

# Technology in Agriculture and Crop Disease Detection

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**Abstract:** *The United Nations Food and Agriculture Organization states that world population is going to increase 2.1 billion in 2050. As the technology is rapidly increasing, the technologies like AI, ML and IOT used in many fields, similarly these technologies are used in the field of agriculture sector, food sector. This paper consists of AI and ML methods are used in the farming as agriculture sector. And many optimal solutions are giving by these technologies that will help farmers for cultivation and finding the strength of the soil and crop disease detection, various processes are used to identify the disease in the crop. The current paper throws a vision of how diverse agriculture can be fulfilled using the technology*

**Keywords:** Artificial Intelligence(AI), Machine Learning(Supervised, un-supervised, Reinforcement), Deep learning, IOT, Agriculture, Disease detection

## I. INTRODUCTION

According to the United Nations, the total population of the world is around 7.7 billion currently. May be in next 30 years it may increase by 2 billions as 9.7 billion by 2050.

There is a rapid population growth and change in climate and change in market demands that are pushing agricultural system into a new system. As the technology is improving also technology can be used in various fields and can get efficient outputs.

Artificial intelligence defined as manmade things, i.e. the machine will work like a human, if we train a machine in such a way that it will work like a human. There are some challenges that can be solved through AI, in many fields agricultural, medical, etc. where AI is applicable to solve the real-world problems.

United States Department of Agriculture(USDA), Agriculture Research Service(ARS) is an agricultural research organization in the world, conducted research on agriculture with more than 2000 scientists in more than 89 locations around United states. It conducts research mainly on crop production, crop protection, and sustainable agriculture as well as food nutrition and food safety.

ARS established a virtual center of Excellence (COE) to provide awareness on the application of AI in agriculture.

## II. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Artificial intelligence(AI) is a technology that simulates human intelligence and ability of thinking by machines as computer systems, robotics, and digital equipment. Some applications of AI are NLP(Natural language processing) as for example google will take the text and it divide the text into piece of words and it will search for those parts of words, and it will give the results accordingly. But there is a problem with NLP is that it cannot understand the local languages if we type a word in telugu it is a bit difficult to give the results. To overcome this problem, work is still going on this. AI encoding is actually based on the learning that takes the data and then create the algorithms and make sure that algorithms should give results accurate. AI is used in various sectors as finance, medical, retail etc...

Machine Learning (ML) is the subset of AI, defined as T,P,E i.e. task, performance, Experience. It can be said as having a specific task, based on the previous experiences or experience results that can be taken as a reference and can apply on current task and get the better results from a particular task. ML is based on mathematical and statistical methods where probability is used mostly. There are n number of datasets which are already available, working on those datasets and applying algorithmic methods and getting efficient results from the ML methods. In

general machine learning is divided into three parts/ tasks: supervised, unsupervised, reinforcement learning. The aim of supervised learning is guiding for example a teacher is guiding students where teacher is a supervisor as same as everything is known. Similarly unsupervised learning is there is no guide or unknown. Reinforcement learning works on hit and trail method it can be happened or may not happened. Unsupervised learning includes Artificial neural networks(ANN), clustering and deep learning and uses unlabelled datasets without prior knowledge of input and output variables. Artificial neural networks (ANN) has n number of neurons that are connected and number of hidden layers that are present. ANN comes from the biological neuron as it has dendrites as input, axon gives output, synapse is the link between two nodes and cell body is the processor.

### III. DEEP LEARNING

Deep Learning is the subset of ML. Neuron is a cell in the brain process and transmit information. Perceptron, it is a type of artificial neural network that is used to classify patterns. Brain consists of neurons. In 1871-1873, initially reticular theory, Joseph von Gerlach proposed that the neuron system is a single continuous network as opposed to a network of many discrete cells. Cells in our nervous system, it is not a network of discrete cells.

#### Staining technique

Camillo Golgi discovered a chemical reaction that allowed him to examine nervous tissue in much detail than ever before.

#### Neuron Doctrine

Santiago roman y kajal used golgi's technique to study the nervous system and proposed that it is made up of discrete individual cells forming a network(as opposed to a single continuous network). So, it is a tissue a group of cells combinely got the cell, it is not a single cell.

Kajal proposed it and waldeyer Hartz is responsible for the consolidate for the neuron doctrine and chromosomes. He further consolidated the neuron doctrine. The term neuron coined by Hein-rich Wilhelm Gottfried von waldeyer-Hartz around 1881.

In 1906, Nobel prize to both Golgi(reticular theory) and kajal(neuron doctrine) were jointly awarded the 1906 Nobel price for physiology/medicine, that result in lasting conflicting ideas and controversies between two scientists.

The final word, In 1950's, electron microscopy finally confirmed the neuron doctrine by unambiguously demonstrating that nerve cells individual cells interconnected through synapse(a network of many individual neurons). From spring to winter of AI, Boom of AI. In 1943, interest in understanding, how human brain works and computational or mathematical model.

### IV. MCCOLLOCH PITTS NEURON

McColloch (neuroscientists) and Pitts(logician) proposed a highly simplified model of the neuron (1943).

#### A. Perceptron (1957-1958)

- Able to learn
- Make decisions
- Translate languages

The perceptron may eventually be able to learn, make decisions and translate languages- Frank Rosenblatt. Cold war-Research happened; translations happened between different countries.

The embryo of an electronic computer that the navy expects will be able to talk, walk, see, write, reproduce itself and be conscious of its existence-New York times.

Deep Learning- Large number of artificial neurons connected to each other in layers and functioning towards achieving some goal or schematic of the neural network.

**B. Perceptron Limitations (1969)**

Perceptron cannot handle some simple functions also; we make perceptron to learn has huge functions. XOR function cannot be used to model, single perceptron cannot do it, but perceptron multi-layer network of perceptron's can do it. Back propagation (1986) discovered and rediscovered several times throughout 1960's, enables to train a deep neural network. Werbos(1982) first used it in the context of artificial neural networks. Eventually popularized by the work of Rumelhart et .al in 1986. All neural networks are trained using backpropagation and it is used in conjunction as gradient descent.

Network	Error	Layers
Alex Net	16.0%	8
ZF Net	11.2%	8
VGG Net	7.3%	19
Google Net	6.7%	22
Ms ResNet	3.6%	152

Gradient descent, Cauchy discovered gradient descent motivated by the need to compute the orbit by heavenly bodies. UAT(Universal approximation theorem)(1989): A multi-layered network of neurons with a single hidden layer can be used to approximate any continuous function to any of desired precision.

**V. DEEP REVIVAL**

In 2006, (unsupervised pre-training) contribution given by the two scientists Hinton and Salakhutdinov. During the period people are unable to use deep neural network, that cannot be work done on huge data, So, in practical it is not easy to train data.

**Un-Supervised Pre-training**

The idea of unsupervised pre-training actually dates back to 1991-1993(J.Schmidhuber) when it was training a very deep learner. More insights, further investigations into the effectiveness of unsupervised pre-training. Greedy layer wise training of deep networks.

In the year 2009, success in handwriting recognition, Graves et al outperformed all entries in an international Arabic handwriting recognition system.

In the year 2010, success in speech recognition, Dahl et .al showed relative error reduction of 16, 23.2 over a state-of-the-art system using the ANN system or procedures the errors are reduced.

In the year 2010, handwritten digit recognition, Ciresan et .al set a record on the MNIST using good old back propagation on the GPUs. MNIST will be high and gives higher accuracy. DNN requires a lot of computation, so, to get lost of computation we use GPU.

In the year 2011, First superhuman visual pattern recognition, D.C.Ciresan .et.al achieved 0.56 error rate is in the IJCNN traffic sign recognition.

Winning more visual recognition challenges: Classifying the images into various groups.

**From Cats to Convolution Neural Networks**

Experiment on cats: Parts of brain responds to the stimuli. All neurons fire the different types of stimuli.

**Hubel and Wiesel Experiment (1959)**

They experimentally shown that each neuron has a fixed receptive field i.e. a neuron will fire only in response to a visual stimulus in a specific region in the visual space. In the year 1980, Neo Cognitron, used for handwritten character recognition and the pattern recognition

Algorithm	Year
Ad grad	2011
RMS	prop,2012
Adam	
Adam,	Batch2015
norm	
EVE	2016
Beyond Adam	2018

### Convolution Neural Network (1989)

The handwritten digit recognition using back propagation over a convolution neural network.

In the year 1998, an algorithm inspired by an experiment on cats is today used to detect also in videos... Faster, higher, stronger (system must be made faster, better, accuracy) etc... In parallelly, research is going on far better optimization algorithms etc..

### Better Optimization methods (1983) (Nesterov)

Faster convergence, better accuracies.

Many new algorithms proposed (for better accuracies and better solutions)

The curious case of sequences (image, speech, pattern, recognition, NLP etc. . . )

There are sequences there while dealing with the data. Time series, speech, music, text, video. Each unit in the sequence interacts with other units. Need models to capture this interaction. A recurring neural network is something which allows you to capture the interaction which allows you to between the elements of sequence.

In the year (1986), Jordan network, the output of each time step is fed to the next time step there by allowing interactions between time steps in the sequence.

In the year 1990, the hidden state of each time step is fed to the next time step thereby allowing interactions between time steps in the sequence.

In the year 1991-1994, they found some drawbacks of RNN, Hoch Reiter et al and Benigno et al showed the difficulty in training RNNs (the problem of exploding and vanishing gradients).

In the year 1997, Long short-term memory, for NLP it is actually building block, i.e. showed that LSTM's can solve complex long time lag tasks that could never be solved before. In 2014, Sequence to sequence learning, attention mechanism, unable to deal with the lots of sequential prediction problems. Initial success is using RNN or LSTMs for large scale sequence to sequence learning problems. Introduction of attention which inspired a lot of research over the next two years.

RL for attention as reinforcement learning is used for learning the attention mechanism. Schmidhuder, Huber proposed RNNs that use reinforcement learning to decide where to look. In 2015, AlphaGo zero-best go ever, surpassing human players. Go is more complex than chess, because of number of possible moves. No brute force back tracking unlike previous agents.

In 2016, under reinforcement learning, deep stack defeated 11 professional poker players with only one outside the margin of statistical significance.

Dota (2017), Defence of the ancients-widely popular game, with complex strategies, large visual space. Bots was undefeated against many top professional players.

The madness (2013), Language modelling, speech recognition, Machine translation, Machine translation, Conversation modelling, object detection/ recognition, visual tracking, image capturing, video captioning, visual questioning answering, video summarization. Generating authentic photos (machine creates images), generates raw audio, pixel RNNs.

#### **VI. NEED OF SANITY**

The paradox of deep learning, why deep learning works so despite?? It is having high capacity, means their susceptibility to overfitting (susceptible to overfitting). Numerical instability (vanishing/exploding gradients). Sharp minima (leading to overfitting) (non-convex optimization problem)

In machine learning, overfitting is not good, just learn memorizing training data, not able to de testing. Machine is trained properly and slowly but steadily there is increasing emphasis on expandability and theoretical justifications.

#### **VII. AGRICULTURE**

Recently AI technology is used in agri-food sector. In fact, AI approaches are understanding a model's identification, service creation and the decision-making processes as support to the different agri-food's applications and supply chain stages. Decisions are taken to improve the productivity with resource preservation. AI tools produces algorithms to provide better efficiency and evaluates the performance and predict the problems and classify the patterns. To solve any complex problem in the agricultural field and for the identification of pests and diseases on the plants and for that the suitable treatment, as well as the management of irrigation process and water consumption by setting up the irrigation system. AI produces an efficient way to harvest and produce crops and checking the defective crops and improving them for the health crop production. AI also used in weather forecasting and disease identification with an around 97.5 accuracy. Similarly, recently Sujatha et al. [5] compared the performance of deep learning and machine learning methods, to detect and identify the citrus plant leaf disease. VGG-16 deep learning gives more better results as compared with others and it is giving high accuracy. Many people developed many approaches for augmenting parametrical statistical model with the deep neural networks, in term as semiparametric neural networks (SNN) by using the crop and they shown output as using this approach gives nonparametric neural networks. By using AI tools, farmers can remain updated with the data which is related to the weather forecasting and therefore, predicted data helps farmers increase in the crop yields and gets profits without risking in the crop, as a result, after analysing the data, AI makes the farmers to learn and understand and then make precaution by implementing practices in to make a smart decision. The collected data as from the different weather parameters like temperature, wind, speed, and humidity, from the Indian climate data centre and implemented a weather forecasting model by using a recurrent neural network (RNN) with LSTM (Long-short-term memory) technique. It gives better results as in terms of high accuracy. AI approach can monitor the strength of soil as soil health and management by conducting and identifying the possible defects and nutritional deficiencies in the soil by either image capture with the camera recognition tool or by deep learning based tool to analyse floral patterns in farmland. Similarly understanding the plant diseases and soil strength.

#### **VIII. CASE STUDY**

Firstly classify and predict the soil fertility and pH level in Kerala north central laterite Indian region soil by using the Extreme Learning Machine (ELM) technique with the different activation functions as squared, triangled, they revealed the maximum performance around 80-82 were obtained in gaussian radical basis function followed by hyperbolic tangent. The better performance is around 90 of the PH classification problem was given by using the hyperbolic tangent. The most important functional benefit of the AI technology is decreasing the pesticides usage. To manage the weeds with great accuracy the AI techniques by implementing robotics, CV, ML could help farmers to spray chemicals only where weeds are there... they directly reduce the chemical substances. AI-based technologies has advantage is on the agri-food supply chain as reducing employee – training costs and gives the robust decision-making on the time with the lower costs.

#### **IX. AI TECHNOLOGY TO IMPROVE AGRICULTURE AND FOOD INDUSTRIES**

In the machine learning algorithms (ML), there are four steps are there, they are:

- Preproduction
- Production
- Processing
- Distribution

In the preproduction step, the ML techniques are used, the prediction of crops and in the next phase ML could be used to detect disease and weather prediction. And the third step is processing phase, in that it is used to estimate of the production planning to reach high and safe quality of product.

It mainly focuses on prediction of crop yield, soil properties and irrigation system. In fact taking the input data as fertilizers, nutrients etc... predicting them based on ML algorithms, there precision agricultural tools aim to skate holders and farmers to support ideal decision in crop yield forecasting and improves the farmer practices. ML algorithms like Bayesian networks, regression, decision trees, clustering, deep learning, and ANN are used. LS-SVM method is used to study the soil samples, and to boost the performance of the extreme learning machine architecture (ELM) to estimate the soil temperature. The most popular method called CSM (Crop selection method) to resolve crop selection problems and helps to improve the net yield rate of the crops over the season. Using Bayesian network they studied and understood that the parameters are tolerance, productivity, oil content. They revealed oil content was highly by the tolerance of the crop.

Cluster is the irrigation management that plays a crucial role in affecting the crop quality and quantity. [8] Cruz et. al exploited the ANN- feed forward and back propagation technique is used to optimize the water resources in the smart farm.

[9] Recently, Choudhary et al. used PLSR and other regression algorithms as an artificial intelligence tool combined with sensors for data collection and IOT hardware implementation to improve the efficiency. There are n number of parameters are there that plays a key role in crop production. Many ML algorithms are used to estimate or used to simulate effective models of weather prediction (ANN, deep learning, deep tree), K means Clustering, K nearest neighbour, ANN and crop quality management (Clustering and regression) and harvesting (deep neural networks, data mining techniques, KNN, ANN, SVM).

During the harvest part, which is final stage after ripening of the crops, ML algorithms are used to predict the transformation of the fruit colour or crop colour.

Much research used ML algorithms to predict the fruit ripening stages and fruit maturity such as Goa et al. [10] who achieved 98.7 classification accuracy when they used on datasets and the Alex Net CNN deep learning model to classify the strawberry fruits into early ripe and ripe stages.

Among all the ML algorithms, there are genetic algorithm, ANN, Clustering and Bayesian networks and SVM classifier and artificial neural networks (ANN) models are build to detect the presence of nitrosamine in the red meat food samples and also obtained predictive modelling results as accuracy has highest were obtained by using the deep learning model.

#### **A. IOT (Internet Of Things)**

Nowadays huge amount is generating every day it can be in structured as traditional data or unstructured data as big data. The data can be related to weather, pest attack, soil related data and by imaging, through drones and cameras, where IOT solutions can sense, recognize, and yield smart solutions to enhance the crop yields. There is a technology called remote sensing. Image based generation, precision farming, where with the help of drones doing analysis and monitoring crops and scanning the fields. With the combination of CV technology, drone data the IOT will certain that farmers can take rapid actions.

#### **X. DISEASE DETECTION**

Image sensing and analysis ensures that the plant leaf images are sectioned into surface areas like background area and non-diseased area of the leaf. And do the identification of the pest and sense the nutrient efficiency. Remote sensing (RS) is a method along with hyper spectral imaging and 3D scanning thousands of acres of cultivable land. It has potential to monitor the farmlands by the farmers perspective of both time and effort. There are several steps that are there in disease detection

- Plant Imaging
- Advance Processing
- Transmission to laboratory
- Identification of disease

## XI. DISEASE DETECTION

### CITRUS PLANT DISEASE

There are mainly four major steps are there for identification of citrus plant disease, they are:

- Pre-processing
- Segmentation
- Feature extraction
- Classification

Every year around 50% of citrus peel is destroyed due to different plant diseases. By using the image processing, segmentation, feature extraction, feature selection and classification methods are used for identifying the citrus plant leaf disease

## XII. CONCLUSION

AI is having boom and giving better solutions to become more viable to assume that this technology reaches to the farming community. AI solutions are given in an open platform that would make solutions easy and affordable, the result will be faster and greater insight among farmers. Agri-food industries are one of the major fields for humanity, and it is also a part in Sustainability development rules. As input is concern, the inputs are taken in distributed supply chains and forming the stages as agriculture supply chain, to reach the output as consumer. So, there are several challenges are faced in the growth of the food and agriculture and various climatic changes, population growth etc. . . In this paper, we studied and demonstrate the main applications of AI and ML algorithms in agri-food supply chain that to improve agriculture and food industries. In this survey, the methodologies like image classification, feature selection, segmentation, pre-processing, feature extraction, we used and find the disease present on the crops, plants(leaf). So, we conclude that pre-processing techniques will help in increasing the accuracy.

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