

Ai and lot Precision Agriculture

¹Vishnu Prasad k, ²Nithin K, ³Nandish K B, ⁴Dushyanth Gowda,
⁵Chethan Kumar T, ⁶Divya C Brijesh.

^{1,2,3,4,5}TH Sem, Dept. of ISE Kit, Tiptur

^{5,6}Associate Professor Dept. of ISE Kit, Tiptur

Abstract - The agriculture sector is seeking innovative technologies for increasing food-grain production and productivity because of the rapid increase in population, unpredictable climatic changes and food security concerns. The inherently complex, dynamic, and non-linear nature of agricultural system require solutions based on advance techniques and technologies that can monitor, control, and visualize various farm operations in real-time to provide greater accuracy, better understanding, and appropriate solutions. Thus, artificial intelligence and internet of things is progressively emerging across all the industries including agriculture. Advancement in artificial intelligence and IoT based technologies has made revolutionary changes in agriculture to maximize the crop productivity. In this paper a comprehensive review on artificial intelligence and internet of things(IoT) in the areas of the agriculture is presented. The main objective of this paper is to review various potential applications of artificial intelligence and IoT such as robotics, drones, fertilizer application, weed and pest control, IoT based smart irrigation, real time weather forecasting etc.

Keywords - Artificial intelligence, Internet of things, Robotics, Smart irrigation
How to Cite: Vishnu Prasad k, Nithin K, Nandish K B, Dushyanth Gowda N; Chethan Kumar T; Divya C Brijesh (2025) AI AND IOT FOR Precision Agriculture. International Journal of Innovative Science and Research Technology, 10(12), 51-61.

I. INTRODUCTION

The global population is expected to reach 10 billion people by 2050 (FAO, 2017). This puts a huge burden on the agriculture sector to increase crop production and yield per hectare. The rapid increase in global population and high demand of quality products intensify the modernization and automation of agricultural practices which provides high efficiency and precision in the use of water and other resources like pesticides, fertilizers etc. (Pandey and Mukherjee 2022). Emerging technologies like artificial intelligence and IoT have the potential to revolution precision agriculture and smart farming

II. RELATED WORK

Smarter applications based on artificial intelligence and internet of things has huge potential to make the farming more controlled and precise. The brief details of applications of artificial intelligence and internet of things for precision agriculture are given below:

Robotics

One of the main aspects of agricultural robotics is concerned with the substitution of the human workforce by field robots or mechanized systems that can handle the tasks more accurately and uniformly at a lower cost and higher efficiency (Shamshiri et al., 2018). Agricultural field robots can play a key role in increasing productivity, quality, reducing production cost and enabling customized plant and crop treatments. A review of the recent advances in agricultural robotics for (i) harvesting (ii) field scouting and data collection, and (iii) weed control and targeted spraying are given below.

Harvesting robots

Traditional harvesting of fruits and vegetables for is a labor-intensive task that demands shifting from traditional manual operation to automated harvesting. Despite advancements in agricultural automation, millions of tonnes of fruits and vegetables are still hand-picked from open fields and greenhouses. Research on robotic harvesting of fruits and vegetable were carried out by many

researchers. Figure 1 shows some robotic harvesting platforms:

Harvey, an autonomous robotic harvester that can harvest sweet pepper with 46% success rate for unmodified crop, and 58% for modified crop grown in protected cropping environments (Lehnert et al., 2017).

an apple harvesting robot which uses image-based vision servo control system for harvesting apple. The average harvesting time was approximately 15s per apple and success rate of apple harvesting was 77% (De-An et al., 2011). (c) The citrus harvesting robot (Mehta et al., 2016) which uses a robust image-based visual servo controller to regulate a robotic manipulator to a target fruit in the presence of unknown fruit motion. (d) Dual robot coordination for fruit collection uses kinematically redundant picking manipulator with eight degrees of freedom for apple harvesting. Over 50% reduction of average cycle time resulted in pick-and-catch harvesting method as compared to the pick-and-place method (Davidson et al., 2017).



Fig. 1 Harvesting robots

Weed control and targeted spraying robots

Weed control and targeted spraying are the most needed applications for agricultural robots. Agricultural field robots not only substitute the traditional manual weed removal operation, but also reduces the application of agrochemical and pesticide on the field. Figure 2 shows:

RHEA (Emmi et al., 2014) uses advanced perception systems to identify crop status, including crop row detection and innovative actuation systems to remove or eliminate weeds directly as well as to apply herbicides and fertilizers precisely. (b) RIPPA (Bogue, 2016) is equipped with an array of cameras and sensor and is designed to operate autonomously to detect and classify weeds and

manage them either mechanically or chemically, as well as applying fertilizers for site-specific crop management. (c) Hort Bot (Sorensen et al. 2016) is a robust tool carrier that enable an automatic execution of one-sided repetitive weeding for outdoor gardening. (d) Green Trac (Sorensen et al. 2016) is a future tool carrier to be used in the growing season with light tools such as an inter-row cultivator for row crops.



Fig. 2 Weed control and targeted spraying robots

Field scouting and data collection robots

For providing reliable data and measurements, field scouting and data collection robots can be used and processed by precision agriculture and crop models. Field scouting robots are developed for data collection and modern farming, and improved sensors are used extensively for precision agriculture. Some of the agricultural field robots for automated field scouting and data collection are shown in Figure 3:



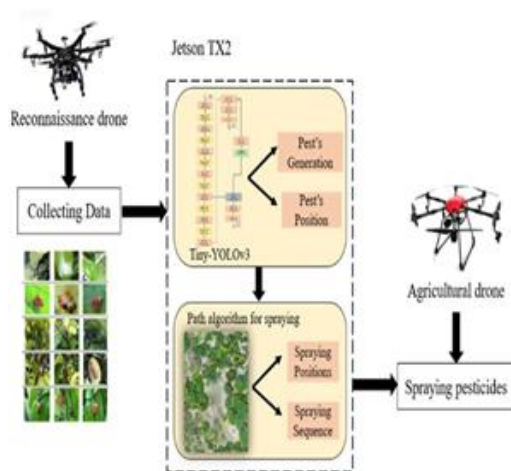
Fig. 3 Field scouting and data collection robots

III METHODOLOGY

A real time system that successfully detect trees in a scene and also recognizes them in each and every frame is developed by Bassine et al. (2018) to create detailed maps having information about trees health, sizes, stem density and trees distribution. To detect and count trees all image processing stages starting from camera raw image acquisition to image processing is done completely on C++ framework. To reduce the time gap between image collection and herbicide treatment Deng et al. (2020)

conducted real-time image processing onboard a UAV. A hardware environment is created for real-time image processing onboard a UAV that incorporates flight control, map visualization, image collection, and real-time image processing. To develop a lightweight network architecture for weed mapping tasks the proposed model design is exploited.

Novel applications for edge intelligence are applied by Chen et al. (2021) to establish an intelligent pest recognition system to manage the pest problem. The system architecture flow chart is shown in figure 5. To detect *T. papillosa* in the orchard, a detecting drone is used to photograph the pest and a Tiny-YOLOv3 neural network model built on an embedded system NVIDIA Jetson TX2 to determine the position of the pests in realtime. To plan the optimal pesticide spraying route for the agricultural drone pests' positions are used.



The system architecture flow chart (Chen et al. 2021)

Fertilizer Application

Variable fertilization technology is an important part of precision agriculture. This technology seeks to achieve on- demand fertilization and fixed-point fertilization greatly increases the utilization of fertilizers, reduces production costs, reduces the adverse impact of excess fertilizers on the environment, and increases farmers' income. The backward fertilization method, blind and extensive fertilization and severe partial planting have caused

problems such as the decline of crop yield, excessive harmful substances, groundwater pollution, and soil compaction in China.

These problems seriously affect the ecological environment and food safety, which are extremely unfavorable to our country's construct A centrifugal variable-rate fertilizer applicator is developed by Yinyan et al. (2018) to improve the spreading performance and fertilizer distribution uniformity. To simulate the field spreading performance of the developed centrifugal variable-rate fertilizer applicator and to evaluate the uniformity and consistency of fertilizer spreading simulation model is used. A novel method to optimize the control sequence (L, N) is presented by Zhang et al. (2019) to improve fertilization accuracy and uniformity, while guaranteeing the rapidity of equipment adjustment. By using an improved General Regression Neural Network (GRNN) the variable-rate fertilization process model was formed and by using a differential evolutionary (DE) algorithm the optimum spread parameter was calculated.

An Internet of Things (IoT) based system is developed by Lavanya et al. (2020) by designing a novel Nitrogen- Phosphorus-Potassium (NPK) sensor with Light Emitting Diodes (LED) and Light Dependent Resistor (LDR). Block diagram of proposed IoT based fertilizer intimation system is shown in figure 6.

To detect the deficiency of nutrients from the sensed data of fuzzy logic concept is applied. Since cloud services like google cloud platforms provide scalable, timely, uninterrupted service and this option can be utilized for SMS service. An alert message is sent to the farmer's mobile phones about the recommended fertilizer quantities.

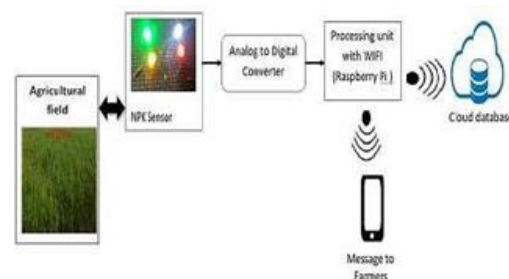
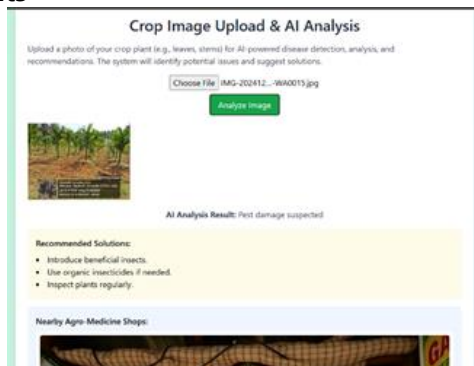
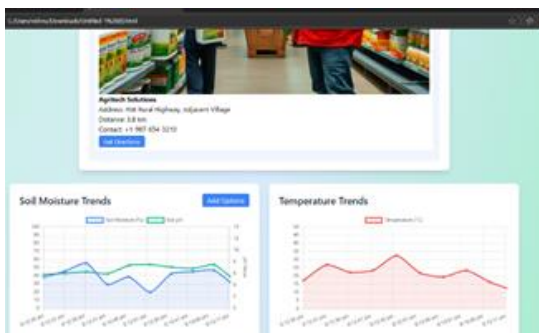


Fig. 6 Block diagram of proposed IoT based fertilizer intimation system (Lavanya et al. 2020)

Results



An image processing based real-time variable-rate chemical spraying system is developed by Tewari et al. (2020) for the precise application of agrochemicals in diseased paddy crop based on crop disease severity. To detect the diseased region of paddy plants the chromatic aberration (CA) based image segmentation method was used. A minimum 33.88% reduction in applied chemical is observed while operating in the VRA mode as compared with the CRA mode.



Irrigation is the one of the most important part of the agriculture. It plays an important role in crop productivity. Agriculture accounts for 83% of total water consumption in India (Hegde). For water supply for field farmers mostly depend on the rainfall. They need to depend on the available water resources if rainfall doesn't happen. Water scarcity is a major issue in remote locations, farmers mostly depends on underground water for irrigation. Improper management and unplanned use of water for irrigation results in high wastage of water. Hence to prevent wastage of water there is need to develop

systems for efficient water management. For efficient water management technological intervention has been started from years, but the evolution of the Internet of things has made revolutionary changes in the area of irrigation

IV. CONCLUSION

In the agriculture sector crop yields, soil and plant health, weeds, and disease are major issues that can be addressed with artificial intelligence and IoT-driven technology. From crop monitoring to autonomous harvesting robots, these technologies are rapidly revolution agriculture and making farmers lives easier and faster.

This review paper has provided an overall idea and state of art work regarding various potential applications of artificial intelligence and IoT in some core areas of agriculture, e.g. robotics, drones, fertilizer application, weed and pest control, IoT based smart irrigation, real time weather forecasting. Robotic harvesting and weeding have received more and more attention in the recent years due to the decrease of the workforce and the increase of production cost. Irrigation is one of the most critical operation of farming, but nowadays the farm owner can monitor the IoT enabled irrigation system online through remote access without going into the field.

An accurate and intelligent IoT system that automatically informs about the fertilizer can be accessed by farmers at the appropriate time through SMS. This study is an attempt to introduce the concept of agricultural automation through artificial intelligence and IoT in order to increase crop productivity with reducing labour and time.

REFERENCES

1. Anthony, D., Elbaum, S., Lorenz, A., & Detweiler, C. (2014, September). On crop height estimation with UAVs. In 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems (pp. 4805-4812). IEEE.
2. Bannerjee, G., Sarkar, U., Das, S., & Ghosh, I. (2018). Artificial intelligence in agriculture: A

- literature survey. International Journal of Scientific Research in Computer Science Applications and Management Studies, 7(3), 1-6.
3. Bassine, F. Z., Errami, A., & Khaldoun, M. (2018, December). Real time video processing using RGB remote sensing by drone. In 2018 International Conference on Electronics, Control, Optimization and Computer Science (ICECOCS) (pp. 1-5). IEEE.
 4. Bogue, R. (2016). Robots poised to revolutionise agriculture. *Industrial Robot: An International Journal*
 5. Chen, C. J., Huang, Y. Y., Li, Y. S., Chen, Y. C., Chang, C. Y., & Huang, Y. M. (2021). Identification of fruit tree pests with deep learning on embedded drone to achieve accurate pesticide spraying. *IEEE Access*, 9, 21986-21997.
 6. Chen, C., He, P., Zhang, J., Li, X., Ren, Z., Zhao, J., ... & Kang, J. (2018). A fixed-amount and variable-rate fertilizer applicator based on pulse width modulation. *Computers and Electronics in Agriculture*, 148, 330-336.
 7. Christensen, S., Heisel, T., & Walter, A. M. (1996). Patch spraying in cereals. In 2. International Weed Control Congress, Copenhagen (Denmark), 25-28 Jun 1996. SP..
 8. Dasgupta, A., Daruka, A., Pandey, A., Bose, A., Mukherjee, S., & Saha, S. (2019). Smart irrigation: IOT- based irrigation monitoring system. In *Proceedings of international ethical hacking conference 2018* (pp. 395-403). Springer, Singapore.
 9. de Souza, C. H. W., Lamparelli, R. A. C., Rocha, J. V., & Magalhães, P. S. G. (2017). Mapping skips in sugarcane fields using object-based analysis of unmanned aerial vehicle (UAV) images. *Computers and Electronics in Agriculture*, 143, 49-5