LITERATURE SURVEY

Artificial Intelligence in Agriculture

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The domain of agriculture faces many challenges such as disease and pest infestation, improper soil treatment, inadequate drainage, and irrigation, and many more. These lead to severe crop loss along with environmental hazards due to excessive use of chemicals. Several researches have been conducted to address these issues. The field of artificial intelligence with its rigorous learning capabilities have become a key technique for solving different agriculture related problems. Systems are being developed to assist the agricultural experts for better solutions throughout the world. This literature survey covers 100 important contributions where artificial intelligent techniques were employed to encounter the challenges related to agriculture. This paper addresses the application of artificial intelligent techniques in the major subdomain of agriculture so that the readers can capture the multidimensional development of agro-intelligent systems during last 34 years, from 1983 to 2017.

Artificial Intelligence (AI) is one of the key areas of research in computer science. With its rapid technological advancement and vast area of application, AI is becoming pervasive very rapidly because of its robust applicability in the problems particularly that cannot be solved well by humans as well as traditional computing structures. Such an area of extreme importance is agriculture where about 30.7% of the world population is directly engaged on 2781 million hectares of agricultural land. Such a venture is not so smooth running, it faces several challenges from sowing to harvest. The major issues are pest and disease infestation, inadequate application of chemicals, improper drainage and irrigation, weed control, yield prediction, etc. The application of computers in agriculture was first reported in 1983. Different approaches have been suggested to solve the existing problems in the agriculture starting from the database to decision support systems. Out of these solutions, systems that apply AI have been found to be the most excellent performers as far as the accuracy and robustness are concerned. Agriculture is a dynamic domain where situations cannot be generalized to suggest a common solution. AI techniques have enabled us to

capture the intricate details of each situation and provide a solution that is best fit for that problem. Gradually very complex problems are being solved with the development of various AI techniques. This literature survey covers 100 important contributions where AI techniques were employed to encounter the challenges in agriculture. Three major AI techniques; Expert Systems, Artificial Neural Networks and Fuzzy systems are considered as the focused areas. This paper addresses the application of AI techniques in the major subdomain of agriculture so that the readers can capture the gradual development of agro-intelligent systems during last 34 years, from 1983 to 2017.

Issues pertaining to soil and irrigation management are very vital in agriculture. Improper irrigation and soil management lead to crop loss and degraded quality. This section highlights some researches carried out in soil and irrigation management assisted by artificial intelligent techniques. designed a rule based expert system for evaluation of the design and performance of micro irrigation systems. used farmers' knowledge to model a fuzzy based system to recommend crops depending on land suitability maps generated by the fuzzy system. Inference system to estimate the stem water potential of a plant based on meteorological and soil water content data. An artificial neural network-based system for estimation of soil moisture in paddy was designed by Arif et al. Other popular systems using artificial neural network for soil and irrigation include Broner and Comstock. Manek and Singh compared several neural network architectures in prediction of rainfall using four atmospheric inputs. This study found that radial basis function neural networks perform best in comparison to other models.

Crop diseases are also a matter of grave concern to a farmer. Significant expertise and experience are required in order to detect an ailing plant and to take necessary steps for recovery. Computer aided systems are being used worldwide to diagnose the diseases and to suggest control measures.

The disease prediction since a long time has become a great task for the farmers where the artificial intelligence aids freeing this job by making things easy at the same time more accurate.

At the counter side the things which is required either the physical or software cost eventually reaches the maximum extreme some may not be affordable.

FERTILIZER RECOMMENDATION METHODS FOR PRECISION AGRICULTURE – A SYSTEMATIC LITERATURE STUDY

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Spatial variability management of soil chemical attributes is one of the approaches to be employed in the face of the constant challenge of increasing agricultural yield to meet world demand. In this sense, precision agriculture has as one of its tools the application of inputs at varying rates, which seeks to determine the ideal amount of fertilizer at each point of the crop, contrary to the conventional recommendation approach based on average values. In this context, this work studied the fertilizer recommendation methods used in site-specific nutrient management and the calculation methodologies for N, P, and K recommendations. For this purpose, a systematic literature study (SLS), consisting of systematic literature mapping, snowballing, and systematic literature review was performed. The analysed studies were grouped into five domains (precision agriculture, soil fertility, site-specific nutrient application, fertilizer recommendation methods, and recommendation software for site-specific nutrient application). As a result, the SLS identified 12 methods for recommending N, nine for recommending P, and six for recommending K, in addition to five computer programs for precision agriculture that perform fertilizer recommendations at varying rates.

Software for recommending fertilizers with a focus on precision agriculture
We sought to identify, throughout the SLS process, which cited software had the functionality to carry out fertilizer recommendation at varying rates

- Nutrient Expert (NE) system: Decision support tool for fertilizer recommendation based on (i) characteristics of the growing environment, such as water availability (e.g., irrigated, totally rainy, and supplementary rain) and occurrences of flood or drought; (ii) soil fertility indicators (e.g., soil color and texture, and organic matter content), soil test for P or K (if any), historical use of organic materials (if any), and problematic soils (if any); (iii) cutting sequence in the farmer's cutting pattern; (iv) crop residues, inputs, and fertilizers management; and (v) farmers' current income. The system advocates site-specific nutrient management using the 4R nutrient management technique: (i) applying the right nutrient

source, (ii) at the right rate, (iii) right time, and (iv) right place. This system can provide a recommendation of specific nutrients for small farmers who do not have access to soil tests. Therefore, it was designed to work with or without soil testing. The NE system estimates yield based on crop conditions, determines the nutrient balance in the crop system based on crop yield and the fertilizer applied to the previous crop, and combines this information with soil characteristics to generate a specific nutrient recommendation for the location.

1. RISSAC-RIA: Computerized recommendation system designed to help farmers rationally and economically use the available nutritional resources. The system includes fertilizer recommendations for 48 main crops, developed by experts from two academic institutes, the Research Institute for Soil Science and Agricultural Chemistry (RISSAC) in Budapest and the Agricultural Research Institute in Martonvásár, Hungary.

2. Nutrient Manager for Rice: Tool for decision making that consists of questions, which, according to the authors, can be answered within 15 minutes, without the need for soil analysis. The answers to the questions provide sufficient information to develop K and P recommendations for specific field fertilizers, using the approaches and algorithms described by Buresh et al.

3. SST Summit: System developed by the company SST Software, which produces other agricultural management systems with different purposes. The SST Summit allows working with soil fertility data to generate nutrient availability maps and fertilizer recommendation maps for application at varying rates. Also, it enables the creation of sowing maps at a varying rate

4. QUEFTS: Software that implements a model to analyze the effect of nitrogen, phosphorus, and potassium limitation on crops grown in tropical soils. This system uses a methodology of successive calculations of potential nutrient supply, actual nutrient uptake, yield ranges, and yield ranges combined in pairs, in addition to an estimate of production.

PREDICTION OF CROP YIELD AND FERTILIZER RECOMMENDATION USING MACHINE LEARNING ALGORITHMS

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Machine learning is an emerging research field in crop yield analysis. Yield prediction is a very important issue in agriculture. Any farmer is interested in knowing how much yield he is about to expect. In the past, yield prediction was performed by considering farmer's experience on field and crop. The yield prediction is a major issue that remains to be solved based on available data. Machine learning techniques are the better choice for this purpose. Different Machine learning techniques are used and evaluated in agriculture for estimating the future year's crop production. This paper proposes and implements a system to predict crop yield from previous data. This is achieved by applying machine learning algorithms like Support Vector Machine and Random Forest on agriculture data and recommends fertilizer suitable for every crop. The paper focuses on creation of a prediction model which may be used for future prediction of crop yield. It presents a brief analysis of crop yield prediction using machine learning techniques.

Support Vector Machine SVM develops a hyperplane or set of hyper planes in a high-or boundless dimensional space, which can be utilized for characterization, relapse, or different errands. Naturally, a great partition is accomplished by the hyperplane that has the biggest separation to the closest preparing information purpose of any class, since by and large the bigger the edge the lower the speculation blunder of the classifier. The computational burden have to be reasonable, the mappings are utilized by the SVM plan to guarantee the tiny items will be figured as far as the variable in the first degree, for that a bit capacity k (x, y) chose to get the ideal computational time. Advantages of the SVM are listed here: SVM calculation has a regularization parameter, which stays away from over-fitting. SVM calculation utilizes the portion trap, so you can construct master learning about the issue. Random Forest Random Forest is a supervised machine learning algorithm based on ensemble learning. Ensemble learning is a type of learning where you join different types of algorithms or same

algorithm multiple times to form a more powerful prediction model. The random forest algorithm combines multiple algorithms of the same type. Random Forest algorithm can be used for classification and regression problems.

Advantages of the random forest algorithm are as follows:

- The random forest algorithm is not biased, since, there are multiple trees and each tree is trained on a subset of data.
- Random Forest algorithm is stable if a new data point is introduced in the dataset the overall algorithm is not affected.

From ancient period, agriculture is considered as the main and the foremost culture practiced in India. Ancient people cultivate the crops in their own land and so they have been accommodated to their needs. Since the invention of new innovative technologies and techniques in the agriculture field is slowly degrading. Due to these, abundant invention people are been concentrated on cultivating artificial products that is hybrid products where there leads to an unhealthy life. Nowadays, modern people do not have awareness about the cultivation of the crops in a right time and at a right place. Because of these cultivating techniques the seasonal climatic conditions are also being changed against the fundamental assets like soil, water and air which lead to insecurity of food. The machine learning learns the algorithm based on the supervised, unsupervised, and Reinforcement learning each has their importance and limitations. Supervised learning, the algorithm builds a mathematical model from a set of data that contains both the inputs and the desired outputs. Unsupervised learning-the algorithm builds a mathematical model from a set of data which contains only inputs and no desired output labels. Semi-supervised learning- algorithms develop mathematical models from incomplete training data, where a portion of the sample input does not have labels. This paper aims to improve the yield of the crop in several ways and recommends fertilizer suitable for every crop. As the prediction of crop yield under machine learning algorithm has many parameters and it becomes clumsy to predict the disease in the crop in an exact manner which is still an unsolved dispute in the machine learning world.

Soil Based Fertilizer Recommendation System for Crop Disease Prediction System

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India is an agricultural country and depends on agricultural products for their wellbeing. It is agriculture that promotes the economic growth and the development of our country. But recently many problems have been faced by the farmers due to certain natural calamities. Apart from these major calamities, they were also in lack of sufficient knowledge about the nutrients present in their soil. The characteristics of the soil type vary accordingly based on its nutritive value. Not only the soil type, the climatic condition and the usage of fertilizer also play a major role. Certain varieties of crops can be cultivated based on the climatic condition in their locality and accordingly the fertilizers can be preferred. In certain situation the usage of fertilizers also affects the cultivation. Under a climatic condition the cultivation of a right crop, usage of right fertilizer to the soil gives better yield. Mostly, fertilizers were recommended based on the nutrients present in the soil. Hence while preferring fertilizer the farmer needs to consider the soil type, the crop, and the pesticides. On using chemical fertilizer, the quality or the nutrients present in the soil was degraded, that promotes a decrease in the nutritive value of the soil. Another major factor to be considered is the disease in the crop cultivated. Identifying the disease in the plants and preferring appropriate fertilizer by the agriculturist to the farmers plays a major role. In earlier days, all these processes were carried out manually. But with the advancement of technology the entire system was digitalized. On considering all these the authors proposed a new framework that can be used in real life, which enables the farmers in solving certain problems.

In most of the existing methods, the process of finding the soil type, identifying the leaf disease, and preferring the fertilizer were all carried out manually. The method was prone to various disadvantages. Even when the framework was digitalized, it has certain problems as, predicting a diverse fertilizer for a soil type, certain files regarding the leaf disease or soil type or fertilizer International Journal of Engineering Trends and Applications. In other

situation the system may not provide the needed support. Hence in order to overcome some of these issues, the authors proposed a new approach.

Agriculture is the main aspect for the economic development of a country. Agriculture is the heart and life of most Indians. But in recent days, the field was going down due to various natural calamities. In order to overcome the problem, various issues in this field need to be addressed. The soil type, fertilizer recommendation, diseases in plants and leaves. All these features need to be considered. Our proposed system was organized in such a way, to analyse the soil type, diseases in the leaves and finally to recommend the appropriate fertilizer to the farmers, that may be of great help to them. Plant disease, especially on leaves, is one of the major factors that reduce the yield in both quality and quantity of the food crops. Finding the leaf disease is an important role to preserve agriculture. Smart analysis and Comprehensive prediction model in agriculture helps the farmer to yield right crop at the right time. The main benefits of the proposed system are as follows: Yield right crop at the right time, Balancing the crop production, control plant disease, Economic growth, and planning to reduce the crop scarcity. Hence to Detect and recognize the plant diseases and to recommend fertilizer it is necessary to provide symptoms in identifying the disease at its earliest. Hence the authors proposed and implemented new fertilizers Recommendation System for crop disease prediction.

In 2020, S.Yoganand addressed the problem of preventing crop disease using a naïve model which was monitored with the help of sensors. Internet of things (IoT) is a promising technology which provides efficient and relevant solutions towards the modernization of agricultural domains. Humidity and Temperature sensor was deployed to verify the humidity and the atmospheric temperature of the plant. Similarly soil moisture sensor was deployed to get status of the soil. Sensors, webcam, GSM and Controllers were used by them for receiving the data from the groundnut farm. The received data was analysed using machine learning models (XG boost) and so the prediction of crop disease was done. Thus, a novel approach for preventing the crop disease (Groundnut Crop) was proposed and their prediction was intimated to farmers through SMS/E-mail

To predict the crop this method goes with predicting the soil first and then to the crop, where the soil-based experiment is a new method of predicting the disease on the crop.

But each time the shortcomings of soil and the crop may or may not be the same which becomes a pitfall from another side.

Fertilizers Recommendation System for Disease Prediction in Tree Leave

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Detection and recognition of plant diseases using machine learning are very efficient in providing symptoms of identifying diseases at its earliest. Plant pathologists can analyse the digital images using digital image processing for diagnosis of plant diseases. Application of computer vision and image processing strategies simply assist farmers in all the regions of agriculture. Generally, the plant diseases are caused by the abnormal physiological functionalities of plants. Therefore, the characteristic symptoms are generated based on the differentiation between normal physiological functionalities and abnormal physiological functionalities of the plants. Mostly, the plant leaf diseases are caused by Pathogens which are positioned on the stems of the plants. These different symptoms and diseases of leaves are predicted by different methods in image processing. These different methods include different fundamental processes like segmentation, feature extraction and classification and so on. Mostly, the prediction and diagnosis of leaf diseases are depending on the segmentation such as segmenting the healthy tissues from diseased tissues of leaves.

A digital camera or similar devices are used to take images of different types, and then those are used to identify the affected area in leaves. Then different types of image-processing techniques are applied to them, the process those images, to get different and useful features needed for the purpose of analysing later-Plant leaf disease identification is especially needed to predict both the quality and quantity of the First segmentation step primarily based on a mild polygonal leaf model is first achieved and later used to guide the evolution of an energetic contour. Combining global shape descriptors given by the polygonal model with local curvature-based features, the leaves are then classified overleaf datasets. In this research work introduce a method designed to deal with the obstacles raised by such complex images, for simple and plant leaves. A first segmentation step based on graph-cut approach is first performed and later used to guide the evolution of leaf boundaries, and implement classification algorithm to classify the diseases and recommend the fertilizers to affected leaves.

Segmentation: Implements Guided active contour method. Unconstrained active contours applied to the difficult natural images. Dealing with unsatisfying contours, which would try and make their way through every possible grab cut in the border of the leaf. The proposed solution is used the polygonal model obtained after the first step not only as an initial leaf contour but also as a shape prior that will guide its evolution towards the real leaf boundary.

Disease Prediction: Leaves are affected by bacteria, fungi, virus, and other insects. Support Vector Machine (SVM) algorithm classifies the leaf image as normal or affected. Vectors are constructed based on leaf features such as colour, shape, textures. Then hyperplane constructed with conditions to categorize the pre-processed leaves and also implement multiclass classifier, to predict diseases in leaf image with improved accuracy.

Fertilizer Recommendation: Recommend the fertilizer for affected leaves based on severity level. Fertilizers may be organic or inorganic. Admin can store the fertilizers based on disease categorization with severity levels. The measurements of fertilizers suggested based on disease severity.

This further research is implementing the proposed algorithm with the existing public datasets. Also, various segmentation algorithms can be implemented to improve accuracy. The proposed algorithm can be modified further to identify the disease that affects the various plant organs such as stems and fruits.

Image Classification Steps: The proposed image classification technique is divided into the following steps: Image acquisition: To get the image of a leaf so that evaluation in the direction of a class can be accomplished.

Pre-processing: The purpose of image pre-processing is improving image statistics so that undesired distortions are suppressed and image capabilities which are probably relevant for similar processing are emphasized. The pre-processing receives an image as input and generates an output image as a grayscale, an invert and a smoothed one.

A Comprehensive Review on Automation in Agriculture using artificial intelligence

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Authors: Kirthan jah, Aalap Joshi

With the advent of technology in this digital world, we humans have pushed our limit of the thinking process and are trying to coalesce normal brain with an artificial one. This continuing exploration gave birth to a whole new field Artificial intelligence. It is the process by which a human can make an intelligent machine. AI comes under the domain area of computer science which can be able to discern its milieu and should thrive to maximize the rate of success. AI should be able to do work based on past learning. Deep learning, CNN, ANN, Machine learning are certain domains which enhances the machine work and helps to develop a more advance technology.
The term IOT is elucidated as "thing to thing" communication. The three main targets are communication, automation and cost saving in the system. Dr. D.K. Sreekantha, Kavya.A.M provides the in-depth application of IOT in the field of agriculture and how it can be helpful to the humans.

AI has penetrated in medical science, education, finance, agriculture, industry, security, and many other sectors. Implementation of AI involves learning process of machines. This brings us to a sub-domain in this AI field "Machine learning." The sole purpose of machine learning is to feed the machine with data from past experiences and statistical data so that it can perform its assigned task to solve a particular problem. There are many applications which exist today which includes analysing of data from past data and experience, speech and face recognition, weather prediction, medical diagnostics. It is because of machine learning that the domain of big data and data science has evolved to such a great extent. Machine learning is a mathematical approach to build intelligent machines.

As AI stimulated, many new logics and method were invented and discovered which makes the process of problem- solving simpler. Such methods are Fuzzy logic, Artificial neural networks (ANN), Neuro-fuzzy logic, Expert system.

Over the past 50 years, there has been a sustainable development in artificial intelligence due to its robustness in the application and is pervasive in every field. One such field is agriculture.

Agriculture faces many challenges daily and is not smooth-running business. Some of the problems faced by farmers from seed sowing to harvesting of crops are as follows: Crop diseases infestations, Lack of storage management, Pesticide control, Weed management

Artificial Intelligence and Machine learning has penetrated each category mentioned above. Banerjee et al. (2018) segregated advancements in AI category wise and gave a brief overview on various AI techniques. Computers and technology started penetrating in this sector from 1983 onwards. Since then, there have been many suggestions and proposed systems for betterment in agriculture from the database to decision making process. Filtering out every process, only AI based systems have proved to be the most feasible and reliable one. The AI-based method does not generalize the problem and gives a particular solution to a particular defined complex problem. The literature survey covers major breakthroughs in the domain of agriculture from early 1980s to 2018. The paper discusses more than fifty advancements in technologies in the sub domain of agriculture. First it discusses penetration of Artificial neural networks and expert systems to solve above mentioned problems, then machine learning and fuzzy logic system. Lastly it covers automation and IOT in the agriculture.

Artificial neural networks in agriculture

Artificial neural networks have been incorporated in the agriculture sector many times due to its advantages over traditional systems. The main benefit of neural networks is they can predict and forecast on the base of parallel reasoning. Instead of thoroughly programming, neural networks can be trained. Gliever and Slaughter (2001) used ANN to differentiate weeds from the crops. Maier and Dandy (2000) used neural networks for forecasting water resources variables. Song and He (2005) brought together expert systems and Artificial neural networks in predicting nutrition level in the crop. Traditional ES (Expert systems) have considerable backdrops when it is being implemented. Use of ANN makes it up to all glitches of ES. The whole system is built on a single chip computer. Neural networks always prove to be the best when it comes to predicting methods.