Artificial Intelligence In Agriculture: The Future Of The Agricultural Industry

Abstract - Food remains one of the most basic needs of man. With an estimated population increase, Agricultural practices should become more efficient and cost-effective to increase productivity to match demand. This paper examines various Artificial Intelligence techniques and the impact of their adoption on the future of Agriculture.

1. INTRODUCTION

The United Nations' Department of Economic and Social Affairs predicts that world population would rise to 11.2 Billion by the end of the 21st century and this will be 47.37% higher than its current value[1]. This rapid increase will be characterized by scarcity of resources especially food, requiring that agricultural processes are more effective and efficient to eradicate waste and improve overall productivity whilst using as little resources as possible. This level of productivity is made possible through Precision Agriculture (PA)[2]. Precision Agriculture is the use of a low-input, high-output efficiency system in agriculture and it is primarily driven by Artificial Intelligence (AI). This paper covers four main areas of AI and how it can be implemented in agriculture to improve overall productivity[3].

2. ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) refers to developing systems that behave like humans concerning data acquisition, reasoning and making decisions in complex and cognitive tasks that produce performances with equal or even greater efficiencies than humans[4]. The future of agriculture is dependent on our ability to makes our processes more effective, minimize waste, and maximize resources leading to overall productivity. This is made possible by implementing precision agriculture which is powered by artificial intelligence on the fronts, some of which are discussed below;

2.1 BIG DATA ANALYTICS

As years roll by, the agriculture industry evolves and therefore its future will be dependent on our ability to extract value from the rapidly growing data sets that characterize the field. The use of big data analytics to identify correlations, recognize trends and discover patterns that are crucial in ensuring that processes are productive, will be dependent on its characteristics which include (but not limited to) volume, veracity, value, variety, velocity, valence, valorization, visualization etc.[5]

Big data analytics collates data from various sources, analyzes and simplifies the data, and then uses a good visualization tool to display the result enabling better understanding for the user and hence better decision making. Big data is essential for precision agriculture to be implemented[6].

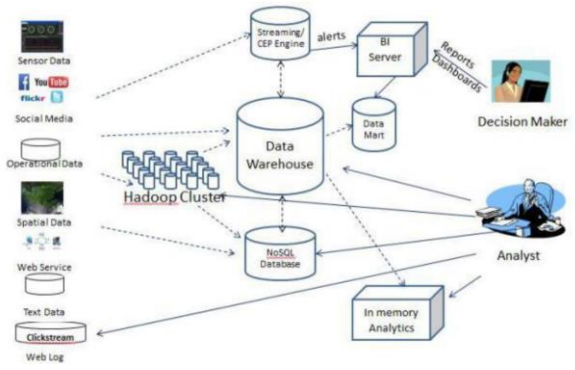

FIG 1: BIG DATA ENVIRONMENT SHOWING VARIOUS SOURCES OF DATA [6]

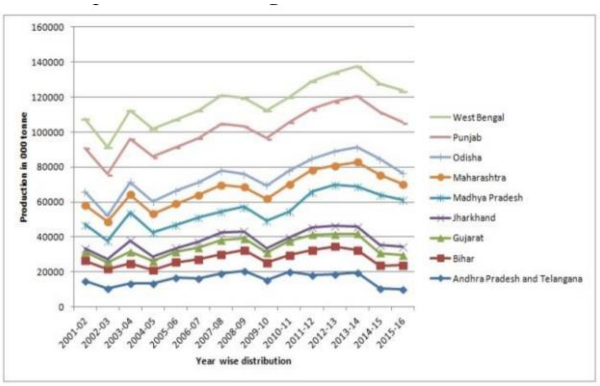

FIG 2: AN EXAMPLE OF ANALYZED DATA BEING DISPLAYED – FOOD PRODUCTION DATA IN A PARTICULAR AREA BETWEEN 2001 AND 2015.[6]

2.2 COMPUTER VISION

Computer vision requires the use of a system to capture physical changes in the environment for further analysis, and this is essential to the application of machine learning, automation and robotics in agriculture. It uses cameras, computers and Unmanned Ariel Vehicles(UAVs) such as drones to effectively monitor crop and livestock growth. Computer Vision aids early detection and avoidance of diseases and pests, as well as enabling quality inspection of produce and effective management of farms[7]. It can be combined with deep-learning algorithms to process agricultural data which will be used in eradicating threats to food security such as weed and soil degradation[8]. Computer vision can also be implemented in ensuring the security of agricultural areas equipment and products from physical threats and biological hazards.

FIG 3: APPLICATION OF DRONES FOR REMOTE SENSING AND IMAGE PROCESSING [9]

2.3 MACHINE LEARNING

The future of the agricultural industry employs the use of machine learning algorithms and models implemented in specialized systems to instruct the performance of tasks. It does not have to rely on the input of instructions but deduction and inductions based on patterns obtained from training data[10]. Machine learning is effective as a predictive analysis tool for analyzing and predicting weather and crop sustainability in an area. It collates, analyzes and trains data from natural sources like rainfall, temperature and solar radiation which it then uses to develop patterns that are employed when performing (or instructing) tasks.

Other important factors affecting agriculture such as soil management, yield prediction, crop quality, species breeding, weed and disease detection can be improved by Machine Learning using high-precision algorithms[11, 12].

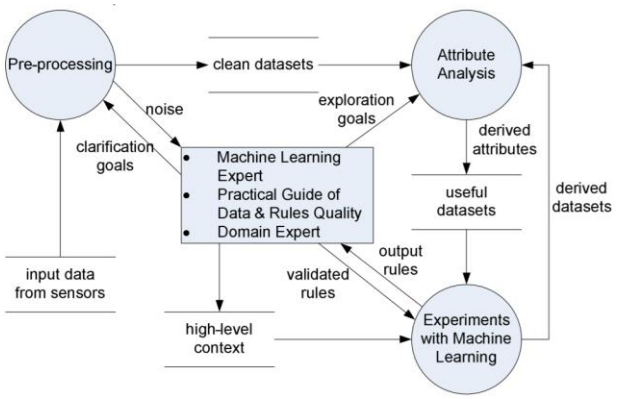

FIG 4: THE MACHINE LEARNING PROCESS MODEL [13]

2.4 ROBOTICS

Automation and Robotics are already one of the most popular applications of AI in agriculture. However, its development is still essential to the future of the agricultural industry. The use of intelligent robots (which take informed decisions using computer vision and machine learning) to implement precision agriculture would ensure effective control and administration of agricultural processes[14]. An example is a robot built by Blue River Technology which identifies weeds using computer vision and kills them to save the plants[8]. Autonomous robots could be used for essential activities such as livestock breeding (including activities such

as cow milking), crop planting and harvesting etc. Although most robots are currently used in agriculture for routine tasks, we have already begun to see the gradual implementation of intelligent autonomous robots which elevate overall productivity. Some robots which are already being used include Blue river lettucebot2, RoBoPlant, Agribotix, Ecorobotix etc.[15]

FIG 5: A PICTURE OF THE ECOROBOTIX BEING USED TO SPRAY HERBICIDES ON WEEDS [15]

3. ADVANTAGES OF ARTIFICIAL INTELLIGENCE

I) The use of AI increases the yield of plants and reduces risk through its predictor nature such as in forecasting of weather based on previous weather data sets gathered[16].
II) Precision Agriculture has led to a decrease in the need for pesticides and herbicides.
III) AI has strengthened the agro-business and agro-allied industries as a result of the high and predictable farm yield[16, 17].
IV) The use of AI in farming reduces human labour requirements through the utilization of AI robots. This further reduces the labour time required and increases productivity[17].
V) As a result of precision farming, accurate predictions and deployment of AI robots in Agriculture, there is a reduction in the production cost of agricultural produce[16].
VI) There is a general increase in the general efficiency of agricultural processes as a result of the adoption of AI.

4. DISADVANTAGES OF ARTIFICIAL INTELLIGENCE

I) It is estimated that the advent of AI in agriculture would result in an increase in the number of unemployed field workers by the next decade[18].
II) Intelligent Robots remain out of reach for most farmers as a result of their high cost[19].
III) The potency of any AI model is largely dependent on data. Insufficient data sets would lead to a highly inaccurate model with faulty predictions.

5. CONCLUSION

Our quest to provide adequate agricultural produce to sustain human life is dependent on a huge number of underlying factors. Beginning from obtaining accurate data sources, high precision data analysis tools and the application of efficient agricultural processes, waste can be eliminated and food production increased. Furthermore, other revolutionary methods like vertical farming (which includes hydroponics, aquaponics and plantscaping), genetic editing and Blockchain technology should be applied for greater yield. This paper shows the ability of artificial intelligence to constructively deal with the challenges faced in the agricultural sector and provide a sustainable solution to the provision of adequate agricultural produce to feed the world, even as it grows.

REFERENCES

[1] U. Nations. (2017). *World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100*. Available: https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html#:~:targetText=The%20current%20world%20population%20of,Nations%20report%20being%20launched%20today.

[2] N. Zhang, M. Wang, and N. Wang, "Precision agriculture—a worldwide overview," *Computers and electronics in agriculture*, vol. 36, pp. 113-132, 2002.

[3] D. I. Patrício and R. Rieder, "Computer vision and artificial intelligence in precision agriculture for grain crops: A systematic review," *Computers and electronics in agriculture*, vol. 153, pp. 69-81, 2018.

[4] I. J. Rudas and J. Fodor, "Intelligent systems," *International Journal of Computers, Communications & Control*, vol. 3, pp. 132-138, 2008.

[5] M. K. Saggi and S. Jain, "A survey towards an integration of big data analytics to big insights for value-creation," *Information Processing & Management*, vol. 54, pp. 758-790, 2018.

[6] M. Kumar and M. Nagar, "Big data analytics in agriculture and distribution channel," in *2017 International Conference on Computing Methodologies and Communication (ICCMC)*, 2017, pp. 384-387.

[7] H. Tian, T. Wang, Y. Liu, X. Qiao, and Y. Li, "Computer Vision Technology in Agricultural Automation——a review," *Information Processing in Agriculture*, 2019.

[8] K. Sennaar. (2019). *AI in Agriculture – Present Applications and Impact*. Available: https://emerj.com/ai-sector-overviews/ai-agriculture-present-applications-impact/

[9] P. Ace, "The Most Thrilling Machine Learning and Computer Vision Use Cases in the Industry," 2019.

[10] S. Marsland, *Machine learning: an algorithmic perspective*: CRC press, 2015.

[11] Sciforce. (2019). *Machine Learning in Agriculture: Applications and Techniques*. Available: https://www.kdnuggets.com/2019/05/machine-learning-agriculture-applications-techniques.html

[12] K. G. Liakos, P. Busato, D. Moshou, S. Pearson, and D. Bochtis, "Machine learning in agriculture: A review," *Sensors*, vol. 18, p. 2674, 2018.

[13] S. Dimitriadis and C. Goumopoulos, "Applying machine learning to extract new knowledge in precision agriculture applications," in *2008 Panhellenic Conference on Informatics*, 2008, pp. 100-104.

[14] P. Baylou, "Agricultural Robots," *IFAC Proceedings Volumes*, vol. 20, pp. 111-119, 1987.

[15] D. Alexander. (2018). *9 Robots That Are Invading The Agriculture Industry*. Available: https://interestingengineering.com/9-robots-that-are-invading-the-agriculture-industry

[16] G. Bannerjee, U. Sarkar, S. Das, and I. Ghosh, "Artificial Intelligence in Agriculture: A Literature Survey," *International Journal of Scientific Research in Computer Science Applications and Management Studies*, vol. 7, pp. 1-6, 2018.

[17] R. v. Hooijdonk. (2018). *4 Ways Robotics Will Affect Agriculture in 2019*. Available: https://www.roboticsbusinessreview.com/agriculture/4-ways-robotics-change-agriculture-in-2019/

[18] A. Strong, "Applications of artificial intelligence & associated technologies," *Science [ETEBMS-2016]*, vol. 5, 2016.

[19] H. Soffar, "Artificial Intelligence in Agriculture advantages, disadvantages & uses," 2019.