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USE OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE TO OPTIMISE IRRIGATION, PESTICIDE AND HERBICIDE APPLICATIONS

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ABSTRACT:
Agriculture industry contributes significantly to the economy. The primary worry and a hot topic globally is the automation of agriculture. The inhabitants are growing quickly, and with it, so are the need for nutrition and effort. Agriculturalists have been employed traditional methods, but they were insufficient to meet these demands. New automated techniques were consequently introduced. These fresh techniques enabled billions of people to find work while simultaneously meeting the world food needs. A revolution in agriculture has been sparked by artificial intelligence. The crop has been shielded by the technology produce since a diversity of causes comprising the concerns with food security, population increase, employment issues, and climate change. The key purpose of this research work to evaluate numerous ways artificial intelligence is being used in agriculture, including the use of devices and other implements assembled into drones and robots for weeding, spraying, and irrigation. These technologies reduce excessive use of water, pesticide, herbicides, maintain soil fertility, and also aid in the effective use of labour, which raises production and improves quality. In order to deliver a concise instantaneous of the current state of agriculture automation, including the use of drones and robots for weeding, this study surveys the research of several researchers. The employment of drones is covered, as are their varied techniques.

KEYWORDS: Agriculture, Artificial Intelligence, Herbicide, Irrigation, and Pesticide.

1.INTRODUCTION

By 2050, the world people is projected to be close to 10 billion, increasing agriculture production in a context of modest economic growth by almost 50 percent as compared to 2013. Currently, 37.7 percent of the Earth surface is dedicated to growing crops. Agriculture has a noteworthy role in the Country budget and in creating jobs (Praburaj, 2018). It makes a considerable involvement to the financial success of industrialised nations and actively participates in economies of emerging Nations. The per-capita revenue of the rural inhabitants has significantly increased as a result of the expansion of agriculture. Therefore, giving the agriculture sector more attention will be sensible and appropriate (Wagh, et al, 2016). Approximately, 50 percent of the workforces in countries like India are employed in the agricultural sector, which contributes 18 percent of the total GDP to the Nation. In the agriculture sector development will spur rural development, which will then accelerate rural transformation and ultimately produce structural transformation (Mogili and Deepak, 2018; Shah et al, 2019).
Many sectors around the world have seen a significant transition as a result of technology (Kakkad et al, 2019). Surprisingly, despite being the least digitalized sector; the research and commercialization of agricultural technology have witnessed a boost (Upadhyay, 2019). Artificial Intelligence has started to have a substantial impact on day-to-day life, growing our capacity for seeing the world and enabling us to alter it (Kudalia et al, 2020; Gandhi et al, 2020; Ahir et al, 2020; Plessen, 2019) provided a system for return preparation that relies on integration of yield consignment and truck routing. AI is built on a wide range of disciplines, including agriculture, soil science, plant breeding, entomology, plant pathology and engineering as well (Panpatte, 2018). The fundamental clue after Artificial Intelligence (AI) is to make skill that works equally to a humanoid mind (Parekh et al, 2020; Jani et al, 2019). The expansion of AI based software and systems is based on research into how the humanoid mind functions, how people study, make results, and work together to solve problems.
The core of AI incorporates a varied variety of fields, including Machine Learning (ML) and Deep Learning (DL) (Patel et al, 2020a; Patel et al, 2020b; Pandya, 2019; Sukhadia et al, 2020). The study of creating intelligent computers and programmes is known as AI, whereas ML and DL are both related concepts (Kodali and Sahu, 2016; Kulkarni and

Deshmukh, 2013). Making problem solving simple is the primary objective of AI, which may involve using Artificial Neural Networks (ANN). According to (Shah et al, 2020a; Shah and Shah, 2018), ANN is a processed algorithm of hardware whose operation is motivated by structure and process of the humanoid mind. Neural networks have exceptional self-organization and adaptive learning capabilities. It has taken the place of many conventional approaches in a variety of disciplines; including computer science, arithmetic, physical science, and engineering, image processing, economics, business and neurology. When the environment changes the learning is the procedure of acclimatizing to the modification on its own. Unsupervised learning and supervised learning are the two types of knowledge. The effort of encircles the related interactions amongst the numerous entrenched structures and the AI knowledge intelligible with the agriculture field, and it presented a brief about the many uses of ANN, ML, in this subdivision for precision farming (Jha et al, 2019).

The world of agriculture is AI based research and development knowledge. The modern agricultural system has advanced and thanks to equipment have and machines powered by AI. Real time monitoring, collecting, dispensation, and promotion of crops have all improved because of this technology. Agriculture based subdivision has benefited greatly from the most recent automated systems innovations including drones and farm robots. A lot of sophisticated computer based systems are created to identify a variety of crucial characteristics, including wild plant detection, crop detection, crop excellence, and several more ways (Liakos et al, 2018). The skills utilised for automated irrigation, tidying, and drenching to increase output and lighten workload of farmers. There is discussion of various automated soil sensing methods (Wall and King, 2004). The temperature and moisture sensors were combined by (Hemalatha and Sujatha, 2015) to plug the gaps in the vehicle forecasts. Robots utilised for sensing were localised using GPS modules, and their whereabouts were monitored using Google Maps (Mohiuddin, 2015). In the present study authors address the practice of AI and drone technology in agriculture domain.

2.MATERIALS AND METHODS

2.1 AI Effects on Agriculture

The technologies that are based on AI assistance to growth output across totally industries and achieve the tasks that diverse industries, counting the agriculture segment, face in terms of produce crop, irrigation, soil content detecting, harvest checking, weeding, and harvest establishing (Kim et al, 2008). In order to quantity high-value AI presentations in aforementioned industry, agriculture automatons are constructed. The farming business is in trouble as a result of rising worldwide residents, but AI has the capability to deliver a critical remedy. AI based technical advancements have made it possible for farmers to produce more with less incomes, to increase the worth of their productivity, and hasten the period it takes for their harvests to reach market.

2.2 Perception, Workforce, Skills, and Image Recognition

According to a self-directed Unmanned Aerial Vehicle (UAV), and their submissions, such as appreciation and investigation, humanoid figure detection and geolocalization, exploration and release, and woodland fire detection, have experienced an increase in interest in recent years (Bhaskaranand and Gibson, 2011; Doherty and Rudol, 2007; Tomic et al, 2012; Merino et al, 2006). Drones are becoming more and more popular because of their adaptability, incredible imaging technology that ranges from transfer to camerawork, capability to be directed with a remote controller, and the expedients' dexterity the air, which allows us to do a lot with these devices.

Artificial intelligence allows agriculturalists to compile vast quantities of data from public and government websites, analyse it all, and deliver agriculturalists answers to many vague problems. It also gives us a wiser manner of irrigation, which increases the farmers' produce. AI can be used in agronomy to mechanise various procedures, lower risks, and give farmers' relatively simple and effective farming (Giridhar and Mittal, 2002).

2.3 Maximize the Output

The extreme presentation level for all floras is strong-minded by diversity of collection and seed superiority, according to (Ferguson et al, 1991), the emerging technologies have enhanced the selection of hybrid seeds that are most suited for farmer's demands, as well as the optimum crop selection. It has been put into practise by figure out how seeds respond to various climatic conditions and soil types. The likelihood of plant illnesses is decreased by gathering this information. As a result, farmers are effectively able to maximise the reappearance on harvests. We can now satisfy marketplace tendencies, yearly results, and consumer requirements.

2.4 Farmer Social Group

The conversational virtual assistants that automate conversations with users are known as Gapshap. With the use of ML and AI powered Gapshap; we can now understand normal dialectal and interconnect with users in an additional individualised way. Agriculture has made use of this facility by subsidiary the agriculturalists in receiving answers to their unrequited inquiries, for offering them guidance, and for giving them various recommendations. They are frequently prepared for trade, transportable, and broadcasting. School of Agriculture, Galgotias University, Greater Noida, established a Farmer Community Social networking group Our Farmers in WhatsApp Group (Figure 1). Through, this group we are communicating to the local farmers and aware them about the weather forecasting, different types of seeds, weedicide, insecticide, herbicide, nematicide etc., and helping them in different extension activities as well.

3.RESULT AND DISCUSSION

3.1 Robots in Agriculture

Large economic sectors with poor productivity, including agriculture based food, are introducing Robotics and Autonomous Systems (RAS) (Syed, 2015). In the management and production of agriculture, robotics has a significant impact. Due to the inefficiency of conventional farming machinery, researchers are increasingly placing more emphasis on technologies to create autonomous agricultural instruments (Dursun and Ozden, 2011). This technology has primary goal to substitute humanoid labour and deliver tangible compensations for small and large-scale productions. The availability of robotic technologies in this field has greatly increased productivity (Pedersen et al, 2008). The robots are carrying out a variety of agricultural tasks on their own, including hoeing, irrigation, safeguarding the farmhouses to deliver accurate reports, making sure that unfavourable ecological circumstances do not disturb the manufacture, increasing precision, and managing specific floras in numerous novel habits (Reddy et al, 2016).

As a result, the implementation of robots in agriculture is a complicated process that requires expert systems to deal with a changing and unstructured environment while doing the desired job. Researchers from many colleges have attempted to build robotic systems for various agricultural tasks such as seeding, planting, weeding, spraying, harvesting, and material handling with agricultural robots during the previous few decades. The majority of these works were completed in control environments and laboratory nations. As a result, substantial study is required for the implementation of robots in real-world settings. This study is an attempt to present the work done in robotic application in agriculture both internationally and in India as well. The components of robots and their working principles are explored in detail in this research paper. The major and secondary tasks of robots, as well as their benefits and limits, are discussed. The notion of using robots in agriculture must fit with the following criteria: better reaction to unexpected and uncertain working environments, feasibility with existing technology, and economic viability over alternatives. The notion of using robotic technology to mimic or copy traditional agricultural techniques has been tested in many agricultural unit operations, but no commercial robots of complicated agricultural field settings are available.

3.2 Irrigation

In the world, 85 percent of the fresh water resources are used by the agricultural sector. The population is expanding, and food demand is rising, which is contributing to the rapid expansion of this percentage (Sultana et al, 2021). This means that in order to ensure proper usage of aquatic resources for irrigation, must develop additional actual technology. Techniques for involuntary irrigation arrangement have taken the position of physical irrigation, which was founded on soil water dimension (Kumar, 2019). When implementing autonomous irrigation machines, it was important to keep in mind that plant evapo-transpiration was dependent on a number of atmospheric factors, including moisture, wind haste, solar radioactivity, and even crop aspects, including crop phase, herbal thickness, soil physiognomies, and vermin. With the main goal of creating a scheme that uses rarer assets and is more effective (Kumar, 2014) explores various irrigation techniques. On the field, tools like fertility metres and pH metres are put up to measure the proportion of the soil's primary constituents, such as potassium, phosphorous, and nitrogen, in order to assess the soil's fertility. Drones are equipped with hyper-spectral, multispectral and thermal sensors may detect whether areas of a field are dry or in need of renovation. Furthermore, after the crop is developing, drones can calculate the flora index, which represents the qualified thickness and wellbeing of the harvest, as well as reveal the warmth sign, which is the amount of energy emitted by the harvest (Kulothungan et al, 2018).

3.3 Weeding

To capitalize on agricultural harvest and lessen its undesirable effects on the atmosphere, precision agriculture based technology that brings together sensors, information systems, and knowledgeable management. Precision farming is used in many different agricultural contexts today, including pest management, fertilisation, irrigation, sowing, and harvesting, has a wide range of uses (Bechar and Vigneault, 2016). Precision farming is also effective when used in integrated weed management. Due to technical advancements in sensors, computer hardware, nanotechnology, UAV, and robotics that may enable precise identification of weeds that are present in the field, precision agriculture has advanced quickly over the past ten years. One of the technologies used in precision agriculture that has the most success is UAV. The UAV based platforms that offer a number of benefits for the execution and monitoring of agricultural activities. AI manages wild plant by utilising computer visualization, automation, and ML to collect data on the weed, allowing agriculturalists to spray elements just where the wildflowers are present and reducing the use of biochemical scattering a whole field (Aithenhead, 2003). Finally, it effectively lowers wild plant while also reducing herbicide use in the field in comparison to the volume of chemicals routinely applied. AI submissions in farming include irrigation, weeding, and scattering using sensors and other techniques implanted in automatons and drones. An idea for effective and automatic irrigation schemes by constructed remote sensing technologies to utilise microcontroller technology, which may enhance productivity up to 40 % (Babu and Rao, 2007).

Different sensors were created for various reasons, such as the soil moisture sensor, which detects soil moisture, and temperature sensor, which detects temperature. A pressure regulator sensor is used to regulate pressure, while the molecular sensor is used to improve crop growth. The water demand for the plant aerial parts is the amount of pond of aquatic essential to generate one pound of dry matter (Balleda et al, 2014). However, precision agriculture is also including insect reduction, weed control, and the development of weed management systems. The nonstop enhancement in weed regulator processes is an ongoing demand for agricultural activity based growth. Because of injury of creative possible and excellence that these weeds source in yields, differential supervision of these wild plants is critical in the pursuit of sustainability and effectiveness (Ghamari et al, 2010). Current expansions in this sector have been made possible by combining remote sensing with leading-edge technologies such as DL, computer vision, UAV robots, multisensory systems, and so on emergency models, identification outlines, and site planning may be developed by gathering and evaluating data at various sizes and resolutions to allow the formulation of improved yield fortification methods. The most recent improvements in remote sensing, utilising very high-resolution satellites, enable the evaluation and analysis of agricultural problems based on reflectance data via visible, multispectral, or hyper spectral sensing (Bhatt and Sharma, 2020; Bhatt et al, 2015; Bhatt et al, 2014; Bhatt et al, 2013; Bhatt et al, 2015). Advanced weed control systems rely on accurate weed detection and reliable weed crop plant discrimination (Jayaram and Marad, 2012). Key factors for describing a weed infestation situation include spatial distribution, infestation intensity, and herbicide resistance degree. As a result, the detection system is designed to gather data on goal regions and variety spatially careful weed-control results (Kalpana and Karthiba, 2016). A variety of machineries that aid in choosy controller, such as the use of Global Navigation Satellite System (GNSS) precision guiding systems with discrepancy improvements, computer vision, object-based image analysis, AI-based cognitive systems and 3D characterisation, are based on remote sensing (Katkamwa, 2013). Differentiation in the field becomes tough since highly changeable natural items must be distinguished from one another.

3.4 Drones in Agriculture

Unmanned aircrafts that may be remotely operated in a mechanical environment include UAVs and unmanned ethereal frameworks (UAS), sometimes known as automatons. Together, they operate the GPS and other attached sensors. Agriculture is using drones to monitor yield fitness, irrigation kit, weed detection, herd and wildlife observing, and disaster managing (Veroustraete, 2015). Agriculture is being greatly impacted by remote sensing using UAVs for image capture, dispensation, and examination. The rustic sector seems to have embraced technological novelty with great eagerness, adapting traditional farming practises with the use of these powered tools. The impact of technology on the Indian agricultural industry has always been good in terms of ensuring food security and alleviating farm difficulties (McKinion and Lemmon, 1985). Drones have shown to be among the most promising technology, emerging as crucial instruments for farmers for a diversity of submissions such as crop observing and field monitoring, as well as addressing several difficulties in the agricultural industry (Prasad et al, 2006). Drone technology has the potential to alter the way ordinary manual agricultural tasks are carried out. It will undoubtedly aid in optimising inputs and reducing waste, as well as increasing agricultural yields and reducing time and expenditures (Prasad et al, 2002).

Revolutionized the farming industry through need based, accurate, and targeted crop input application, which will immediately improve input use efficiency and farmer safety while concurrently cutting costs. Farmers face several challenges, including labour shortages, excessive labour costs, as well as health issues caused by chemical exposure in the field (Rafea, 1993). The significance of Union Agriculture Minister issued Standard Operating Procedures (SOP) for the usage of drones in pesticide request for yield fortification and scattering soil and harvest nutrients. Drones have numerous characteristics, such as multi-spectral and picture cameras, and may be utilised in many aspects of agriculture, such as monitoring crop stress, plant development, predicting yields, applying inputs, and watering (Verma and Dubey, 2019). Drones may be used to analyse the health of any agricultural vegetation, field regions infested with weeds, disease infection, and pest infestation, and based on this evaluation, the correct amount of chemicals can be administered, hence optimising the total cost for the farmer (Yadav et al, 2014). Many start-ups have also shaped drone establishing systems that allow drones to shoot seeds and spray crucial nutrients into the soil. As an outcome, this technique improves harvest management uniformity and efficiency while also lowering costs.

3.5 Resource Mapping

One of the most important requests of drones in agriculture is plotting capitals and harvests across a specified region. Field size diagramming of harvests and a calculation of their health might be critical for manufacture informed decisions (Zhang et al, 1994). It also aids in determining crop health and yield potential by examining crop ailment and health in diverse soil types and organization zones; this drives the development of the agricultural drone's market for field plotting applications (Anand et al, 2014). Field mapping acquired the highest part of the agriculture drone's industry in 2015 and is predicted to continue in this tendency through 2022.

3.6 Real-Time Imaging

The agriculture scheme is very active in time and space. As a result, monitoring for optimal management necessitates high temporal resolution capabilities in the relevant geographical area (Rahman, 2014). Drones are capable of capturing real-time ground truth at a spatial resolution of a few centimetres, which is not achievable with aeroplane or satellite pictures (Bing, 2014). While the presence of cloud renders satellite and aeroplane photography susceptible to rejection, drones are capable of capturing excellent photographs in such conditions due to their activities at low altitude orbits (Bencini et al, 2009).

3.7 Monitoring and Specific Applications

Because drones can sail and detention vast variations in field size, they may be employed for a variety of real-world applications when equipped with the appropriate sensors. Different remote sensing-based sensors are currently being utilised to interpret crop spectral signatures, which can then be used to derive scientific indices such as the Normalized Difference Vegetation Index (NDVI), the Normalized Difference Water Index (NDWI), and a variety of other crop health indicators (Yueling et al, 2011). These indicators give critical information regarding intra-field difference in harvest fitness, which can be caused by abiotic (water, heat, nutrients, etc.) or biotic (disease, pests, etc.) pressures (pest-diseases etc.). Precision farming can benefit from proper data analysis. Different chemical detection sensors can be useful for mapping if utilised in a drone.

3.8 Geo-Fencing

Drones may also be utilised for security purposes like Geo-fencing, which is a virtual border or zone that surrounds any geographical region (Jesus et al, 2008). Many crops are now being harmed by wild animal attacks such as elephants, nilgai, mountain bulls, wild boars, and birds, among others. Geo-fencing can be effective in preventing these animal assaults by informing the owner through text message anytime an intruder enters a Geo-fenced territory.

3.9 Geo-Tagging

Today's market is flooded with references to geo-tagging. Things are being geotagged, whether it's in a blog post or a social network status update. When a user creates a new post on one of the major social media platforms, such as Instagram, Facebook and Snapchat; he can take use of features like adding location to the post, which is a form of geotagging. Significant geotagging is adding critical geographic data to the metadata of images, video files, audio files, etc., such as longitude, latitude, and altitude. The idea of geotagging can achieve a wide range of goals in a country like India, where agriculture contributes around one-fourth of the country's GDP and employs roughly half of its labour force (Lieberman et al, 2010). Significant geotagging is adding critical geographic data to the metadata of images, video files, audio files, etc., such as longitude, latitude, and altitude. The idea of geotagging can achieve a wide range of goals in a country like India, where agriculture contributes around one-fourth of the country's GDP and employs roughly half of its labour force.

As a result, sample gatherers go out to gather various agricultural items. Various laboratories in India conduct timely tests on agricultural products to assure quality, nutritional effectiveness, and pesticide residues. Although it can be challenging to confirm, the samples were really taken from the same location as indicated. In this work, a solution is put forth that laboratories can utilise to collect samples. It involves taking a picture of the sample using a mobile application, retrieving the latitude and longitude from the background, and geotagging each sample to preserve the sample's integrity.

3.10 Crop Insurance

Drone-derived aerial images may be used to swiftly categorise surveyed regions into cultivated and non-cultivated land, as well as to estimate the extent of natural catastrophe damage (Capizzi et al, 2016). Crop insures and insurance policyholders help from on-demand area-specific drone footage that is easily accessible and reproducible. In India, insurers intend to employ UAV to analyse agricultural losses during natural catastrophes, allowing them to compute pay-outs more correctly and rapidly (Bashish et al, 2011). Drone data might also be beneficial for early identification and forecast of pest infestations, which insurance companies could share with agriculturalists. Finally, drone data may be used to detect insurance scam, stopping impostors from insuring the same piece of land numerous times or requesting injury when none exists apart from that, these drones will assist to shorten the time it takes to settle claims by providing real-time information on agricultural losses, which formerly took several months by field observers.

3.11 Crop Spraying

Drones may scan the ground and spray the appropriate amount of liquid, regulating distance from the ground and spraying in real time for equal attention (Pasqual, 1996). As a consequence, efficiency has risen while the amount of chemicals entering groundwater has decreased. Experts predict that aerial spraying with drones may be performed up to five times faster than with traditional technology.

3.12 Crop Monitoring

The main challenge in farming is the combination of huge areas and low crop monitoring efficiency (Arif et al, 2013). The difficulties of monitoring are increased by more random weather conditions, which increase hazard and field care charges.

(A)

(B)

(C)

Figure 1. Consolidated overview of drone technology training, practical demonstrations, field operations, aerial monitoring, and digital mapping applications for precision agriculture. (A) Faculties training program on Drone technology. (B) Inter-disciplinary training session on Drone technology. (C) Demonstration on Drone by an industry expert (D) Mapping of manmade grassland by Drone. (E) A clear view of Drone in the field. (F) Drone flying and mapping of University grassland. (G) Mapping of student research plots in the University crop cafeteria. (H) Drone flight direction and agriculture crops mapping in the University crop cafeteria. (I) Hands-on- training in the University crop cafeteria along with senior officials of the University

4.Challenges

Drone, like any possible technology, has obstacles in Science & Technology, as well as working and managerial aspects. The drone hardware scheme still has to be improved for steady flying in all-weather circumstances; this is the foundation for obtaining high-quality photographs of the ground. Most agricultural drones can carry a small weight sensor (up to 2 kg), but they must be developed to carry more advanced sensors that are much heavier (Jha et al, 2019). Drones acquire raw data that requires software for proper pre-processing, complex algorithms for analysing this data into understandable information, and powerful computer resources to achieve all of this. The growth of suitable and simple-to-use software explanations is critical for field submission. In India, where the most agriculturalists are peripheral and land holdings are dispersed, the proliferation of drone submissions may be hampered by their techno-economic practicality (Barenkamp, 2020). Furthermore, due to safety concerns, drones cannot be used publicly without prior approval from the government. Future population demands cannot be satisfied by traditional farming practises. The only solution to this problem is AI, ML, Remote Sensing & GIS technologies. Farmers can produce more and more quickly with the aid of AI. These technologies will be helpful in farming has a very broad use. Although technology is evolving quickly, many farmers cannot afford it due to its high cost. We must overcome these obstacles in order to make AI accessible to small and large-scale farmers. We can eliminate all the shortcomings of traditional farming with the use of AI. AI enables farmers to store crops, increase agricultural production, save water, recommend the best pesticides, and cultivate plants for every season, and forecast weather and rainfall as well.

5.CONCLUSION

It is critical to measure crop health and detect bacterial or fungal contaminations on plants. Drone-carried devices can classify which plants reproduce diverse amounts of green light and near-infrared light by skim through a crop with both visible and near-infrared light (Dahikar and Sandeep, 2014). The data can be used to create multi-spectral images that track changes in plants and indicate their health. Agricultural drones are an astonishing advance technology that is quickly becoming a tool like any other agricultural equipment (Broner and Comstock, 1997). Several factors have contributed to development, including the relatively low cost of agricultural drones with superior imaging capabilities and sensors that provide particular data to farmers. Farmers may boost yields and decrease crop damage by using this data. Furthermore, reducing pesticide use lowers environmental impact (Eli-Chukwu, 2019). Farming, on the other hand, is an input-output problem. Farmers may use drones to minimise inputs such as water and pesticides while keeping the same output, so overcoming the food scarcity. Agricultural drones transform farmers' capacity to monitor and control crucial aspects of farm operations that are hard to sustain in remote locations (Ghadiyali et al, 2011). Finally, we may argue that what began as a military technology may wind up being better recognised as a green-tech technique.

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The authors declare that they hold no competing interests.
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