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Application of Machine Learning in Agricultural Automation

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Abstract

A new opportunity for data intensive science in the multi-disciplinary agri-technologies domain is the agricultural automation. The food security of the blooming population is the main concern for developing countries. The existed traditional methods aren't sufficient enough to serve the increasing demand and so they have to hamper the soil by using harmful pesticides in an intensified manner. This affects the traditional agricultural practice and in the end the land remains barren with no fertility. Machine learning is one of automation technique with several applications in agriculture. Today, there is an urgent need to decipher the issues like use of harmful pesticides, insects/pest resistance, climate change, soil infertility and effects of agricultural practice on environment etc. Automation of farming practices has proved to increase quality and quantity of agriculture products with huge share in global economy.

Introduction

Agriculture is the basis of developing countries holding more than 60% share in the global economy. The continued expansion of population builds a pressure on agro-system. The incorporation of digital platform in day-to-day life making things easier for local people. Digital agriculture, have arisen as new scientific fields that use data intense approaches to drive agricultural productivity while minimizing its environmental impact (Liakos *et al.,* 2018). The data generated in modern agricultural operations is provided by a variety of different sensors that enable a better understanding of the operational environment (an interaction of dynamic crop, soil, and weather conditions) and the operation itself (machinery data), leading to more accurate and faster decision making system. Machine learning (ML) has emerged together with big data technologies and high-performance computing devices to create new opportunities to unravel, quantify, and understand data intensive processes in agricultural operational environments. Machine learning can be defined as the scientific method that will allow machines the ability to learn without programming the devices. Machine learning is used in various scientific areas such as Bioinformatics, Biochemistry, Medicines, Meteorology, Economic Sciences, Robotics, Food Security and Climatology.

Application of Machine Learning in Agriculture

Precision Agriculture

Machine learning algorithms is applied in "Precision farming" which uses real-time and historical data to make specific decisions for particular areas of the application, instead of performing the same task for a very large area as in traditional approaches. For instance, instead

of using large quantities of pesticides to larger areas, one can apply smaller amounts to particular infected area only led to reduced costs and waste, and environmental pollution that a chemical can cause when used in large quantity. Prospera, a company that turns agriculture into data-based practices is an example of precision farming. Prospera uses field video cameras, sensors and meteorological data to monitor and provide crop information in real time. Analysis of collected data was done using Algorithms and computer vision. This initial step will help in finding and eliminating early signs of disease resulted in preventing damage and increase yields in latter stages.

Species Breeding

Species selection from bulk of germplasm is a tedious process. Screening of specific genes that withstand with the adversity of agro-system via traditional methods is laborious. Machine learning, specifically deep learning algorithms, took large field data for analyzing crops performance in various climates and newly developed characteristics. The probability model was constructed based on this data, which predict which genes will most likely contribute a beneficial trait to a plant.

Species Recognition

Plant classification through traditional method would be based on color and leaf shape comparison while machine learning analyzing leaf vein morphology which provide more accurate and faster results and carries more information about the leaf properties. The pest control companies are using them to identify the various bacteria's, bugs and vermins. A company named Rentokil is using this technology to identify the bugs and vermin. Other companies are making Android app which is developed by Accenture to find bugs. The system takes the pictures of the bug and runs on the application called as PestID. When a bug is identified in app it will provide an immediate solution which helps the technician to take further actions. It will also recommend the chemical to be used to kill the bugs.

Soil Management

Soil is a heterogeneous mixture of natural resource, with complex processes and indistinct mechanisms. Soil temperature give brief effects of climate change on the regional yield. Machine learning algorithms study detail process of evaporation, soil moisture content and temperature to understand the dynamics of ecosystems which strongly effects agriculture.

Water Management

Machine learning applications are connected with estimation of daily, weekly, or monthly evapo-transpiration. Water management in sustainable way impacts in hydrological, climatologically and agronomical balance. The estimation of effective use of irrigation system and prediction of daily dew point temperature is the basic principle for which ML based application are connected. This helps to identify expected weather phenomena and estimation of evapo-transpiration and evaporation.

Yield Prediction

Yield prediction and yield estimation is the basic output that is ultimately required. Precision agriculture deals with yield mapping and estimation, matching of crop supply with demand, and crop management. The yield prediction through historical data is far beyond approach. The incorporation of computer vision and technologies provides historic data in one go and also comprehensive multidimensional analysis of crops, weather, and economic conditions for farmers and associated groups.

Table 1: Example of crop yield prediction

Crop	Observed features	Functionality	Result
Green Citrus	Image features (form 20-20 pixels digital images of unripr green citrus fruits) such as coarseness, contrast, directionality, line likeness, regularity, irregularity, brightness, smoothness and fineness	Identification of the number of immature green citrus fruit under natural outdoor condition	80.4% accuracy
Cherry	Colored digital images depicting leaves, branches, cherry fruits and the background	Detection of cherry branches with full foliage	89.6% accuracy
Coffee	Forty-two color features in digital images illustrating coffee fruits	Automatic count of coffee fruit on a coffee branch	Automatic count of coffee fruits on a coffee branch

Crop Quality

The detection and classification of crop quality can increase product price and reduce waste. In comparison with the human experts, machines can analyze the seemingly meaningless data and interconnections between them to reveal new qualities that are playing role in the overall crop quality.

Disease Detection

The traditional approaches uses uniformly spraying of pesticides in pest and disease control both in open field and in greenhouse conditions. This approach requires significant amounts of pesticides which results in a high financial and significant environmental cost. With the help of machine learning agro-chemicals input is targeted in terms

of time, place and affected plants. Example -detection and discrimination of healthy *Silybum marianum* plants from those infected areas by smut fungus *Microbotyum silybum* area. A new system was also developed for the detection of nitrogen stressed, and yellow rust infected and healthy wheat crop based on hierarchical self-organizing classifier and hyperspectral reflectance imaging data. The study aimed at the accurate detection of these categories for a more effective usage of fungicides and fertilizers according to the plant's needs (Pantazi *et al.,* 2017).

Weed Detection

Weeds are the threats to crop production as their identification is difficult when present in growing crops. Computer vision and ML algorithms can improve detection and discrimination of weeds at low cost and with no environmental issues and side affects e.g. **Hortibots**. In future, it was proposed that these technologies will drive robots that will destroy weeds and minimizing the need for herbicides.

Automated Irrigation Systems

Working under large fields and maintaining the agronomic practices are tedious process and further the dependency of agro-fields on weather conditions are also making it more difficult to manage. Automated irrigation systems are employed for continuously maintenance of requisite soil conditions in order to achieve increment in average yield. This will reduce production costs and human labor consumption. Irrigation systems through automation are crucial for optimizing and accounting for water consumption statistics. Many scientists believe that these technologies will subsequently have a global impact on global water supply processes.

Robocrop: Smart Robots for Picking Fruit

Many leading technology companies have been working from long time on the innovation approach to reduce human intervention such as Blue River Technology. Agriculture has become one of the key areas where such equipment has become extremely necessary and useful. Smart tractors equipped with software with "ready" intellectual technologies like sensors, radars, GPS systems that go around the fields, cultivating harvesting the land, without needing a driver. With such technologies it is possible to cultivate large area in short time.

Conclusion

Traditional methods in agriculture are not able to fulfill the demand of increasing population due to lack of awareness and unavailable resources. Agricultural monitoring through the modern technology making things very easier for farmers as it reduces labor load as well as increase productivity by ensuring proper field management. This will reduce the import exchange in the country and helps in overall growth at global level. Many loop holes in existed system and the alarming need to protect the agricultural land leads to the development of agriculture automation that bring technology revolution in agriculture in the coming eras.

Figure 1: Hortibot It is about 3-foot-by-3foot. is self-propelled. and use global positioning system (GPS). It can recognize 25 different kinds of weeds and eliminate tham by using its weed-removing attachments.

Figure 2: Drones Easy-to- fly devices that are designed to spray pesticdes on crops. It is possible to capture high resolution images of whole field for further analysis

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