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USE OF ARTIFICIAL INTELLIGENCE (AI) IN AGRICULTURE

BY

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Abstract

This review paper took a cursory look at the important role and benefits of artificial intelligence in agriculture. The paper identified and enumerated the two major components of AI as: (1) Growth is driven by cognitive intelligence and (2) Image-based insights generation. In the use of cognitive intelligence AI makes use of proximity sensing and remote sensing while in image-based insights generation. AI uses in depth field analysis and scanning of fields using Cognitive Vision Technologies (CVT). Other areas that AI can benefit agriculture were highlighted such as crop disease detection, Crop readiness identification, weather prediction, use of drones in aerial operations and precision farming. Some challenges in the use of AI in agriculture were identified. The paper recommended that these cognitive technology solutions be made available and affordable to reach every farmer in the world.

INTRODUCTION

According to the prediction of Food and Agriculture Organization, FAO, (2017) the global population is set to reach 9.2 Billion by the year 2050. This means that the global agriculture sector is under more strain than ever. With 2 billion more mouths to feed within the next 31 years and with available average estimate at just an additional 4%, it seems it is no longer an option to simply plant more crops and rear more animals. In fact, what is needed is greater efficiency within the current farming systems and methods as farmers will be required to do more with less. It is as a result that experts are prescribing the use of artificial intelligence as a possible solution to the looming global food security problem.

Artificial Intelligence (AI) is intelligence exhibited by machines. It involves the use of cognitive technologies that help in understanding, learning, reasoning, interaction, prediction etc. The principles of Artificial Intelligence is one where a machine can perceive the environment and through a capacity of flexibility then rationally take action to address a specified goal related to that environment. This is based on the hypotheses that it is possible for machines to learn to solve any problem on earth relating to the physical interactions of all things within a defined environment. (Artificial Intelligence, 2017a)

The Scope of Artificial Intelligence

- Application of artificial intelligence: Artificial intelligence has been adopted and applied in a wide range of areas including medical diagnosis, stocks trading, robot control, law, scientific research and investigations.
- Machine learning: This is when a machine according to a specified set of protocols, improves in its ability to address problems and goals related to the environment as the statistical nature of the data it receives increases. In other words, as the system receives an increasing amount of similar set of data that can be categorized into specified protocols, its ability to rationalize increases, allowing it to better ‘‘product’’ on a wide range of outcomes.
- Synthetic Intelligence (SI): This is an alternative to artificial intelligence which emphasizes that the intelligence of machines need not be an imitation.
- Artificial Brain (Artificial Mind): Is a term commonly used in the media to describe research that aims to develop software and hardware with cognitive technologies.
- Ethics of Artificial Intelligence: As part of the ethics of technology specific to robots and other artificially intelligent beings.
- Glossary of Artificial Intelligence: This is a glossary of policies and guidelines relating to the use of AI, its sub – disciplines and related fields’ (Wikipedia, 2019).

Taking a cursory look on the scope of AI in agriculture it has been established that agriculture is witnessing rapid adoption of artificial intelligence and machine learning (ML) both in terms of agricultural production and farming techniques. Technological advances such as Chatbots for farmers are conversational virtual assistants who automate interactions with end users. Chat bots are used mostly by retail, travel, media or insurance players. Agriculture could also leverage on it in assisting farmers with answers to their questions, giving advice and recommendations on specific farm practices and data generated by sensors or agricultural drones collected at farms about soils, seeds, livestock, crops, farm costs, farm equipment, or the use of water and fertilizers. Advanced analytics using the internet help farmers analyze real time data like the vagaries of weather (temperature, humidity, etc), price or how to optimize and increase yields, improved farm planning, make good decisions and prevent waste.(Artificial Intelligence,2017b). This study was conceived and carried out to bring to light the areas of Artificial Intelligence (A1) that can benefit agriculture. Some of these areas are: Growth driven by cognitive intelligence. Large volume of data are generated every day in both structured and unstructured format. These are related to data on: Historical weather patterns, soil reports, new research, rainfall, Pests infestation e t c.

Cognitive technologies such as drones and cameras can sense all these data images and provide strong insights to improve agricultural production, the two cognitive technologies that are primarily used for intelligent data fusion are proximity sensing and remote sensing.The proximity sensing is used for soil testing and capturing other high resolution data. Remote sensing requires sensors to be built into airborne or satellite systems while proximity sensing requires sensors to be in contact with the soil or at very close range. (Arka, 2018a). Image – Based Insight Generation and Drone – based images can help in indepth field analysis, crop monitoring and scanning of fields etc. Computer Vision Technology (CVT) can be combined with drone data and other cognitive technologies to help farmers in precision farming. Other areas where computer vision technology can be put to use in agriculture include:

i. Crop Disease Detection

This involves three stages of capture of images, preprocessing and transmission to remote laboratories. Preprocessing of images ensure the plant part images are segmented into areas like background, non-diseased part and diseased part. The diseased part is then removed and sent to remote laboratories for further diagnosis. This also helps in pest identification, nutrient deficiency recognition and more.

ii. Crop Readiness Identification

This involves capturing images of different crops under white/UV – A light to determine how ripe the green fruits are. Using these technology farmers can create different levels of readiness based on the crop/fruit category and add them into separate stacks before sending them into the market.

iii. Field Management

This involves using high definition images from airborne systems such as drones and helicopters where real time estimates can be made during cultivation by creating a field map and identifying areas where crops require water, fertilizer or pesticides. This helps in optimum use of farm inputs.

iv. Weather Predictions and Crop Sustainability

This involves the use of machine learning technologies in connection with satellites to predict weather, analyze crops sustainability and evaluate farms for the presence of pests and diseases.

v. Health Monitoring of Crops

This involves remote sensing techniques along with hyper spectral imaging and **3-D** laser scanning to build crop metrics across thousands of areas. This has the potential to bring in revolutionary change in terms of how farmlands are monitored. This technology can also be used to monitor crops along their entire life cycle.

vi. Automation Techniques in Irrigation

This involves training machines on historical weather patterns, soil quality and kind of crops to be grown can automate irrigation and increase overall yield. With close to **70%** of the world's fresh water being used in irrigation, automation can help farmers to manage their water problems better. **(Arka, 2018b).**

Driverless Tractors

Most operations in the world today are technology-driven. Technology firms have been developing driverless vehicles for quite some time now and agriculture is not left out in this growing technology. With a combination of sophisticated software and other cognitive technologies such as sensors, radars and GPS systems farmers can now remote control their tractor operations or even hand over the tractors to robots to operate in place of humans. This innovation will boost production, reduce pressure on overstretched farm labour and bring more acres into agricultural production circle.

Farm Bot

This cognitive technology was founded in 2011; it has taken precision farming to a different level by enabling environment conscious people with precision farming technology grow crops at their own pace. The farm Bot helps the owner to do end-to-end farming all by himself ranging from seed sowing, weed detection, soil testing, watering of plants etc. In fact, everything is taken over by this physical “bot” using an open source software system**. (Watson, 2015a)**

Use of Drones

Drone-based solutions in agriculture have a lot of significance in terms of managing diverse weather conditions, productivity gain, precision farming and yield management. Before the crop cycles, drones can be used to produce a 3-D field map of detail terrain, drainage, soil viability and irrigation nitrogen level management can also be done by drone solutions. Aerial spray of plots with seeds and plant nutrients provide necessary supplements to plants. Apart from that drones can be programmed to spray liquids by modulating distance from the ground depending on the terrain. Crops monitoring and health assessment is one of the most significant areas in agriculture to be provided with drone-based solutions in collaboration with artificial intelligence and computer vision technology.

High resolution cameras in drones collect precision field images which can be passed through convolution neural net to identify areas with weeds, which crops need water, plant stress level in mid growth stage. Scanning with near – infra red light can generate multi spectral images using drone devices. With this it is possible to specify or detect infected plants and their location in a vast field and apply remedy instantly. (**Watson, 2015b)**

6. Precision Farming:

This is a more accurate and controlled technique that replaces the repetitive and labour intensive part of farming. It also provides guidance about crop rotation, optimum planting and harvesting time, water management, nutrient management, pest attack etc. Key components of precision farming technologies include high precision position system, automated steering system, geo mapping, sensor and remote sensing, integrated electronic communication and viable rate technology.

Objectives of Precision Farming

1. **Profitability:** Identifying good crops for sale (marketing strategy)
2. **Efficiency:** Better, faster, and cheaper farming as it enables accurate and efficient use of resources
3. **Sustainability:** Ensures improvement in social, economic and environmental performance throughout the production period

Examples of precision farming management

- Stress identification in plants using high resolution images and multiple sensor data on plants. These large sets of data from multiple sources need to be used as an input for machine learning to enable data fusion and feature identification for stress recognition.
- Machine learning models trained on plant images can be used to recognize stress levels in plants. The entire process can be classified into four stages of identification, classification, quantification and prediction to make better decisions , **(Justin, 2016a)**

Challenges in Artificial Intelligence Adoption in Agriculture

Agriculture is one of the most difficult fields to contain for the purpose of statistical quantification; even within a single field, conditions are always changing from one section to another. There are unpredictable weather conditions, changes in soil quality, diseases and pest infestation etc. Although, artificial intelligence offer vast opportunities for application in agriculture there still exist low level of familiarity with high tech machine learning solutions across most parts of the world.

Another challenge is the issue of impact of variance, for example, what may occur with the same seed and fertilizer in three different regions of the world would be unrelated. These factors that impact on variance includes the measurement of rain per unit of a crop planted, soil type, pattern of soil degradation, daylight hours, temperature and so forth. Since no two environments are exactly alike it makes the testing validation and successful roll out of cognate technologies more cumbersome in agriculture than in other industries.

One other challenge in the offing is intelligence explosion which simply means that in future the use of these cognitive technologies can reach an avalanche where robots or other technology creations will take over the work of man in our farms. Finally, these cognitive solutions are very expensive. For example, farmBot costs as high as 4000 US dollars per unit therefore, they are not affordable so their impact or use is limited and coverage low. **(Justin, 2016b).**

Conclusion

Agriculture the world over is witnessing what is referred to as technological revolution and the enabler of this revolution is Artificial Intelligence (AI). Drones, robots and intelligent monitoring systems are now successfully being used in research. Machine learning is set to revolutionize the future of farming while the next phase of ultra precision or precision farming is on the horizon. In addition, AI can ease farmers work, remove a large number of people from farms. Farming can be done remotely, processes will be automated, risks will be identified and issues solved before they occur and farmers can make more informed, rapid and real time decisions. However, these innovative solutions need to become more affordable to ensure that the technologies reach every farmer in the world.

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