Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 02 (MAR-APR, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

In Support of Robotics Use in Agriculture

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Gathering information about the procedures involved in order to guarantee that the resources are used as efficiently as possible has always been a key component of successful and productive farming. Utilizing technology tools to assess whether key procedures are proceeding smoothly has become standard practice in today's world. Drones equipped with satellite communication capabilities, for example, can fly over the fields and gather data, while moisture sensors with wifi capabilities allow farmers to conserve more water by only watering the areas of the fields that require it. Thus, technology have the ability to address a wide range of farming-related issues. Agricultural robots are one of the most promising new technologies that could help farmers save costs while increasing efficiency in light of a variety of issues, including the aging farming workforce and climate change. They provide the necessary degree of adaptability and quality enhancement that is rarely possible with human labor. Furthermore, as robotic technologies advance and change over time, farmers can take advantage of the most cutting-edge models available for integration into their farming operations. Therefore, farms should embrace and be able to produce and deploy robotic technologies.

Background on Robotics Use in Agriculture

Robotics has come a long way in the modern era, and many new products are hitting the market. Robotic fruit pickers, for instance, can now select delicate fruits and vegetables like strawberries without being awkward or large. New, agile robots can help in situations when there aren't enough laborers to harvest every berry a plant produces over its growing seasons. One of the newest innovations in this field is the Octinion picker robot Rubion, which can continually pick berries without requiring further physical labor (Lallensack). In addition to automated fruit pickers, farmers now have the option to purchase weed pullers as a means of addressing the weed problem. New weed pulling robots have gotten so advanced that they are capable of without disturbing the soil through tillage, especially the pesticide use has caused weeds to be more resistant to chemicals and are difficult to control. To help farmers meet all of their weeding needs, FarmWise has developed weeding robots that combine the most recent advancements in machine learning and mechanical engineering.

Small rover-like robots have also entered fields, in addition to robot-pickers and weed-pullers. Thanks to advances in light-detecting and range technology, it is now feasible to get pertinent data from the difficult-to-reach understory of fields (Lallensack). For instance, the University of Illinois' TerraSentia system was created to gather information on the physiology, health, and stress response of plants. In addition, the robot's designers are working on programming the bot to evaluate the health of young plants, corn ear height, plant biomass, as well as the capability of detecting and recognizing illnesses and abiotic stresses. Due to its ability to provide "immediate insights to diagnose and correct agronomic, disease, and pest concerns," drones have also been employed extensively in agriculture (Lallensack).

Drones are appealing to farmers because they can provide accurate information about particular land parts and even plans. Drones may also be utilized in the future for irrigation, planting, agricultural spraying, soil analysis, and other pertinent tasks.

The availability of farming exoskeletons is another important way that robots improves agriculture. Their rise in popularity has been linked to the aging of the farming community, with the average farmer being between 50 and 58 years old (Lallensack). Long-term, the aging labor force is a major problem, particularly for medium-sized or small farms where the number of available workers was lowered due to the absence of a generational labor stream (Lallensack). But because to scientific advancements, farmers no longer have to strain their knees and backs when working with wearable exoskeletons, or "supersuits," like those made at Virginia Tech. Additionally, a university research team is developing a robotic glove to assist farmers suffering from arthritis in performing labor-intensive tasks without excruciating pain prior to retirement (Lallensack). These kinds of products aim to keep farmers healthy and enable them to continue doing what they love instead of making them work longer hours.

Increased Farming Efficiency: It's evident that robotics offers a number of advantages to agriculture when one considers the abundance of field-applicable robotics solutions. The speed and consistency with which robots can operate will enable farmers to provide goods swiftly and effectively in light of the growing demand for food resources worldwide (Saiz-Rubio and Rovira- Más 3). The University of Cambridge's vegetable-picking robot, which use machine learning to harvest iceberg lettuce, is an illustration of the advancements in this field. The device has the potential to address labor shortages and minimize food waste (Birrel et al. 230). Within its field of view, the robot can recognize the target crop, judge if a given plant is healthy enough to be picked, and only then separate the lettuce from the rest of the plant without crushing it. Because of the advantages of machine learning, waste can be decreased with the aid of such harvesting technologies (Birrel et al. 225). In particular, the robot exclusively targets ripe veggies since machine learning makes it easier for it to recognize when a particular plant is ready to be harvested. This leads to a decrease in the amount of fruits or vegetables that are thrown out because they are not fit for sale or consumption.

Increased Health and Safety of Production Operators and the Public: The use of pesticides, which have been demonstrated to endanger farmers' safety, has posed a constant threat to the increased health and safety of production operators and public agriculture (European Parliament Directorate-General for External Policies). The study by Gonzalez-de-Santos et al. claims that individual robots as well as multi-robot systems can be utilized extensively for pest control operations (590). Because canopy sprayers combine observation, decision-making, and action to enhance the pest management system and lessen farmers' exposure to hazardous chemicals, they can be utilized independently in agricultural tasks (Gonzalez-de-Santos et al. 599). For example, it has been demonstrated that the smart sprayer created by integrating the Central Direct-Injection Pesticide System can accomplish variable rate application (VRA) by spraying the carrier at a predetermined continuous flow and adjusting the pesticide concentration as necessary (Gonzalez-de-Santos et al. 598). The usage of these technologies has the advantage of enabling the monitoring of chemical concentrations applied and providing the ability to create maps of pesticide application for better data analysis.

The Precision of Weed Control: The use of autonomous weeding systems has demonstrated significant potential to “alleviate the current dependency on agrochemicals such as herbicides and pesticides, thus reducing environmental pollution and improving sustainability” (Wu et al. 2). This is just one advantage of using robots in agriculture, as demonstrated by the example of FarmWise's weeding robots. Furthermore, these robots can aid in the introduction

of real-time weed detection, tracking, and treatment systems. The devices are equipped with intra- and inter-camera tracking to identify weeds and improve the precision and resilience of weed estimations. It is easier to enable predictive control about the employment of the weeding equipment based on the obtained data because the robots enable the collection of a wide variety of data. Despite criticism for robotic weeding robots' inability to distinguish weeds from crops, machine learning research is progressing at the moment (Steward et al. 6). The developments allow robots to reduce errors in the remote weeding process by learning the unique characteristics of plants, which is useful in differentiating agricultural plants from weeds (Steward et al. 9). In general, research into enabling robots to make decisions in unpredictable field conditions is still ongoing, but it is anticipated to expand the use of robots in agriculture.

Reduction of Greenhouse Gases: Regarding robotics in agriculture, taking into account its impact on lowering farming's carbon footprint (Association for Advancing Automation). According to Darby, the use of modern technologies like drones has made it feasible to deliver microdots directly to plants, reducing the need for 99.9% of the herbicide used in plant spraying operations. Furthermore, undesirable plants can be eliminated using 5W lasers, which will eventually require less weeding. Robots' use of electricity to power themselves rather than diesel fuel, which is a major source of carbon emissions, is another way that they reduce greenhouse gas emissions in farming (Darby). Consequently, employing robots saves about 90% of the energy required for cultivation (Brown). Another advantage of sustainability is the rearrangement of land use through the deployment of adaptable and effective robots and drones to tend to small areas. With the use of this strategy, it is possible to manage land use appropriately in some settings to lessen the impact of pests and diseases, which in turn helps to minimize energy consumption and carbon emissions (Brown). All things considered, technological advancements have strengthened drones and robots with a variety of data from satellites, which may be used for ongoing data analysis and procedure quality enhancement. It is possible to rapidly obtain inexpensive, on-demand guidance for resolving crop quality problems and identifying problems that affect crop development, which promotes improved farming practices and lower energy use.

Conclusion

In conclusion, because of their multifaceted applications and room for continued development, robotic technologies have great promise for usage in the agricultural industry. The most recent developments in robotics, which range from exoskeletons to autonomous weeding robots, increase agricultural efficiency while also taking into account the long-term effects of farming on the environment and the health and safety of both farmers and the populations they hope to feed with fresh, high-quality produce. Additionally, the ability to do research and development offers unrestricted chances for progress depending on new trends and shifting industry demands.