Robotic Utilization in Farming Field—A Review

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Abstract Recently, many revolutionary changes are developing based on the existing agriculture technologies, and it creates new opportunities for the farmers to adopt these technologies. However, farmers have experience with traditional methods; the robot-based precise devices can give fruitful yields and good profit margins. So, the developed countries are using this technology in agriculture to improve their agriculture economy. The paper discusses the possible use of wireless sensor networks and robots in farming, and also the new obstacles that will be encountered during the operation of this technology with traditional farming methods. Finally, based on the current survey, it is identified that the essay also discusses the present and future robotics developments in additional agricultural domains, as well as potential research problems.

Keywords Internet of Things (IoT) · Sensor · Precision agriculture · Smart agriculture · Standards · Protocols · Networks

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I. A. Palani et al. (eds.), *Recent Advances in Materials and Modern Manufacturing*, Lecture Notes in Mechanical Engineering,
https://doi.org/10.1007/978-981-19-0244-4_8

1 Introduction

Robotics is a discipline of engineering and technology that encompasses electronics, mechanical engineering, and computer science engineering, among other things [1, 2]. This branch is concerned with the design, development, and application of robot control, sensory feedback, and information processing. Many farmers are working very hard to get the yield. By using data precision robots and automated gadgets, a farmer can feel free to work in the farming field and it will help them in a great manner during climate issues and other issues without any hindrance. Furthermore, digitalization, or the socio-technical process of implementing digital advancements, is becoming a more widespread trend. Big data, IoT, augmented reality, robotics, sensors, 3D printing, system integration, ubiquitous connectivity, artificial intelligence, machine learning, digital twins, and blockchain are examples of digitalization phenomena and technology.

Coming to the new era, our world is developing very rapidly day by day. Robotics will change the way of agriculture and makes it easier for farmers. Financially, a farmer can earn a lump sum in a relaxed manner and with less effort [3].

With an ever-increasing population comes the issue of food scarcity. Researchers are working to find strategies to boost food production without jeopardizing the planet's natural resources or ecosystem. Integrating new technologies into agriculture, such as Global Positioning System (GPS), spatial information, robotics technology, laser scanners, Charge-Coupled Camera (CCD), gyroscopes, and so on, is one potential option to boost food production [4].

As a result of the data flow between sensors and other devices, IoT is a fundamental technology in smart farming, allowing for the addition of value to the collected data through automatic processing, analysis, and access, resulting in more timely and cost-effective production and management effort on farms. Simultaneously, IoT offers the reduction of intrinsic environmental effects through real-time response to alert on events such as weed, insect, or disease detection, weather, or soil monitoring warnings, allowing for the reduction and appropriate use of inputs like agrochemicals and water [5].

Digital technologies give new opportunities for innovation that make it easier, efficient, and economically successful for farmers today than before. It also creates a new means of tackling longstanding commercial agriculture difficulties. It is worth noting that these advances might be understood as a wider reaction to the changes in agriculture's economic and individual worlds [6].

The agriculture robot is introduced to perform various operations in the farming field for helping the farmers. It involves different types of mechanical operations are Rotary motion, Furrow mulching, Pest control machine, Transplanter, and handling machine. In addition, the IoT part contains many sensors which respond to do many different conditions in the farming field. The different types of sensors used are Crop sensor, Environmental sensor, Soil moisture sensor, Irrigation controller, Bug detectors, Leaf sensor, Acoustic sensor, Mechanical sensors, Electromagnetic sensors, Ultrasonic ranging sensors, Electrochemical sensors, Airflow sensors, Farmbot, etc.

These devices have been used in that robot, which makes farming chores easier and more precise [7–19].

In this review, the paper discusses the usage of sensors in agricultural robots and the working principle of the robot.

2 Process Sequence

The essay examines the benefits of robotics and their application overall, as well as in agriculture, and serves as a foundation for further research. The primary purpose is to assess the existing status of robotics as well as its possibilities in regional development and farming in order to develop new techniques. This project aims to develop long-term research objectives based on the latest possibilities identified through recent trends. Also, its goal is to compile methodical methods to project solutions, with the following being the most important:

- Determining and exploring various platforms for usage in agricultural robotics.
- Examining robotics-related standards and protocols.
- Equipment utilized in agricultural robots are categorized and classified.
- Examining details of robotic practice in the farm area and parallel grounds.
- Identifying needs and developments in the agricultural sector and regional development for robotics development.

The above statements constitute the identification of appropriate new technologies for robotics. The work focuses mostly on the investigation of existing robotics systems and techniques for data transfer and processing in the agriculture industry. The agricultural user carried out the experimental assessment for the real problematic issues. Identification of the technological and functional shortcomings of robotics would be the main practical advantage of this study. However, in this research review model, the prototype can perform actions for the regular farming work, and they can make a yield for his/her field.

2.1 Input Parameters Used by Farming Robot

Crop data, Environmental data, Soil data, Crop standers, Weather forecast, Best practices, Government policies, and Market demands.

2.2 Processes for Inputs

Land preparation, sewing, irrigation, fertilization, pesticide, and harvesting.

2.3 Outputs

Quantity, quality, control, economy, future predictions, update standers, policies, and best practices.

2.4 Use of Input Parameters

- Crop data is used for the preparation of land, pesticides, and the quantity of the crop to increase the yield.
- Environmental data is used for irrigation, fertilization, quality of the crop, and control of disease and insects.
- Soil data is used for the crop for the robot to decide when to crop a particular crop at that particular time.

3 Sensors Required for Farming Robot

3.1 Crop Sensor

The crop sensor is smaller than the 35 mm film screen for any other sensor. Measuring the lenses of focal length is based on the field of view of 35 mm. In the sphere of agriculture, the crop sensor camera was proposed to employ the sensor inserted in the cutting out of the frame margins and thus extending the focal length of yield as described in Fig. 1.

Fig. 1 Crop sensor attachment to plant

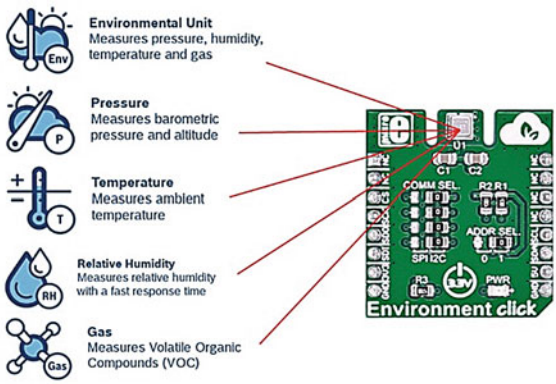


Fig. 2 Environmental sensors

3.2 Environmental Sensor

As indicated in Fig. 2, environmental sensors are used for measurement, monitoring, and recording environmental factors such as temperature measurement, humidity, heat loss, and food spoiling.

3.3 Soil Moisture Sensor

Soil humidity sensors evaluate the number of volumetric soil water. This direct specific gravity measurement of free soil moisture requires removal, drying, and weighing of samples and, as a humidity proxy, a soil moisture sensor measures volumetric soil water content indirectly, using certain other soil characteristics such as electric resistance, dielectric constant, and neutron interaction (Fig. 3).

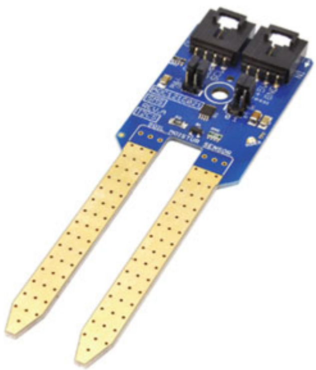


Fig. 3 Soil moisture sensors

Fig. 4 Irrigation controller

3.4 *Irrigation Controller*

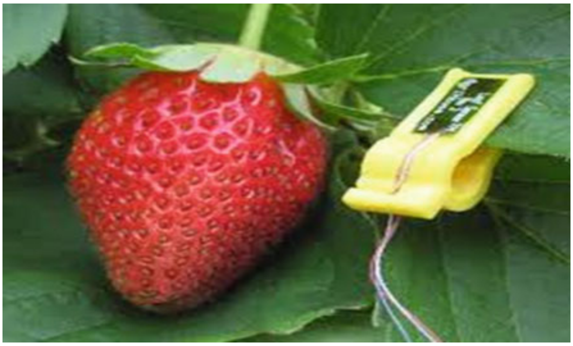
The irrigation controller is an automated irrigation device that operates lawn sprinklers and dripping irrigation. The regularity of watering of the initial period and the duration of watering are determined by most controls. There are additional capabilities in some controllers, such as several programs for varied irrigation frequency for various kinds of plants, rain delay setting, rain and freeze sensor input terminals, soil humidity sensors, weather data, distant operations, and so on. This irrigation system is shown in Fig. 4.

3.5 *Bug Detector*

Bug detectors are one of the best instruments for detecting unwanted surveillance in order to ensure privacy and with a professional or personal setting. Customers can use bug detection to locate hidden video cameras, cameras, GPS trackers, and more in their space. Figure 5 shows the bug sensor model.

Fig. 5 Bug detector

Fig. 6 Leaf sensor



3.6 Leaf Sensor

The leaf sensor is a photometric instrument that measures water loss or WDS in plants by monitoring the humidity of plant leaves in real time. The Israeli firm confirms the mechanical sensors invention for leaves and it is granted for the United states to produce for commericialization of the first leaf sensor. The leaf sensor is shown in Fig. 6.

3.7 Sensors Acoustic

A range of farm-managing instruments, including soil-growing, weeding, fruit-gathering, etc., contain acoustic sensors. The principal benefit of this technology is its low-cost rapid response solutions, particularly when mobile devices are considered. The subject works when the instrument interacts with other objects. An acoustic sensor is illustrated with the difference in the noise level in Fig. 7, e.g., soil particles.

3.8 Field Programmable Gate Array (FPGA)-Based Sensors

Plants have their reconfiguration versatility; FPGA-based sensors have recently begun to be used in agriculture. Most major decisions by using the FPGA sensor are really the measurement of genuine transpiration, fertilizer, and moisture. However, their usage in agriculture is at an early stage because of its constraints, such as size, expenses, and energy usage. These devices are not recommended for routine observation or possibly compromise performance with further high prices. These sensors need more electricity. By tackling these problems, FPGA-based sensors can provide satisfying answers to specific application needs. An FPGA-based sensor is shown in Fig. 8.

Fig. 7 Acoustic sensor

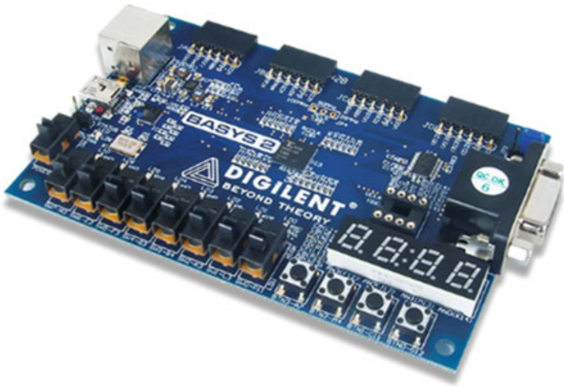


Fig. 8 FGPA-based sensor

3.9 Mechanical Sensor

In order to show the variable degree of compaction, mechanical sensors measure soil mechanical resistance. Such mechanical sensors enter and cut into the ground, recording the observed strength using load cells or pressure gauges. Mechanical sensor is impervious to the surrounding area, that is most essential for the pressure proportion needed to penetrated into soil area. Also, it is actually engaged mostly on the ground using the front instrument and determined with help of pressure unit. The sensor is shown in Fig. 9.

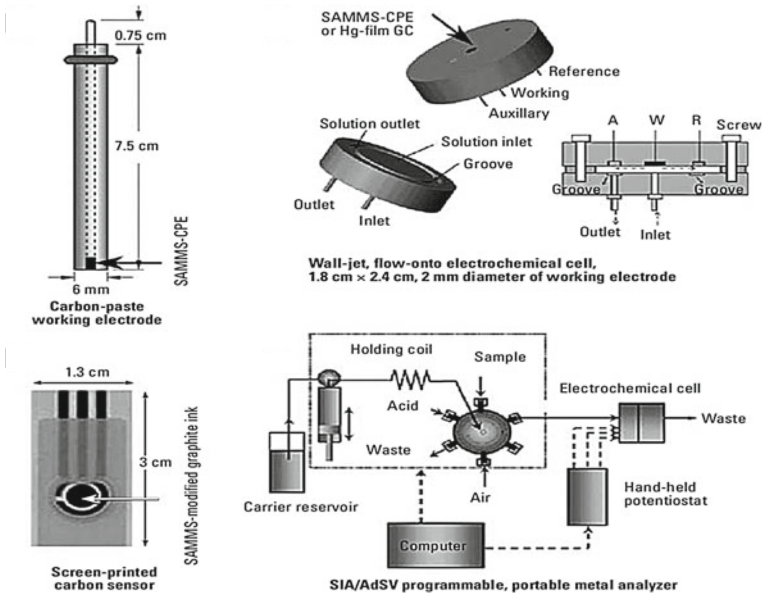


Fig. 9 Mechanical sensor

3.9.1 Ultrasonic Ranging Sensors

A suitable selection for sensors in this category is believed to be cheap cost, the ability to operate in such a range of applications, and the ease of use and adaptability for sensors. Tank tracking, spray range measuring (e.g., booming altitude and wide control for uniform coverage of spray, artifact identification, and collision prevention), and cultivated canopy monitoring are common uses. This sensor is used in conjunction with a camera for weed detection. An ultrasonic rating sensor is shown in Fig. 10.

Fig. 10 Ultrasonic ranging sensor

Fig. 11 Airflow sensor

3.9.2 Airflow Sensor

Such sensors measure the permeability and humidity level of soil air and recognize the soil structure to distinguish unlike types of soil. In individual positions, measurements can be carried out or, when in motion, dynamic, for example, in a fixed position or in mobility mode. Its output current was the pressure required to drive a well before mass of water in the earth. An airflow sensor is shown in Fig. 11.

3.9.3 Farmbot

A farming robot consisting of a Cartesian co-ordinate system for agriculture, program and documentation with including the agricultural data repository are added with designed robot. FarmBot is an open-source precision agriculture project. The initiative intend to provide open and accessible technologies to help all people for the food cultivation and other food related farming purposes. FarmBot is a device for the agricultural environment that allows people to modify and contribute hardware, software and documentation.

4 Robotics and Analytics

To mine data for patterns, robotics and analytics are used. For instance, robotics is used in farming to predict which genes are better suited for the development of crops. This has provided farmers worldwide with the best seed varieties, which are very well adapted to the individual locales and climatic conditions. Algorithms have demonstrated, on the other hand, which products are in great supply and which things are not yet available on the market. For next farming, this offered good knowledge. Recent improvements in machine learning and analytics would allow families to properly identify and weed out their produce.

4.1 Raspberry Pi for Sensor Farming

Raspberry Pi is a family of compact one-board devices created by the Raspberry Pi Foundation in the United Kingdom together with Broadcom. This Raspberry Pi project was initially designed to promote the core teaching of computer sciences in schools and in impoverished nations. The first model later got far more popular than anticipated and was sold outside of its original market for applications like robots. It is currently commonly utilized in numerous ways, for example for weather forecasting, due to its low cost, versatility, and open design.

4.2 Agricultural Advanced Practices

So it is not new to adopt new techniques for improving the quality and quantity of food, as people have been doing it for ages. Initially, they are used to boost crop output through a focus on seed varieties, fertilizers, and insecticides. The scenario soon recognizes that the conventional forms have not been sufficient to meet the demand gap; farmers have now begun to dream of new choices, such as bio-engineered (BE) crops. BE crops are made for utilizing genetic modification (GM) of crops. GM foods achieved by modifying its DNA. Foodstuffs are GM foods, or GM foods. However, other investigations have shown serious health repercussions, like miscarriage, disturbance of the immune response, accelerated aging, defective insulin checks, and so on. Cultural advances haven't yet garnered a lot of attention and attention in both these and many others since consumers like organic and conventional foods. Over the years, a substantial study has been carried out to increase the efficiency and influence of traditional agricultural operations on the invention of sensors and IoT-based technologies. In this respect, a number of different procedures have been conducted. In order to resolve the aforesaid challenges, modern, advanced, and more managed environments.

5 Conclusion

- A focus on intelligent, cheaper, and more successful cultivation practices must be placed on meeting the increasing demand for food by the growing world population in the face of ever-decreasing arable land. This rise of new crop production and management strategies is now plainly visible.
- Farmers' and retailers and purchasers are the collaborator for the reducing utilizing of fossil fuels and monitoring crop development, protection and nutrition marking. The technology-weaned, for creative young people pursuing agriculture as a career.
- This study takes all these aspects into consideration and underlined the importance of many innovations in making the agricultural more intelligent and effective in achieving future goals, notably IoT.
- Wireless cameras, UAVs, cloud computing, and networking systems are extensively explored for this purpose. A closer look is also given to new study projects. Several IoT-based designs and systems for precision farming are also given.

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