Automation for Indian Agricultural to analyze fitness and life-cycle of crops using drones

Eshan Dutta, Santosh Mahato
Dinesh M
Christ (Deemed to be University)
Faculty of Engineering
Dept. of Computer Science and Engineering
Bangalore-560060, India
Email:santosh.mahato@btech.christuniversity.in

Prof. Mahesh D. S
Christ (Deemed to be University)
Faculty of Engineering
Dept. of Computer Science and Engineering
Bangalore-560060, India.
Email:mahesh.ds@christuniversity.in

Abstract- This paper presents a study on the image processing techniques used to identify and classify various diseases that affect crops. Images captured using drone surveillance is processed using various image-processing techniques SIFT (Scale-Invariant Feature Transform), Edge Detection are few algorithms used to analyze plants disease. There is a steady decline in the agricultural production due to plant infestation and diseases. Many diseases exhibit symptoms that are caused by different pathogens produced by leaves, roots etc. Symptoms often do not possess enough details to assist farmers to diagnose the disease resulting in misshaping of the plant life cycle. Farmers experience great difficulties in controlling diseases that spreads abnormally, this leads to intensive use of pesticides causing incorrect diagnosis. Farmers are also concerned about huge costs involved in these activities and bear the severe loss. However, if these symptoms are identified in their early stages it can help farmers cut cost and increase the life cycle of crops. Early detection is a major challenge in agricultural science. Development of proper methodology is certainly of use in this area. Crops diseases are caused by bacteria, fungi, nematodes etc. of which fungi are the main cause of the disease. The present study is focused on early detection and classification of the diseases to help farmers improve the quality of crops and enhance the growth of the crops.

Keywords-image processing, drone surveillance, SIFT, edge detection, crop diseases, Brute force matcher, Hough circle, Adaptive Thresolding.

General terms: Performance, Algorithms, Processing, Experimentation.

1.Introduction

Agriculture is the mother of all culture. Economy and prosperity of a country depends on agriculture production. Agriculture provides food as well as raw material for industry. Today India ranks second worldwide in farm output. Agriculture is still the largest economic sector and plays a major role in socio-economic development of India. Agriculture in India is the means of livelihood of almost two thirds of the workforce in India. India has over 210 million acres of farmland. Jowar, wheat, sunflower, cereals are the major crops. Apple, banana, sapota, grapes, oranges are the most common fruits. Sugarcane, cotton, chili, groundnuts are the major commercial crops.

As per the 2010 FAO (Food and Agricultural Organization) worlds agriculture statistics, India is the world's largest producer of many fresh fruits and vegetables, milk, major spices, select fibrous crops such as jute, staples such as millets and castor oil seed. India is the second largest producer of wheat and rice, the world's major food staples. India is the world's second or third largest producer of several dry fruits, agriculture-based textile raw materials, roots and tuber crops, pulses, farmed fish, eggs, coconut, sugarcane and numerous vegetables. India ranked in the world's five largest producers of over 80% of agricultural produce items, including many cash crops such as coffee and cotton, in 2010.

Computer Vision Systems (CVS) developed for agricultural applications, namely, detection of weeds, sorting of fruits in fruit processing, classification of grains, recognition of food products in food processing, medicinal plant recognition, etc. In all these techniques, digital images are acquired in a given domain using digital camera and image-processing techniques are applied on these images to extract useful features that are necessary for further analysis. Plant disease diagnosis is an art as well as science. Many diseases produce symptoms, which are the main indicators in field diagnosis. The diagnostic process (i.e., recognition of symptoms and signs), is inherently visual and requires intuitive judgment as well as the use of scientific methods. The photographic images of symptoms and signs of plant's diseases used extensively to enhance description of plant diseases are invaluable in research, teaching, diagnostics, etc. Plant pathologists incorporate digital images using digital image transfer tools in diagnosis of plant diseases. Till now experts identify the presence of the disease in the plants manually, but it is expensive for a farmer to consult an expert due to their distant availability, so it is required to detect the symptoms of the plant diseases automatically as early as they appear on the plant. Early detection will help farmers to avoid huge loss. Technology support would help them in early detection of diseases, cutting on cost of pesticides, and good returns for the efforts, thus making the profession attractive. To remedy this situation various alternatives are being searched to minimize the application of these hazardous chemicals. One of the main concerns of scientists is the automatic disease diagnosis and control. Several key technologies incorporating concepts from image processing and artificial intelligence are developed by various researchers in the past to tackle this situation.

2. Literature Survey

Agriculture is one of the oldest profession taken by men and most rural communities and many cities depended on agricultural production for their livelihood. Not only has the sowing of crops shaped our landscape and environment, it has also influenced many aspects of society. Throughout the history, agricultural activity has been the engine that spurred land ownership, maintained state and local economies, motivated pioneers and family farmers to produce "amber waves of grain." There has been a significant technological advancement in terms of growth in agriculture using modern ways of farming and harvesting crops. These include use of modern machinery that can reduce human labor and enhance the process of cultivation and harvesting of crops, use of heavy machinery like crop harvester, crop sprayer, cotton harvester etc. has tremendously increased the process of agricultural farming and it generates a lot of raw materials for industries in certain amount of time. Due to such technical advancement in the field of agricultural science, crops seasons are not necessary for the growth of crops that grow in certain seasons. Crops can be grown in any seasons to meet all kinds of industrial needs. Industries process these raw materials to produce fodder for livestock and to meet human demands which rises annually. Food scarcity is a major problem across the globe, due to increasing demand in consumption and a steady decline in crop growth rate.

Many countries exports lots of crops from India including fresh fruits. The agriculture in India is an important topic in Indian geography. 49% of the population in India is depending on agriculture. In the total geographical area in India, 141 million hectares is net sown area and 195 million hectares is gross cropped area. The agriculture shares 14% of GDP and distribution of income and wealth. It provides essential amenities like food for the people and fodder for the animals. It also provides the major source of raw materials to the agro-based industries in India. The vast relief of country, varied climate and soil conditions harvest a variety of crops. All tropical, subtropical and temperate crops are grown in India but predominantly food crop is cultivated in the 2/3rd of total cropped area. India has three major cropping seasons called Kharif, Rabi and Zaid. The Kharif season is from July to October and Rabi season from October to March. The crops grown between the months of March to June called Zaid.

Year	Author	Objective	Methodology	Publisher
1971	Robert P. Jenkins	Research on systems approach for pest control	System Analysis	Sourthern Journal of Agricultural Economics
2006	Mark L Gleason, Brooke A Edmundus	Study Tomato Diseases and Disorders	Research Work	IOWA State University Journal
2013	Maged Wafy, Hashem Ibrahim	To identify weed Seeds in mixed sample of Wheat grain.	SIFT Algorithm	IEEE
2013	Rupesh G Mundada, Dr. V. V. Gohokar	Detection of Pest in Greenhouse using image processing	Image Processing	IOSR-JECE
2014	Jagadeesh D. Pujari, Rajesh Yakkundimath, Abdulmunaf S Byadgi	To identify and classify fungal disease affected on Agricultural crops.		IEEE
2016	Amrita A. Joshi, B.D. Jadhav	To Monitor and Control Rice Disease.	Image Processing Technique	IEEE
2016	Preetha Rajan, Radhakrishnan B, Dr. L. Padma Suresh	To detect and classify pests from crops	Support Vector Machine	IEEE
2016	Nileshrao C Sawant,Renuka Panchagavi	Compare and Analyze Image processing Techniques for pest detection	Computer Vision, AI	IJARCSSE

Literature survey and studies in agricultural science indicate lot of studies done to improve the crop growth and its life cycles. Development of an automated system for identifying and classifying different diseases of the contaminated plants is an emerging research area in precision agriculture. Identification of the diseases is the key to prevent qualitative and quantitative loss of agricultural yields. Popular methods proposed include detection of weed in plants seeds, sapling infestations, identification of rice disease, detection of fungal disease in cotton plants, extraction of leaves features to study the production of Ayurveda medicines. The present study is concerned with detection of diseases that affects crops and causes decline in production. Early detection and diagnosis is the main objective of the methodology proposed.

3. Methodology Proposed

Lot of research has taken place in the recent years in the field of agricultural science. Most of them involve detection and diagnosis of plant diseases that misshapes the life cycle of the plant. Our study focuses on detection of disease in the crops that are growing in the fields and diagnosing the disease in the field itself and does not involve any laboratory testing. In order to control plant diseases timely and effectively, improve the quality and the yield of agricultural products and ensure the safety of agricultural production and food security, fast and accurate diagnosis of plant diseases should be conducted. Traditional methods to identify and diagnose plant diseases mainly rely on naked-eye observation by the farmers. These methods are not only time-consuming and tedious, but also inaccurate if farmers lack experience. However, some expert systems for plant diseases could be used for disease diagnosis. Most of them need disease-related information and data as inputs, but the information and data input by the users could not meet the needs because the users lack disease knowledge. So the systems could not give correct and effective outputs. Thus it often results in misuse of pesticides or excessive use of pesticides and poses a great threat to food safety.

Computer technologies have been widely used in data collection, data processing, data analysis and computer simulation in the studies on plant pathology. Computer image processing technologies have been used in the studies on plant diseases. Image recognition of the plant could be achieved by using appropriate image processing technologies. The users could obtain related disease information timely and accurately. Image recognition of plant diseases is implemented based on the main features of the disease images. These features could be extracted from the interested regions of the images by image processing. And then some kind of pattern recognition method could be used to identify the disease images based on the extracted features. The choice of the characteristic features is very important to the performance of image recognition. Usually, color features, shape features and texture features are extracted from the images of plant diseases.

Our current study uses OpenCV (Open source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. It is mainly used for image processing and application area involves facial recognition, gesture recognition, motion tracking, edge detection etc. OpenCL (open computer language) enables use of any programming language to train the program according to the given input. OpenGL (open graphics library) enables use of inbuilt libraries to process and analyze image to extract useful information from the data given as input.

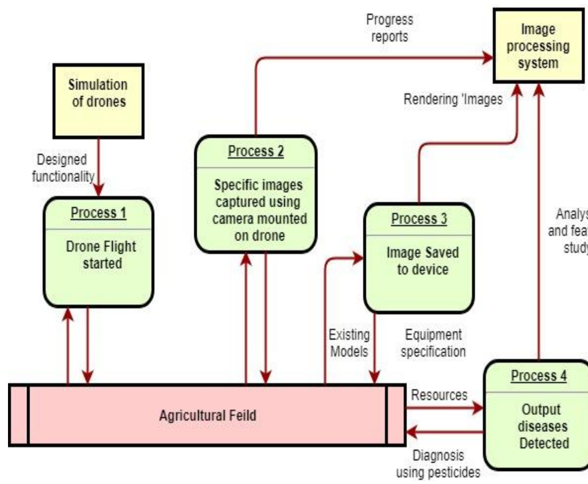

Figure: Flowchart of methodology.

The library has more 2500 optimized algorithms which contains comprehensive set of instruction codes which can be used to detect and identify objects, classify human faces, track movements etc. It supports all kind of OS (operating System) and is platform independent. It needs sufficient amount of computational power to process a raw image and needs enough processing capability for algorithms which involves feature transform and feature matching. Our processing techniques involves use of algorithms such as SIFT (Scale invariant Feature Transform), Brute Force Matcher, Hough Circles, Adaptive Thresolding, edge detection etc.

The complex agricultural environment combined with intensive production requires development of robust systems with short development time at low cost. The unstructured nature of the external environment increases chances of failure. Moreover, the machines are usually operated by low-tech personnel. Therefore, inherent safety and reliability is an important feature.

Food safety is also an issue requiring the automated systems to be sanitized and reliable against leakage of contaminations. This system reviews agricultural automation systems including field machinery, irrigation systems, greenhouse automation and automation of fruit production systems. Using Drone surveillance agricultural farming can be technically surveyed and monitored. Image processing done on the images captured will help in detecting and diagnosing plant diseases. An early detection will help in cutting down costs and improving the overall quality and quantity of crops.

Figure: Images of plants captured in initial phases.

Initially images of plants, crops were captured using digital camera. Images captured involved plants that are healthy and an unhealthy plant of same species. The image captured is cropped and compressed and is given as input to the algorithm used to process the image to extract useful information. The Brute Force Matcher algorithm matches relevant features from both the images and indicates whether the plant is infected and indicates is the level of infestation. However, capturing images using digital camera was done for early experimentation and training the image to obtain results that can be studied and implemented to enhance detection and analyzing process. An automated process would involve capturing of image using a drone that can fly through the agricultural field and capture image using camera mounted on it. This would help in analyzing a large area and speed up the process of gathering data to process it to obtain results.

Drone also known as unmanned aerial vehicle is designed and assembled with technical capabilities that can carry weight of 500gm including a drone mounted camera and pesticide sparing system. Drone is fitted with four 100rpm motor that gives it ample thrust and lift to carry weights that can be used to carry pesticides and lift necessary weights. The propeller is swift and operates at 1000 rotation per minutes providing stability during flight and helps in capturing stable images that is unprocessed data used to extract useful information after processing it. The ESC (electronic speed controller) is the heart of the entire drone system. An electronic speed control or ESC is an electronic circuit with the purpose to vary a servo-motor's speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on motors essentially providing an electronically-generated three-phase electric power low voltage source of energy for the motor. The basic function of ESC is to change the amount of power to the electric motor from the battery based upon the location of the throttle stick.

Flight microcontroller is an integrated circuit which is the CPU of the drone system. It receives signal from the transmitter (remote controlling device) and helps in flight of the drone. It is responsible for maintaining the balance of the drone during the flight. There are often two voltage ranges in the specification of a flight controller, the first being the voltage input range of the flight controller itself (most operate at 5V nominal), and the second being the voltage input range of the main microprocessor’s logic (3.3V). It is internally wired using an integrated chip and is connected from battery to all the motor and is the power hub of the entire flight system. It also has GUI (graphics user interface) which displays various parameters including distance from ground, accelerometer to determine speed. It measures the distance in three axes. Gyroscope measures the rate of change of angular axis in the three axis. These components in the flight micro controller help in providing complete control using a transmitter or a remote control. Remote control(RC) communication usually involves a hand held RC transmitter and RC receiver. For operating a drone four basic channel, Pitch (translates forward and backward motion), Elevation (Closer and Farther from ground), Yaw (rotation clockwise and anti-clockwise), Roll (left or right movement). Additional capabilities include arming and disarming the rotor motor. Flight control completely depends on this hardware and it can also be used to deploy an additional system such as sprayer in this particular system. Most drone pilots prefer handheld control, meaning RC systems are still the number one choice for controlling a UAV. On its own, the receiver simply relays the values input into the controller, and as such, cannot control a UAV. The receiver must be connected to the flight controller, which needs to be programmed to receive RC signals. There are very few flight controllers on the market which do not directly accept RC input from a receiver, and most even provide power to the receiver from one of the pins.

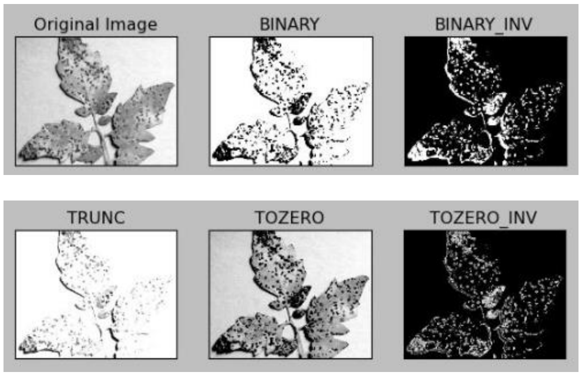

Figure : Comparative Study.

The most important part this entire automation system is the image processing techniques that is used to process the images and extract useful information that is matched with the results to derive useful conclusions. Method for the Image Processing is to perform set of processes on an image, to get an enhanced image or to conclude some useful information of that image which is processed. Image Processing is subset of signal processing which has input as an image and the output whose features associated with that image or that image. Some important algorithms used in this system include Hough Circles, Adaptive thresolding, Brute force matcher, SIFT (Scale Invariant Feature Transform), edge detection. Adaptive thresholding is the method where the threshold value is calculated for smaller regions and therefore, there will be different threshold values for different regions. If pixel value is greater than a threshold value, it is assigned one value (may be white), else it is assigned another value (may be black). The function used is cv. threshold. First argument is the source image, which should be a grayscale image. Second argument is the threshold value which is used to classify the pixel values. Third argument is the maxVal which represents the value to be given if pixel value is more than (sometimes less than) the threshold value. OpenCV provides different styles of thresholding and it is decided by the fourth parameter of the function.

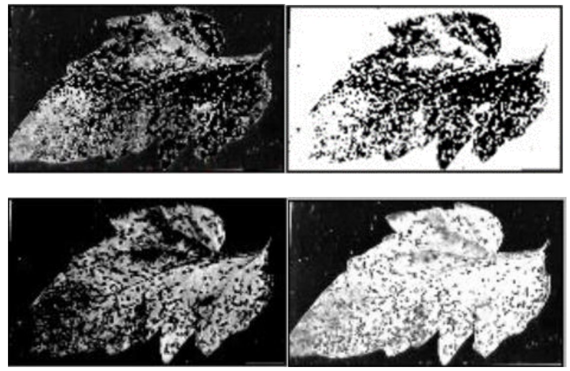

Figure: Septoria plant analysis

The Hough Circle Transform works in a roughly analogous way to the Hough Line Transform. In the line detection case, a line was defined by two parameters (r, theta). OpenCV comes along with an already made function that detects circles using the hough transform. The Circle Hough Transform is a little inefficient at detecting circles, so it uses the gradient method of detecting circles using the hough transform. Brute-Force matcher is simple. It takes the descriptor of one feature in first set and is matched with all other features in second set using some distance calculation. And the closest one is returned. For BF matcher, first we have to create the BF Matcher object using cv2.BFMatcher(). It takes two optional parameters. First one is normType. It specifies the distance measurement to be used. By default, it is cv2.NORM_L2. It is good for SIFT, SURF etc. (cv2.NORM_L1 is also there). Second parameter is boolean variable, crossCheck which is false by default.

4. Future Scope

Plant Disease management is a challenging task. In that mostly diseases are seen on the leaves of the plant. Basically there are three main types of Leaf disease, they are Bacterial, Fungal and Viral. There is main characteristics of disease detection are speed and accuracy. Hence working on development of automatic, efficient, fast and accurate which is use for detection disease leaf. Work can be extended for development of machine vision system that automatically recognizes, classify and quantitatively detects leaf disease symptoms. The objective of this work is the detection, classification of diseases affecting on the plants, crops using image processing tools and all information about the disease is send to the farmer’s mobile phone through the GPRS. To increase the speed and accuracy of detection and classification of leaf diseases we using Raspberry pi module. The design and implementation of these technologies will greatly aid in selective Agriculture application, reducing costs and thus leading to improved productivity.

5. Conclusion

Agriculture has come a long way in the past century. We produce more food than ever before, but our current model is unsustainable, and as the world's population rapidly approaches the 8 billion mark, modern food production methods will need a radical transformation and we will need to keep up with the increasing demand. But luckily, there's a range of new technologies that might make it possible.

The advantage of image processing technologies is to find out useful information contained in the images quickly and accurately. The problem that it is difficult to accurately estimate plant disease severity can be solved using computer vision instead of naked-eye observation. With the development of network technologies and the construction of agricultural information, the network and automation of plant disease identification may come true in the future. The studies on plant disease automatic diagnosis methods based on image recognition technologies will be conducive to the development of precision agriculture and will provide some supports for the automatic management of plant diseases.

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