AROGYA - AN INTELLIGENT AYURVEDIC HERB MANAGEMENT PLATFORM

Object Detection and Segmentation of an Image

2020-112

Project Proposal Report

(R.A.M.Nithmali)

Bachelor of Science Special (Honors) Degree in In Information Technology

Department of Software Engineering

Sri Lanka Institute of Information Technology
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DECLARATION

We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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ABSTRACT

Herbal plants are used widely in local medication. But now a day, an ordinary person has little knowledge about those herbs and he may not identify such herbals easily. And some people want to recognize approximately more info of the plants and some human beings has expert know-how about plants. They need to proportion their understanding about plants with others who preference to know about them. So that sort of people like a social medial platform which only allows to percentage Ayurvedic plants associated things. Arogya is an intelligent ayurvedic herb management platform for identifying plant species using automatic visual recognition. The app identifies the plant from photograph of its leaf, flower, fruit or combinations of them. To identify a particular plant accurately, the very first step is that detecting the objects (leaf, fruit, and flower) correctly even if it is in the complex background. As a first step of computer based recognition of herbs, an analysis has been made to identify the best method for segmenting object from its background. Several image segmentation techniques are available for detecting the objects based on global and local features of an image. And also object detection is done in real time. When user captures an image with complex background, existing several applications failed to accurately identify the particular objects. Thus, the end result will be inaccurate and those applications take much time for detecting objects when the objects are in complex background. And also they failed to identify overlapping objects so that gives the end result inaccurately. Thus, we experiment selected segmentation technologies such as a color image segmentation method of automatic seed region growing on basis of the region with the combination of the watershed segmentation, Mask RCNN and Fuzzy c- means as methodologies in order to select the best segmentation approach to our proposed application.

Keywords: object detection, Image segmentation, Computer vision, Watershed, Mask RCNN, Region based, Fuzzy c-means, clustering, threshold, and edge based

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ConvNet – Convolutional neural network

RCNN – Region Convolutional Neural Network

1. INTRODUCTION

1.1 Background

Ayurveda is an ancient medicine that appeared for the first time around 5000years ago. It's in fact some of world's oldest health systems and it has a proven beneficial effect on many health problems. It has helped many people achieve better physical and mental health and overcome some serious health problems. There are masses of benefits of the usage of Ayurveda in preference to the use of western medicines. Some of them are completely natural, Positive influence on mental health, prevent inflammations, boosts the metabolism and thus helps us slim down, more affordable and so on. Specially, Sri Lanka is well self-sufficient country with ayurvedic plants.

But, past 200 years of human activities have led to the extinction of hundreds of species of plants. It is important to shield the variety of plants. The identification of the plant species is the most important step for further protection. However, most of the existing identification methods mainly rely on scientist or specialized knowledge. Thus, an automatic plant species identification system is desired. With the attention of geometric distribution of plants, the identification system based on mobile devices has attracted a lot of attention. Kumar et al. [8] designed the first mobile application for plant species identification, namely Leafsnap.

The manufacturing and marketing of Ayurvedic drugs has become a thriving industry. This commercialization of Ayurvedic sector has brought in to focus several questions regarding the quality of raw materials used for Ayurvedic medicines. Today the plants are collected by women and children from forest areas; those are not professionally trained in identifying correct medicinal plants. Manufacturing units often receive incorrect or substituted medicinal plants. Most of these units lack adequate quality control mechanisms to screen these plants. In addition to this, confusion due to variations in local name is also rampant. Some plants arrive in dried form and this make the manual identification task much more difficult. Incorrect use of medicinal plants makes the Ayurvedic medicine ineffective. It may produce unpredictable side effects also. In this situation, strict measures for quality control must be enforced on Ayurvedic medicines and raw materials used by the industry in order to sustain the present growth of industry by maintaining the efficacy and credibility of medicines
[9].

Type of Material	No. of Materials	Percentage (%)	Total Quantity (10^3 kg)	Total Value (10^3 Rs.)
Dry plant materials	325	65.92	1,857.37	509,221.51
Fresh plant materials	64	12.98	840.99	70,761.96
Minerals	75	15.21	26.40	28,292.90
Animal	12	2.44	72.35	49,982.99
Marine	7	1.42	1.30	195.00
Other	10	2.03	58.15	12,308.17
Total	**493**	**100**	**2,856.56**	**670,762.53**

Figure 1.1.1 - Summary of current usage of medicinal materials

Above figure 1.1 depicts Information on the medicinal plants used in Sri Lanka during January to April 2013 [11]. So it shows how much volume that Sri Lankan people is used Ayurvedic medicines. So correctly identification of Ayurvedic plants is much important. Because some plants have similar features. In order to identify the plant accurately, first we should detect the object accurately.

There are some mobile applications which need details of the leaf, flower and its fruits to identify the plant. In that case user has to manually enter or select the all details of the plant to identify the plant and sometimes it shows the list of suggested plants without giving the exact plant. So it was time consuming. And also there are several applications, user has to take an image in front of a white or non-texture background. It will make some difficulties to the user because at that time user will not be able to find that kind of place. Therefore, it reduces the usability of the application also.

To overcome all above issues, object detection and classification comes into the picture. Using automatic visual recognitions techniques, we can identify plants within few seconds. It reduces waste of time. However to identify the plant, object (leaf, flower or fruit) detection should be done accurately. Shape is the most distinctive individual characteristic of an object. And also it takes prominent role in plant identification. Our application needs a far more granular understanding of the leaf, fruit or flower. We can achieve it using image segmentation techniques [12]. There are several image segmentation techniques are available. Among all of them, we selected some image segmentation techniques. Because rather directly applying a segmentation technique, we are going to experiment different techniques and going to select the best segmentation approach to our proposed application. We are going to measure all selected techniques' accuracy and performance and then select the best one from comparing the final output. Accurately identifying the objects increase our application performance, accuracy and user satisfaction.

1.2 Literature Review

Biodiversity is declining steadily throughout the world [1]. The current rate of extinction is largely the result of direct and indirect human activities [2]. Building accurate knowledge of the identity and the geographic distribution of plants is essential for future biodiversity conservation [3]. Therefore, rapid and accurate plant identification is essential for effective study and management of biodiversity

In a manually identification process, botanist use distinctive plant characteristics as identity keys, which might be used sequentially and adaptively to discover plant species. In essence, a person of an identification key's answering a chain of questions about one or more attributes of an unknown plant continuously focusing at the most discriminating traits and narrowing down the set of candidate species. This series of answered questions leads ultimately to the desired species. However, the determination of plant species requires a tremendous botanical expertise. Sometimes botanists themselves species identification is often a tough task. The situation is further exacerbated by means of the increasing scarcity of professional taxonomists [4]. The declining and partially nonexistent taxonomic knowledge within the standard public has been termed “taxonomic crisis” [5].And other hand, it decreases user satisfaction about the application. Because these applications allow users to identify the plant using traits such as flower structure, leaf shape, flower color or fruit color.

Sometimes users would not prefer to go several steps to identify the plant.

To overcome these issues, we are going to use object detections methods. So that user would not be unsatisfied about the product because user just has to take an image of a picture. After capturing the image, using image segmentation we can detect the object with its shape, color and with other features. Because our application gives deepest attention to identify the objects (leaf, fruit or flower) accurately reason is why identifying objects correctly increases the application accuracy, performance and user satisfaction. Otherwise, it will give incorrect results at the end.

Shape is the most popular feature used in plant identification, be it manual or automatic plant identification [6].So that we are going to use image segmentation techniques rather than using object detection technique. The reason is that Object detection [7] builds a bounding box corresponding to each class in the image. But it tells us nothing about the

shape of the object. But image segmentation creates a pixelwise mask for each object in the image. This technique gives us a far more granular understanding of the object(s) in the image. So we can get clear idea of the shape of leaf, flower and etc.

Researchers have devised and proposed many techniques for segmentation but no general technique exists, which may be used for all images. However, Keri Wood [17] suggested that good image segmentation need to meet the subsequent requirements:

1. Every pixel in the image must belong to a place and each place must be homogeneous with admire to a chosen feature, which might be syntactic e.g. color, depth or texture or the function primarily based on semantic interpretation.

2. Every region have to be linked and non- overlapping i.e. any pixels in a selected region need to be connected by a line that does depart the region.

3. It should not be viable to merge two adjoining regions to shape a single homogeneous region.

These characteristics also include in our segmentation process in order to get successful results.

"Color images can increase the quality of segmentation but complexity of the problem is also increased" [51]". Segmentation of a colored image having different varieties of texture areas is a difficult problem, in particular if an exact texture subject is to be computed and a choice is to be made regarding optimum number of segments in the image. The problem will become further complicated if the image includes similar and/or "non-stationary texture fields. Each pixel of colored images is depicted using three component values that is red, green and blue and as such these are more complex as a long way as segmentation is concerned, than gray scale images which have a single intensity value for a pixel. Colored image segmentation can clear up many issues in medical imaging, bioinformatics, and material sciences [6]. It leads to lost lots of information of the leaf, flower or fruits. The lots of existing plant identifications applications regenerate the user entered pictures into greyscale images due to complexness of the color images. It results in lost voluminous info of the leaf, flower or fruits.

K.Deepak and A.N.Vinoth proposed to develop an application to identify plant species on android platform [13]. They used edge detection as there segmentation technique. This proposed method contain several major drawbacks. It converts the image into gray scale image. It ends with lost plenty of information approximately the detected object.

It will be a major disadvantage when the detected object goes to classification model. And also in order to use this technique, there should be better contrast between objects. Otherwise, this technique isn't going to work and it doesn't detect the object accurately. It leads the application failed among the users. This indicates how the importance of detecting object accurately.

Lin-Hai Ma, Zhong-Qiu Zhao and Jing Wang designed plant identification system called APLeafis [14].They used threshold segmentation for the segmentation process. It is the simplest segmentation method. This application contains several drawbacks. In this application, one leaf image can be either a digital image from the existing leaf image database or a picture collected by a camera. The picture should be a single leaf placed on a light and untextured background without other clutter. Those facts reduce the user satisfaction because before taking a picture, user has to make the background that they mentioned about otherwise this application not going to detect the particular leaf from the image. If the application doesn't select it accurately other all processing things are not going to work. The application is failed. Because now a days, modern people always do and buy things which their lives make easier.

Desta Sandya Prasvita and Yeni Herdiyeni proposed MedLeaf as a new mobile application for medicinal plants identification based on a leaf image [15]. Neeraj Kumar, Peter N. Belhumeur, Arijit Biswas and David W. Jacobs proposed a system called Leafsnap which is a mobile app that helps users identify trees from photographs of their leaves [16].Above two authors proposed systems they identify the plant only using the leaf. The major drawback of that kind of system is that sometimes some leaves have similar features but they are different plants. Because Ayurvedic plants are used by people as their medicine. Thus, it affects to human health also. We have to identify those plants separately. So that our proposed system detect not only leaf but also flower and fruit also. It leads to get best accurate result.

As mentioned above several problems occur when detecting the objects (leaf, flower or fruit).Therefore our proposed method is going to use the most suitable image segmentation

techniques to detect the objects even if the image background is complex. In computer vision, we cannot directly apply an algorithm by believing that matches well with our application. We have to do several experiments and get outputs of those and then we should perform some evaluations on final outcomes to select best approach.

1.3 Research Gap

Currently there is no existing system which identify the objects (leaf, fruit or flower) if they are in a complex background. Although there are several systems available to detect the objects (leaf, flower or fruit), detection of them in a complex background is questionable. Some of the existing system takes much time for processing the result. That frustrates the user, if the app takes much time to load the results. However, some existing applications will not be capable of detecting the objects of the captured photograph of the plant contains multiple leaves. Therefore, those applications give instructions to user to place a single leaf on a light and untextured background without other clutter. At the moment user just wants to capture an image and get the result of the application, but if the applications give those kind of instruction user might be frustrated. Moreover, there are several existing systems which can identify the plant correctly, but the user has to take the leaf in front of the white background. Assume at the instance, user will not be able to find that kind of background and he or she just needs to know about the plant. Thus, those sort of applications, frustrate the user and the user will uninstalled the application because it clearly doesn't assist the user when the user wants it. It leads to failed whole product also. When user capture an image with overlap leaves, existing methods are not going to work and show wrong result at the end reason is why at the begging those applications will not be capable of detecting the objects accurately. Existing Systems used threshold, edge detection techniques for segmentation process in their applications. Those are simplest techniques that will not work above given situations. Accurately identifying the object is more important because classification and other processing things are going to use segmented object result. Thus, we can get granular idea how much of an impact that system has, if it doesn't identify the object correctly. Several current applications identify the plant only using plant's leaf, thus they only detect the leaf as their object. Sometime only detecting the leaf is not sufficient because in the classification phase if this segmented object matches to several plants, there may be no manner to identify the exact plant accurately.

References	Identify th e objects in a simple background	Identify th e objects in a complex background	Accuracy and performance	Experiment several segmentation techniques to select the best approach

Neeraj Kumar, Peter N Belhumeur, Arijit Biswas,David W Jacobs, W John Kress, Ida C Lopez, João VB Soares, "Leafsnap: A computer vision system for automatic plant species identification" [16]	✓	✗	Medium	✗
K.Deepak, A.N.Vinoth," Leaf Detection Application For Android Operating System "[13]	✓	✗	Low	✗
Research Gate, "MedLeaf: Mobile Application For Medicinal Plant Identification Based on Leaf Image" [15].	✓	✗	Low	✗

Arogya our proposed System	✓	✓	✓	✓

Table 2.2 .1: Comparing with existing system

1.4. Research Problem

As a solution to the plant identification, we can use any of the plant identifications systems available. However, none of these systems present a reliable, accurate and a high performance way to identify objects in a complex background. Existing systems works well when the object placed in a simple, light background. Moreover, most of the available systems have low accuracy. So, finding a way to optimize the results is more important

But the real problem occurs when it comes to segmentation process. Detecting objects are difficult when the background and the objects do not have better contrast between them. Thresholding and edge based are segmentation techniques which identify the objects using the contrast between them. As an example, they convert the whole image into grayscale image and then check the difference of grey color values. If the image has significant contrast among the foreground and background, the techniques identify edges of the objects. But if not it is not going to detect the edges, Thus it change the segmented object shape. Shape is the most popular feature used in plant identification [6]. The segmented object is wrong. Thus, Final outcomes accuracy is much low.

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2. OBJECTIVES

2.1 Main Objective

1.Selecting the most accurate and the highest performance segmentation technique using the experimental outcomes.

2.2 Specific Objectives

2.2.1 Detection of objects using image segmentation techniques

In order to detect any object in an image, we can either use object detection technique or image segmentation technique. Among those two categories, we selected the image segmentation because object detection builds a bounding box corresponding to each class in the image. But it tells us nothing about the shape of the object. We only get the set of bounding box coordinates. We want to get more information because shape of the object takes prominent role in our application. Thus, Image segmentation creates a pixel-wise mask for each object in the image. This technique gives us a far more granular understanding of the object(s) in the image.

2.2.2 Comparing and analyzing selected segmentation techniques

The results of the sensors will be analyzed against the results generated by the visionbased approach. By doing so, an addition confirmation can be given to the final output. Moreover, this enables the facility to identity metal items of any shape which is a major drawback in vision-based approach.

2.2.3 Remove the segmented object from the background

When segmentation process is done, object will be removed. It will be used for further processing in classification part.

2.2.4 Measure the accuracy and the performance of selected segmentation techniques.

Final outcomes of all segmented techniques are compared and accuracy and performance will be measured

2.2.4 Select best segmentation approach from experimental outcomes In this phase, most accurate and best performance approach will be selected to apply to our proposed system.

Final outcomes of all segmented techniques are compared and accuracy and performance will be measured.

3. METHODOLOGY

3.1 System Diagram

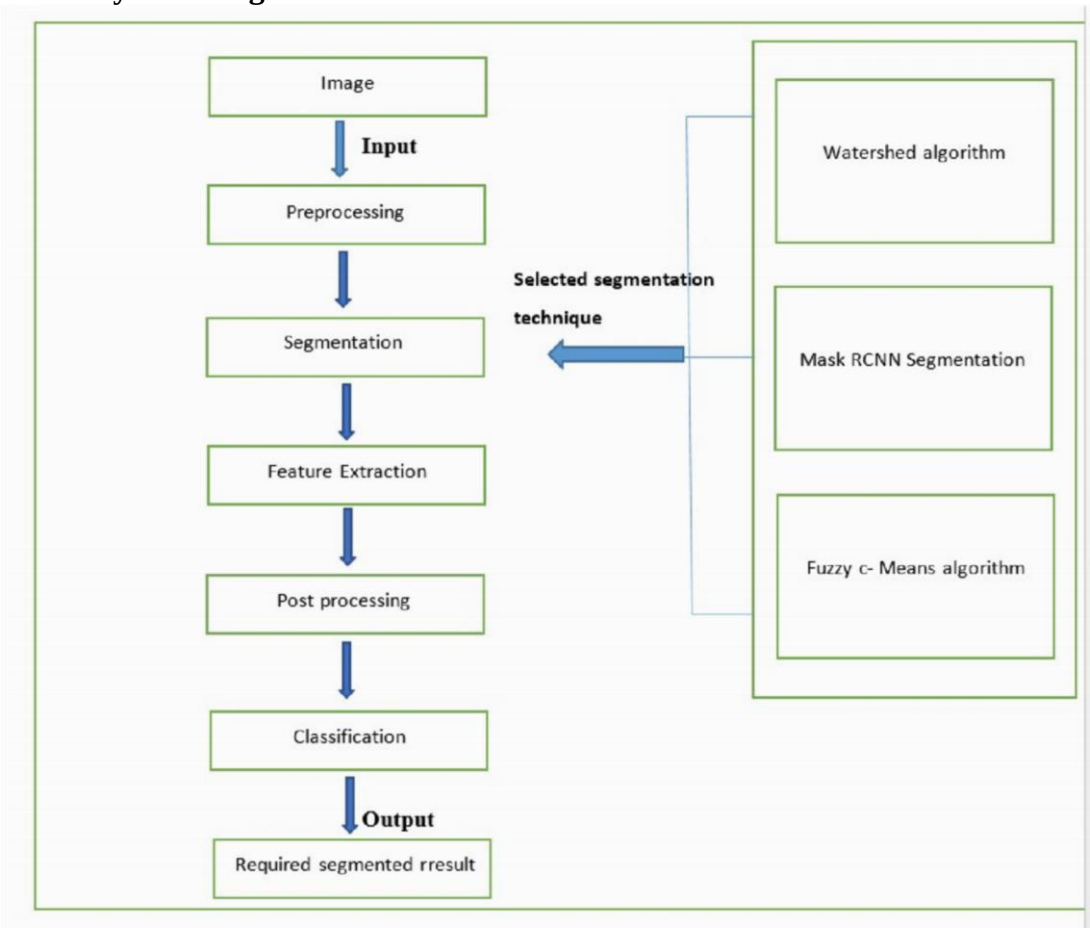

Figure 3.1 - System diagram

Main research area of this component is selecting the best segmentation technique among other noval segmentation technique in order to increase the proposed methods accuracy and performance. We selected watershed algorithm, Mask RCNN and watershed algorithm to perform the segmentation task rather than directly selecting one approach.

3.1.1 Approach 1: A color image segmentation method of automatic seed region growing on basis of the region with the combination of the watershed algorithm. Our expectation is to build a segmentation process that can detect the leaf, fruit or flower even if it is in the complex background. And also we are not going convert image into a grayscale image reason is that it leads to lost the most important information about the

detected objects. This provides a complementary approach to the segmentation of objects. It is especially useful for segmenting objects that are touching one another. But if we use directly watershed algorithm, it views only a grayscale image as a topological surface. Thus, we use our proposed approach 1 mentioned above as our first segmentation process.

Figure 3.1.1.1 – Capturing overlaps leaves for segmentation

Lots of existing application has a major drawback of segmenting that kind of user captured images. When image with overlapping leaves, there segmentation process didn't work. At the end, it produced the wrong result because at the begging they didn't correctly identify the objects. So our proposed method overcome this issue as well.

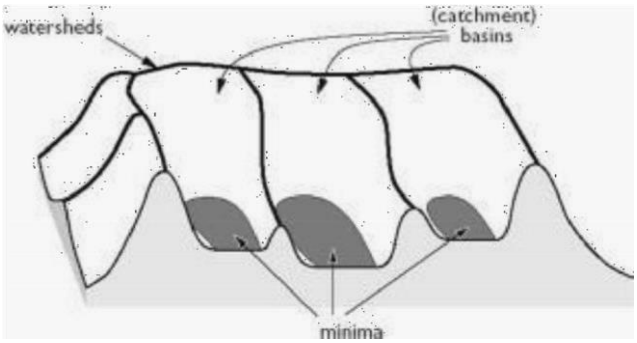

Figure 3.1.1.2 – An overview of watershed segmentation

The flow chart for the algorithm as shown

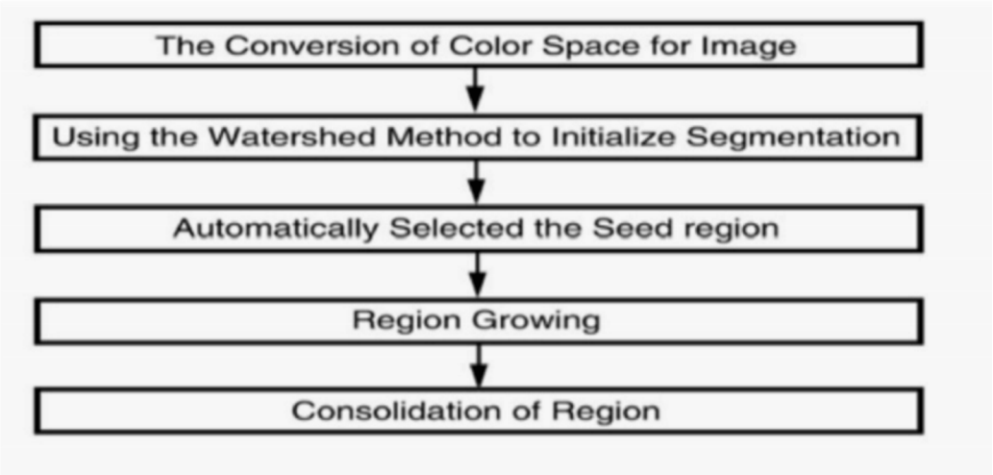

Figure 3.1.1.3 –Flow of watershed segmentation

3.1.2: Approach 2: Mask RCNN (Mask Convolutional Neural Network)

Mask RCNN [18] presents a conceptually simple, flexible, and general framework for object instance segmentation. This approach 2 efficiently detects objects in an image while simultaneously generating a high-quality segmentation mask for each instance. The method, called Mask R-CNN, extends Faster R-CNN by adding a branch for predicting an object mask in parallel with the existing branch for bounding box recognition. Mask R-CNN is simple to train and adds only a small overhead to Faster R-CNN, running at 5 fps.

The fact which we proposed this technique is that the network with the Mask R-

CNN architecture makes possible to select the outlines (“masks”) of different objects in photographs, even if there are several such instances, they have different sizes and partially overlap. The network is also capable of recognizing the poses of objects in an image.

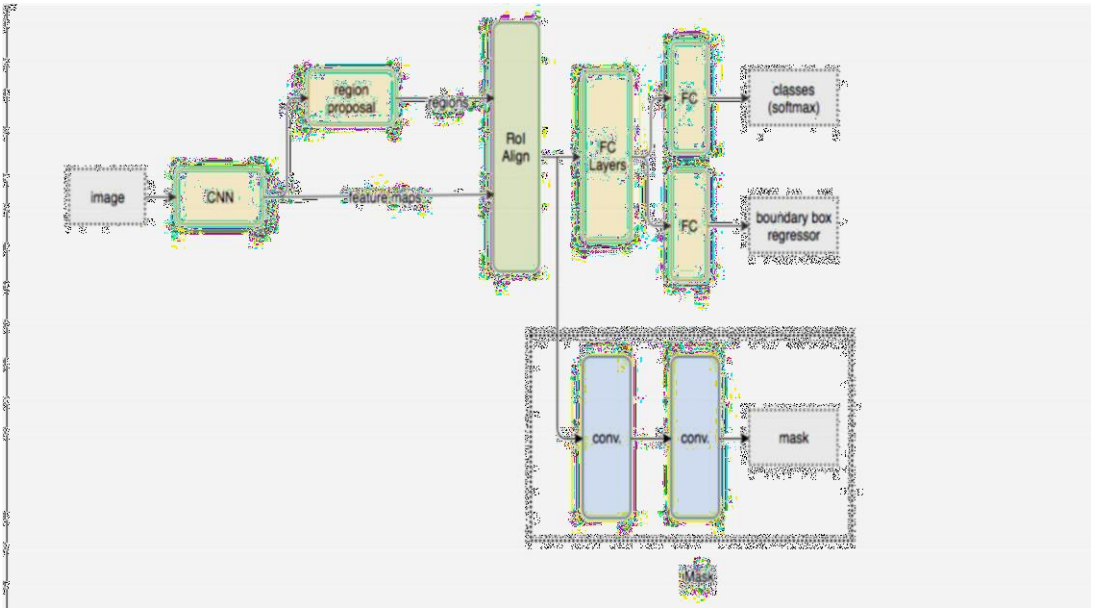

Figure 3.1.2.1 – An overview of Mask RCNN segmentation

Main steps of approach 2:

1) We take an picture as enter and pass it to the ConvNet, which returns the feature map for that picture

2) Region proposal network (RPN) is carried out on these feature maps. This returns the object proposals along with their objectness score. 3) A RoI pooling layer is applied on these proposals to bring down all the proposals to the equal size.

4)Finally, the proposals are passed to a totally connected layer to classify and output the bounding boxes for objects. It also returns the mask for each proposal.

3.1.3 Approach 3: Fuzzy c means clustering algorithm

Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. FCM is the advanced version of K-means clustering algorithm and doing more work than K-means. This algorithm best result for overlapped data set and comparatively better than k-means algorithm. Unlike k-means where data point must exclusively belong to one cluster center here data point is assigned membership to each cluster center as a result of which data point may belong to more than one cluster center.

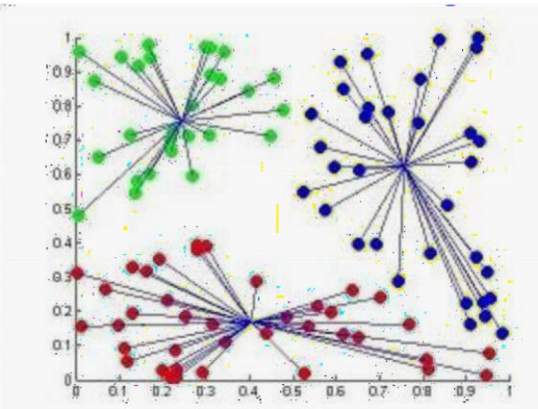

Figure 3.1.3.1 – Fuzzy c-means clustering algorithm

Main steps of approach 3:

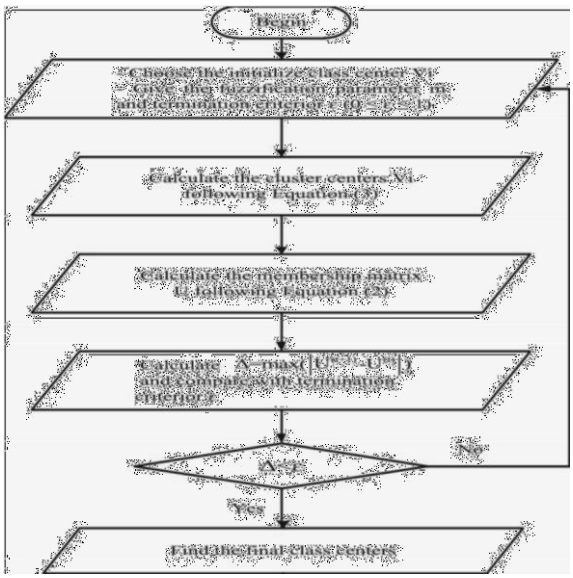

Figure 3.1.3.2 – Fuzzy c-means clustering algorithm steps

After applying these segmentation techniques, background will be removed. Segmented result will be sent to the classification model. Our proposed method is not just find objects in light and untextured background but also it finds the objects even if they are in a complex background. And it would be done with high accuracy and best performance.

4. DESCRIPTION OF PERSONAL AND FACILITIES

Member	Component	Task
R.A.M.Nithmali	Selecting the most accurate and the highest performance segmentation technique using experimental outcomes of plants in Sri Lanka	• Detection of leaf, fruit and flower objects using watershed, Mask RCNN and Fuzzy means segmentation techniques. • Comparing results generated from selected segmentation techniques. • Objects will be removed from the background, after segmenting process completes.
		□ Measuring the accuracy and the performance of each selected techniques and best approach will be selected using experimental outcomes

.

Table 4.1 – Description of Personal and Facilities

5. FUNCTIONAL REQUIREMENTS AND USER REQUIREMENTS

Functional	Non-Functional
• Select the most accurate and the highest performance segmentation technique using the experimental outcomes. • Compare accuracy of selected Segmentations techniques' end results. • Compare performance of selected segmentations techniques' end results. Request to re-train the existing model with new datasets by premium uses	• Application should be able to detect the objects as fast as possible. • Higher accuracy required. • Higher performance required. Interfaces should be user friendly.

6. Gantt Chart

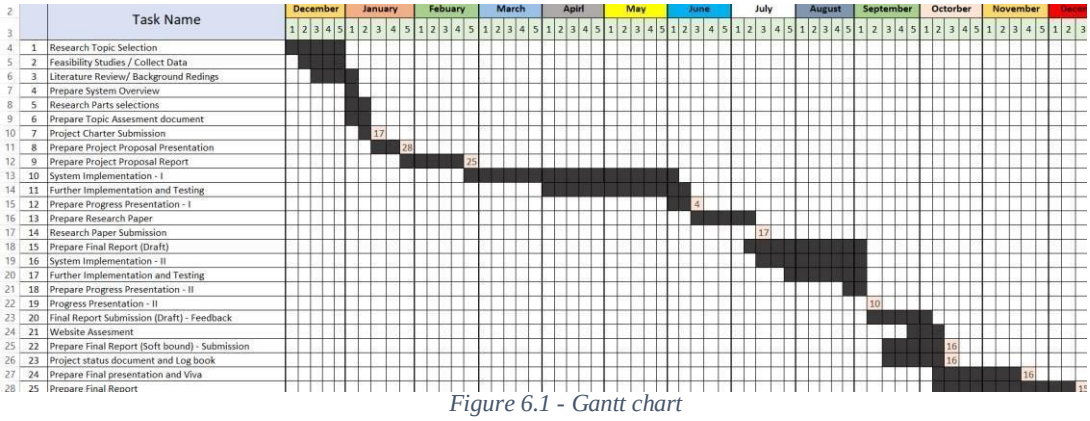

Figure 6.1 - Gantt chart

7. Work Breakdown Structure

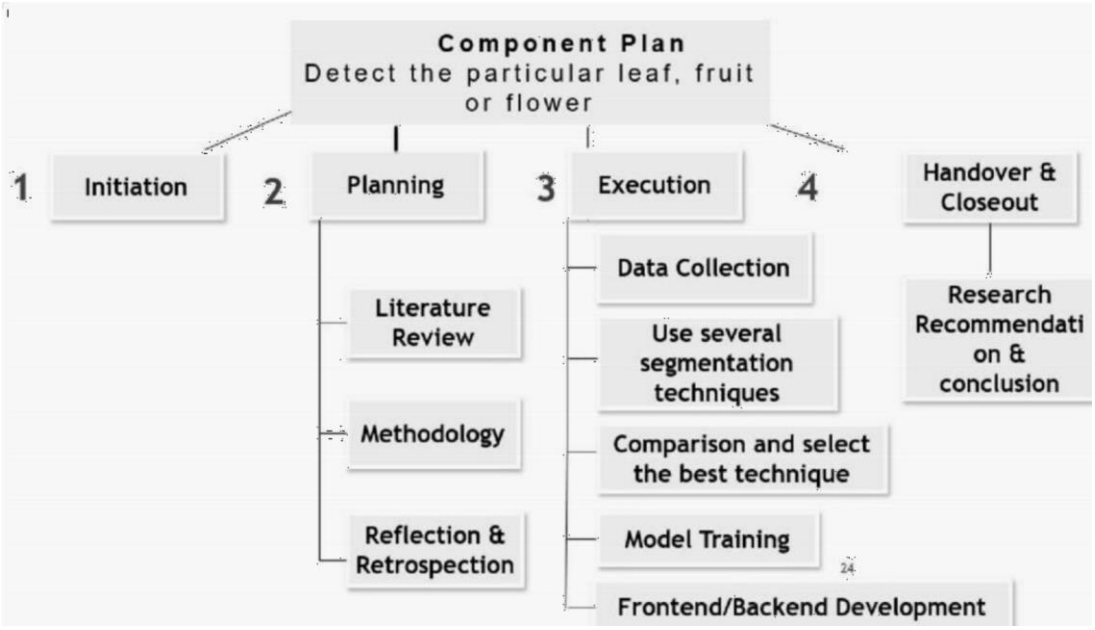

Figure 7.1 - Work Breakdown Structure

8. Budget and Cost Estimation

Data collection travelling charges	6,000
Internet Data charges	22,000
Total Expenses:	
Target Budget	28,000

Table 8.1- Budget and Cost Estimation

9. COMMERCIALIZATION

9.1 Target Audience

- People who use ayurvedic treatment
- Researchers in the field of botany, medicine, chemical structure analysis, agriculture, ayurvedic medicinal practitioners, forest department officials, individuals who are involved in the preparation of ayurvedic medicines and others who are concerned with plant studies
- Doctors, Students, locals and foreigners
- Ayurvedic plant sellers

9.2 Market Space

- No age limitations for the users
- No need of advance computer literacy
- No need of advance knowledge in Ayurveda field

9.3 Revenue Earning

- Through subscription fee
- Revenue via additional services

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