useful for color indexing purposes. It considers only the first three color moments as feature in image retrieval applications. It can be used to compare the two images based on color.

**HOG feature**

The histogram of oriented gradients (HOG) is a feature used in vision and image processing for object detection. The image is divided into small connected regions called cells. Since it works on local cells, it is invariant to geometric transformations.

**HSV Feature**

The Hue Saturation Value (HSV) represents the color, dominance of color and brightness. Therefore, the color detection algorithm can be used to search in terms of color position and color purity. It is used to detect the pixels.

**SVM (Support Vector Machine)**

It is a supervised learning algorithm which can used for binary classification or regression. It is a coordinate of individual observations. It is based on decision planes which defines decision boundaries. It also separated the set of objects having different class. The system is built on two different environments namely using Real Time Fruit and Non-Real Time Fruit.

**KNN (K-Nearest Neighbor)**

Classification KNN is a nearest neighbor classification model where you can change both the distance matrix and the number of nearest neighbour. It stores training data, can use the model to compute the resubstitution prediction. This model can be convenient because training a classifier occurs in one step and classification in other steps.

**6.2 Procedure for Fruit Recognition**

Step 1: Start

Step 2: Input image

Step 3: Image pre-processing

Step 4: Segmentation

Step 5: Feature Extraction

Step 6: Training the SVM and KNN

Step 7: Submit the new Fruit images to the trained SVM, and predict the output

Step 8: Stop

**6.2.1 Procedure for Image Pre-Processing**

Step 1: Start

Step 2: Convert original image to grey scale

Step 3: Convert grey scale to binary image

Step 4: Stop

**6.2.2 Procedure for SVM**

Step 1: Set up training data.

Step 2: Set up SVM’s parameter such as the type of SVM

Step 3: Train the SVM.

Step 4: Regions classified by the SVM.

Step 5: Support vector

**6.2.3 Procedure for KNN**

Step 1: Set up training data.

Step 2: Set up KNN’s termination criteria of the algorithm etc.

Step 3: Load the data

Step 4: Initialize the value of k

Step 5: For getting the predicted class, iterate from 1 to total number of training data points

1. Calculate the distance between test data and each row of training data. Here we will use Euclidean distance as our distance metric since it’s the most popular method. The other metrics that can be used are Chebyshev, cosine, etc.

2. Sort the calculated distance in ascending order based on distance values

3. Get top k rows from the sorted array

4. Get the most frequent class of these rows

5. Return the predicted class

Step 6: Train the KNN.

Step 7: Regions classified by the KNN.

Step 8: Support vector

**6.2.4 Procedure for Fruit Recognition in Non-Realtime**

Step 1: Start

Step 2: Train the dataset by selecting feature extraction option.

Step 3: Browse the image from dataset for testing.

Step 4: Then

Select Pre-processing button to perform preprocessing of the selected fruit image.

Step 5: Then

Select Segmentation button to perform Segmentation of the selected fruit image.

Step 6: Then

Select Feature Extraction button to perform Extraction of features of the selected fruit image.

Step 7: if button is equal to SVM then

SVM algorithm is used for recognition.

Step 8: if button is equal to KNN then

KNN algorithm is used for recognition.

Step 9: End.

**6.2.5 Procedure for Fruit Recognition in Realtime**

Step 1: Start

Step 2: If Camera is ON Then

Capture the fruit image then

Pre-processing of captured fruit image, then

Segmentation of captured fruit image, then

Feature Extraction of captured fruit image

Step 3: if option is equal to SVM then

SVM algorithm is used for recognition.

Step 4: if option is equal to ROC then

Graph with precision-recall is displayed

Step 5: End

**6.2.6 Procedure for Multi-Fruit Recognition in Realtime**

Step 1: Start

Step 2: If Camera is ON Then

Capture the fruit image then

Crop the single fruit image, then

Pre-processing of captured fruit image, then

Segmentation of captured fruit image, then

Feature Extraction of captured fruit image

Step 3: if option is equal to SVM then

SVM algorithm is used for recognition.

Step 4: End

**6.3 Flowchart for Fruit Recognition using Image Processing**

User Interface

Options

Preprocessing

Feature Extraction

Segmentation

Capture fruit image

Select image

Train captured dataset

Train Dataset

Real Time

Non-Real Time

Display Fruit Name

KNN

SVM

Recognition

***Figure 6.3:*** *Flowchart for Fruit Recognition using Image processing*

A system flowchart symbolically shows how data flows throughout a system and how event controlling decisions are made. Initially the image is input, and the pre-processing of the input image takes place followed by segmentation. Later the images are classified according to their extracted feature. Finally, the name of the fruit is detected. The steps involved are shown in figure 6.3.