IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 21, Issue 2, Ser. I (Mar - Apr 2019), PP 68-73
www.iosrjournals.org

Comparitive Study and Review for Development of Disease Prediction System for Indian Crops

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***Abstract*—** *Current Agriculture faces many challenges such as climate change, environmental pollution, Infection of various diseases on plants, water shortages and increased societal demand of food production and many more. Many farmers in India commit suicide because of these challenges. Disease Prediction System for Brinjal crop using machine learning is the promising solution, which is based on predicting and responding to disease symptoms variations on Indian Brinjal plant*

***Keywords*— *ML:** Machine Learning, **IOT:** Internet of Thing**; DL:** Deep Learning, **MDP:** Massive Data Processing, **AI:** Artificial Intelligence, **DPS-** Disease Prediction System*

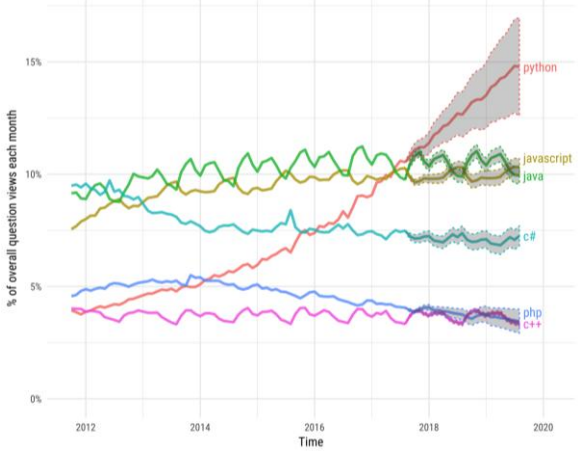
Date of Submission: 25-02-2019 Date of acceptance:11-03-2019

I. Introduction

Quality agriculture relies on gathering comprehensive information from farmland, which includes not only the environmental information but also the plant's information. For example, the environmental condition, such as temperature, soil moisture, humidity, soil composition, solar radiation, wind speed and rainfall, are considered to reveal the weather change and soil pollution, and can help to improve management of fertilizer usage and other inputs. The plant information, such as plant growth, plant disease and insect pest, are useful to predict the production and make decision about pesticide or organic applications.

This Disease Prediction System will give a better prediction of disease on Brinjal and it will recommend suitable pesticide/ organic materials applications using Machine Learning. Python Language is most widely language for Machine Learning, AI, Data Science, Deep Learning and Image Processing because of its simplicity and power full library. Open source python language is used to implement this system with some libraries like OpenCV, pytesseract, NumPy, SciPy, TensorFlow etc.

Why Python for Proposed Model- Google Trend Report



In this Disease Prediction System, Machine Learning and Clustering Algorithms can be applicable for plant growth monitoring. In this solution aggregation of data helps to convert raw data coming from plant into exact accurate data which will be understood by farmers.

Finally exact accurate information processed by Disease Prediction system is conveyed to farmers via messaging / App service on their mobiles, which will help to predict the application of pesticide to the plants

II. Literature Survey on disease prediction techniques

Some of the related literatures are as follows.

[1] In this work, convolutional neural network (CNN) models were developed by the researcher to perform plant disease detection and diagnosis using leaves images of healthy & disease affected plants, through deep learning technology. Training of the this model was carried out using open image database, which contains 25 different plants in a set of 58 different classes of [plant, disease] combinations, including healthy plants but this work does not focuses Indian Brinjal crop in depth level

[2] In this paper, work is presented on deep-learning techniques to detect plant diseases and application of pests in tomato plants using images captured by camera with various resolutions. Main goal was to find the most suitable deep-learning techniques for disease prediction on tomato plant. These researchers had considered 3 main parameters: First - Region-based Faster Convolutional Neural Network (Faster R-CNN), second – Fully Region-based Convolutional Network (R-FCN), and last - Multibox- Single Shot Detector (SSD), because of it, this work is known by "deep learning meta-architectures". They combined all above meta-architectures with "deep feature extractors" such as Residual Network (ResNet) and VGG net. Also they trained and tested systems end-to-end on large Tomato plant Diseases and respective Pests Dataset, which contains some images with diseases and pests, including several inter- and extra-class variations, such as location and infection status in the plant. Experimental results showed that this system can effectively identify different types of diseases and pests, with the ability to deal with some scenarios from a tomato plant's surrounding area. This work is done for tomato plant in Korea; still there is scope to work on Indian Brinjal crop

[3] The work done in this paper is by the, use of image based automated identification systems that can leverage early detection of diseases on plants among farmers and technicians but they perform poorly under real field conditions using mobile devices. A particular image processing algorithm based on candidate hot-spot detection on plant in combination with statistical inference methods is proposed to tackle disease identification in real wild conditions. This work analyses the performance of early identification of three European wheat diseases – septoria, rust and tan spot. The analysis was carried out using 7 different mobile devices and more than 3500 images captured in two pilot sites in Spain and Germany during 2014, 2015 and 2016. Obtained results revealed that, the AuC (Area under the Receiver Operating Characteristic–ROC–Curve) metric is higher than 0.80 for all the analyzed diseases on the pilot tests under real conditions. This work is focused on European wheat crop, so there is still scope to carry out work on Indian Brinjal crop

[4] This paper presents an algorithm for image segmentation technique which is used for precision classification of plant leaf diseases and automatic disease detection on Banana, Beans, Lemons and Rose plants. It also covers survey done on different diseases classification techniques that can be used for plant leaf disease detection. Image segmentation, is an important aspect for disease detection in plant leaf disease, is carried out by using genetic algorithm. This work is carried out on Banana, Beans, Lemons and Rose plant using genetic algorithms and it is not focused towards Indian Brinjal Crop by using machine learning techniques

[5] This paper explains in brief, the latest trends in the prediction of crop pesticides using machine learning techniques. It describes trends in work on methods of the prediction of crop pesticides using machine learning technology. It has introduced methods with 4 different algorithms using Support Vector Machine, Multiple Linear Regression, Neural Network, and Bayesian Network, and takes a look at various cases in which they have been used. Researchers had done the work in leaf moisture, temperature, speed of wind, solar radiations on wheat and coffee plant using generalized regression neural network, multiple linear regression and SVM. This work is also done in Korea and focused on coffee & Wheat plant so still scope is there to work on India Brinjal Crop

[6] The main work done in this paper is the (I) early detection and classifying diseases of sugar beet using Support Vector Machines algorithms and spectral vegetation indices. The aim was to recognize diseased leave from non-diseased sugar beet leaves, (II) to classify between the diseases Cercospora leaf spot, leaf rust and powdery mildew, and (III) to recognize diseases even before specific symptoms became visible. Depending on the type of disease and its stage, the accuracy for classification was received in between 65% and 90%. The work done in this paper is related to sugar beet plant in Germany, so still scope is there to work on India Brinjal Crop

[7] This is an efficient system that identifies the Bacterial Blight disease and it’s symptoms on pomegranate plant. First the captured images by camera are processed for enhancement, and later image segmentation is carried out to find out target regions i. e disease spots on the leaves and fruits. If the diseased spot on leaf is marked by yellow margin then it is called that leaf is infected by bacterial blight otherwise not. In the same way, when black spots are targeted on fruits, they checked it for whether a crack is through spots or not. If these cracks are going through the spots then the disease identified is Bacterial blight. Only these two characteristics for bacterial blight on pomegranate would be appropriately identified. The work done in this paper is more related to image processing and as per the previous results seen in many journal papers show better accuracy can

be achieved in machine learning algorithms, deep learning than image processing, so our research targets India Brinjal Crop with the help of machine learning

[8] This carried out work explains the new prediction method based on SVM for developing weather-based disease prediction models of rice plant diseases. They claims that, their case study shown SVM is better than other machine learning techniques and conventional REG approaches in forecasting plant diseases especially on rice plant. The case study carried out was aimed to find out the usefulness of SVM models over the existing Artificial NN and conventional multiple regression models (CMRM) to predict rice blast severity based on prevailing weather conditions both within and between the locations or years, and to calculate the approximate risk of rice blast infection at these field sites using a set of weights from SVM models. For this, researchers had used 5-year rice blast/weather data which is collected from five different locations (India) spread over the district Kangra of Himachal Pradesh as part of National Agricultural Technology Project (NATP) which was implemented at CSK Himachal Pradesh Agricultural University, Palampur, HP (India).

[9] This carried out work contains different approaches done by researchers for detection, diagnosis and recognition of plant & its leaf diseases. Grape, Cassava, Apple, Citrus, Cotton, Maize, Rice, Sugarcane, Tomato these plants are considered for testing in limited level. Feature Extraction is arguably the extreme important phase of all, and it is very important to choose the most appropriate set of feature for the images at hand. This proper selection sets the tone for better results by the classifier. It has been clearly found that the classifier based on neural network works better than others in most of the cases. Future study will involve evolving the existing algorithms and proposing new and better ones for identification of leaf diseases. Researchers can also continue exploring other crops in detail and it will be interesting to find out whether the existing methods yield satisfying results for the new crops as well or not.

[10] This work explains the, application of texture statistics for identifying the plant leaf disease. They first converted the RGB color structure into HSV space because most of us know that HSV is a definitely good color descriptor. After the conversion, Masking and erasing of green pixels is done with pre-computed threshold level, further segmentation is carried out using 32X32 patch size and obtained useful segments. These segments are considered for texture analysis by color co-occurrence matrix. Finally texture parameters of affected plant are compared to texture parameters of normal leaf. This is an image processing work and the extension of this work done can be developing algorithms and Neural Network's (NN) in order to increase the rate of recognition of classification process

[11] The work done carried here on crop disease prediction is basically on image processing and steps involves are Image Acquisition, Image Preprocessing (Image Clipping, Image Smoothing, Image Enhancement), Image Segmentation (ROI- region of interest) (Binarization, Thresholding, Segmentation), Extraction of Features, Classification based on appropriate classifier (Neural Network, Fuzzy Logic), Statistical Analysis. Here only theoretical work is explained but no work has been carried out. So scope to work on disease prediction system for Indian Brinjal crop is still open.

[12-19] The work done in these papers are based on image processing, as many researchers have proved machine learning mechanisms are definitely better than image processing approaches for prediction of diseases on plant.

[20] The work done in plantix app from collection of image through mobile camera to disease prediction is good. But Agtech is German startup and most of the team members from European countries; they have many crops in their app for disease prediction. This carried out is less feasible for Indian crops and weather conditions. The result of plantix app is less suitable for Indian crops

So the conclusion of literature survey is that, for our research still there is huge scope which can fulfill the requirement of farmers from India with better machine learning algorithm.

III. Issues and Challenges in Disease Prediction System on Indian Brinjal Crop

Brinjal is very common tropical vegetables cultivated and grown in India. It is known by different names like Begun (Bengali), vange (Marathi), Kathiri (Tamil), baingan (Hindi), badane (Kannada), Vashuthana (Malayalam), waangum (Kashmiri), baigan (Oriya), venkaya (Telugu), ringna (Gujarathi) and Peethabhala (Sanskrit)

A large number of famers cultivate different types of Brinjal in their shape; size and color. These Brinjal fruits are used in vegetable curries and a variety of dishes are prepared out of Brinjal.

The main important issues and challenges on Indian Brinjal plant which we need to focus and work more on it are –

- ✓ Monitoring Brinjal plant growth periodically
- ✓ Predicting plant disease based on variations on leaf and on Brinjal both well in advance
- ✓ Recommending appropriate solution for predicted disease in reliable way
- ✓ Increasing the quality and hygienic production required to serve the society

IV. Research objectives

In this direction, our research focus is to resolve some of the issues related to Machine Learning and Image Processing so that it is useful to sense the Brinjal plant periodically and is to get the current conditions of Brinjal crop in reliable way.

Also this information will be helpful to get info about prediction decease related data & suggestion to use appropriate pesticides or organic materials for the same.

In specific, the research objectives are as follows.

- ✓ Intelligent prediction of disease on Brinjal crop based on symptoms of leaf and Brinjal in reliable way
- ✓ Recommending appropriate solution in terms of pesticides or organic material for the same disease predicted earlier
- ✓ Designing of human friendly system which monitors plants growth by using machine learning techniques.
- ✓ To publish the work for information dissemination to the computer or agriculture researchers and different kind of industries

V. The Proposed Model

The architecture of DPS is human friendly system which contains separate back-end server for plants image processing and wireless devices for farmers such as mobile, tablet, PDA, laptop etc.

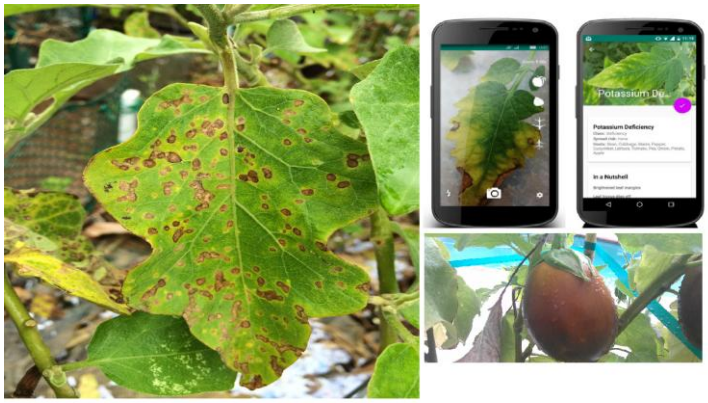


Fig 1. Disease Prediction System on Indian Brinjal Crop using Machine Learning

Figure 1 shows the system architecture of DPS. Datasets of disease affected plant images and non-affected (healthy) are used to create trained model.

The camera of farmer's mobile / PDA / Laptop of DPS system is responsible for capturing image of plant leaf / actual Brinjal to test with earlier created model. Once image captured will be send to back-end for processing with trained model.

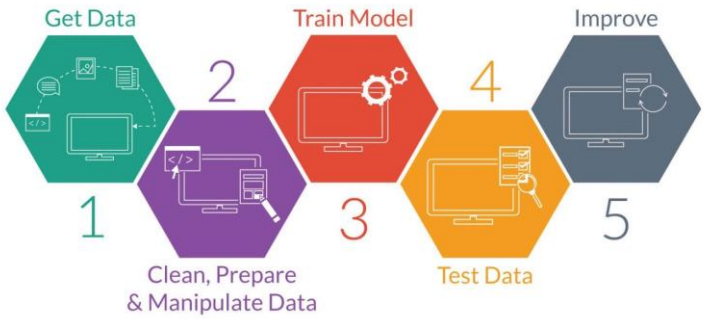


Fig 2. Working Process of Machine Learning Classifiers

K-means Clustering algorithm is used to insert new image into appropriate cluster of disease categories. Using a desktop GUI form / web browser, a user can request and view historical data and along with this the last gathered "almost real-time" data from the back-end server. A Historical data as well as the last gathered "almost real-time" data, plant disease and insect pests of plant is sent to the farmers on their mobile using messaging /App service which can help to improve management of fertilizer usage & other inputs such as pesticide application.

VI. Metholodies

The Research will be carried out using following methodologies for development of Intelligent Monitoring Solution for Indian Agriculture.

- ✓ Literature study/review is to be carried out on Disease Prediction System for various plants along with strength and drawback in Agricultural Applications.
- ✓ Issues and challenges related to DPS for Agricultural Application Systems is to be studied from available literature & Books.
- ✓ Periodically Visits are arranged to Brinjal farm with farmers and agricultural professor / researcher which will help to monitor the growth of plants
- ✓ The probabilistic models for DPS are developed to resolve the issues such as prediction of disease on Brinjal leaf and on actual Brinjal for Indian Brinjal crop.
- ✓ Mobile Network and traditional network will be interconnected so that IP addressing, Client-Server architecture will be utilized.
- ✓ The developed schemes are being tested through application designed / simulation for it.
- ✓ Plant growth monitoring system is to be designed which will send information about management inputs such as pesticide application by messaging /App service to farmers.
- ✓ Application is to be make available to public on various platforms so that people will get it easily (ex. Google Play Store)
- ✓ Performance comparison with standard existing models.
- ✓ At every stage, results obtained will be published in suitable conference and journal.

VII. Research Outcomes

Following are the research objectives to be carried out in upcoming period for topic of development of Intelligent Monitoring Solution for Indian Agriculture

- ✓ Design of Disease Prediction System which will predict disease on Brinjal crop based on symptoms of leaf and Brinjal in reliable way
- ✓ The probabilistic models is to be developed which will recommend appropriate solution in terms of pesticides / organic material for earlier predicted disease
- ✓ Designing of human friendly system (Computer / Mobile) which monitors plants growth by using machine learning techniques.
- ✓ Publication/patent of the work in suitable journals and agencies and Organization of conferences

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IOSR Journal of Computer Engineering (IOSR-JCE) is UGC approved Journal with Sl. No. 5019, Journal no. 49102.

Mr. Balwant J Gorad. " Comparitive Study and Review for Development of Disease Prediction System for Indian Crops" IOSR Journal of Computer Engineering (IOSR-JCE) 21.2 (2019): 68-73.