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5. Robotics in Agriclture

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Abstract:

Agriculture is the foundation of society as it provides the food, feed, and fibre on which all humans rely to survive. Precision agriculture is utilized to supply adequate treatments at the right place and right time in favour to achieve low-input, high-efficiency, and for a long time agricultural production. Automation and robots have developed as critical technologies in precision agriculture, with the goal of reducing environmental impact and increasing agricultural productivity. Automation and robots in precision agriculture are mostly used for accurate agricultural management by utilizing modern technologies. A large amount of study has been conducted in recent decades on the applications of mobile robots for agricultural tasks such as planting, inspection, spraying, and harvesting. To minimize system mistakes during future deployment, the designing process of an efficient autonomous agricultural robotic system must examine all possibilities and problems in various types of agricultural operations. An autonomous system with many simple axis manipulators can be faster and more efficient than the currently available professional, high-priced manipulators.

5.1 Introduction:

In the management and production of agriculture, robotics is becoming increasingly important. In order to run farms effectively, agriculture needs time-saving and autonomous technologies. Although traditional farm machinery is crop and topographical dependant, researchers are currently concentrating on many farming operational aspects to build autonomous agricultural vehicles. The primary purposes for which agricultural robots have been studied and created to date include harvesting, chemical spraying, picking fruit, and crop monitoring. Due to their use of unmanned sensing and machinery systems, robots like these can replace human labour in many situations.

The robots are capable of multitasking, have keen sensory perception, are reliable in their operations, and are adaptable to unusual operating circumstances. Several precision farming tools were combined with a model structure design for the study on agricultural robotic systems. A few prototypes with the names CROPS, ISAAC2 and Michigan Hortibot, Australia's AgBot, Finland's Demeter, India's Agribot, and many others were created by the European Union. Several localization methods, including vision, GPS, laser, and sensor-based navigation control systems, are used in the construction of agricultural robots.

The current trend in agriculture is towards automation in order to increase production through the use of equipment and technology.

The design focuses on implementing three distinct verticals, including sensor modules, frameworks (for applications) and mobile robot navigation. Mobile robots are being developed in these sectors by numerous nations, including the USA, European Unions, Denmark, Australia, Finland, and India, primarily to supply agricultural farming over commercial industries.

To operate robots in a single control space for farming, research teams have created a variety of specialised navigational methods, including odometer, vision-based, sensor-based, inertial, active beacon, GPS, map-based, and landmark navigation. This method is applied to tasks like preparing seed beds, placing seeds, reseeding, crop scouting, mapping weeds, robotic weed management, micro-spraying, robotic gantry, robotic irrigation, etc.

The majority of research on agricultural autonomous robotics has been done in controlled settings, such as when cherry tomatoes, cucumbers, mushrooms, and other fruits are picked by robots. Robots have been used in horticulture to harvest apples and citrus. Moreover, milking robots have received a lot of attention, especially in the Netherlands.

However, there are two difficulties with the development of these platforms: developing an electronic architecture to integrate the numerous electronic components and creating a physical structure suitable for the agricultural environment. An electronic architecture needs to be strong and dependable, quick and simple to maintain, modular and adaptable to allow for future expansions and the connection of new equipment.

5.2 Concepts and Components of Robots:

The idea of using robotics in agriculture must be compliant, that is, it must respond to unexpected and uncertain working environments better, be compatible with existing technology, and be more cost-effective than alternatives. The idea of using robotic technology to mimic or duplicate conventional agricultural methods has been tested in a number of agricultural unit operations, but there are currently no commercially available robots that can handle the complicated field conditions seen in agriculture. Sensors, end-effectors, a control system, a manipulator, and a power source make up the fundamental parts of a robotic system. End effectors are the final robotic components that are attached to the robotic arm or appendages.

They are used to handle, grab, or grasp objects in order to manipulate them. Robotic arms, also referred to as manipulators, are composed of finite, non-rigid parts called links. Joints connect the linkages to one another. Revolute, cylindrical, planar, spherical, spherical, screw, and prismatic joints are frequently employed in robotics. Roll, pitch, and yaw are used to perform the wrist or rotary moment in the x, y, and z axes.

Robot work volume is the three-dimensional area surrounding the robot where it can move its wrist to its maximum and minimum reach. The sensors are an essential part of measuring the environment and transforming the data into something that can be read.

The static and dynamic features of the sensors define them. In robotics, there are two different types of sensors: wheeled sensors and tactical sensors.

Whereas wheeled sensors are used to monitor the position or speed of the motor, tactical sensors are intended to sense physical touch and proximity. When developing a robotic system, choosing the power source is crucial. Care must be made to consider how the power source will affect the system's mechanism, packaging, weight, and size.

In robotics systems, generators, hybrids, batteries, solar cells, and fuel cells are the most often used power sources.

The control system acts to govern the behavior of all other subsystems; it needs information and knowledge about all the subsystems to be controlled, including their current and future stages.

There are two types of control systems: open and closed loop. It is crucial to have an effective control system to monitor and manage the robotic technology subsystems in order to complete a task with the specified aim.

5.2.1 Applications of AI in Agriculture Sector:

There appear to be four main categories in which the most common uses of AI in Indian agriculture may be found:

A. Crop and Soil Monitoring: Businesses are using sensors and various IoT-based technologies to keep an eye on the health of their crops and soil.

B. Predictive Agriculture Analytics: A number of AI and machine learning techniques are being used to forecast the best time to plant seeds, receive alerts regarding the dangers of pest assaults, and more.

C. Supply Chain Efficiencies: To create an effective and intelligent supply chain, businesses are employing real-time data analytics on data streams coming from many sources.

D. Agricultural Robots: Businesses are creating and programming autonomous robots to undertake crucial agricultural jobs, such harvesting crops more quickly and in greater quantities than human laborers.

5.3 Robotics and Automation Reasons:

- Labor issues are a key factor in the rise of automation and mechanization.
- Harvest crops at the right time to minimize crop losses.
- Knowledge and availability when required
- Is the cost of labor truly too high?
- Laborers' skill levels and expertise are frequently unavailable.
- Machines with sensors may be objectively monitored for product throughput.
- Consistency in output quality
- Low-cost labor competition for production

5.4 Production of Vegetables Using Robots:

- Greenhouses and nurseries
- Growing vegetables
- On-site observation
- Mechanical aids
- Machines and mechanization
- Harvesting and picking
- Sorting and grading
- Packing
- Accumulation

In the realm of agriculture, there are many different kinds of robots in use, and new technologies are always being created. Out of all of those, the following types of agricultural robots have gained popularity:

A. Iron Ox Lettuce Robot:

The robot employs a blockish frame to travel from one side to the other and is constructed to operate in glasshouses. Each factory is represented in three confines by the robot using a stereo camera that's installed on its arm. The gripper on the arm is made specifically to fit the capsules.

Figure 5.1: Iron Ox Lettuce Robot

B. Mit Robot Gardener:

The Massachusetts Institute of Technology scholars produce a mobile robot that can regulate the soil’s humidity position and elect ripe fruit. Each factory has a network of detectors that cover the soil’s moisture and signal the robot to bring water. Wireless communication exists between the robot and the factory detector.

Figure 5.2: MIT Robot Gardener

C. Hortibot:

The equipment that assists farmers with weeds is called HortiBot. The robot can recognize and get rid of up to 25 different types of weeds with an environmentally friendly wee-removing attachment.

Figure 5.3: Hortibot

D. Agbot II:

AgBot II is a robot created to assist farmers in making decisions on the application of fertilizers, insecticides, herbicides, and watering systems.

Figure 5.4: AgBot II

E. Hamster Bot:

The independent robot known as the Hamster Bot rolls over spreads without venturing them. A variety of detectors that measure soil temperature, composition, humidity, and factory health are mounted inside the ball.

Figure 5.5: Hamster Bot

F. Rowbot:

The robot Rowbot is made to serve in a range of settings. The junking of height restrictions caused by a crop that's expanding snappily is one exertion that involves moving between the rows of sludge. In order to apply fertiliser and gather information regarding the sludge, the robot can potentially work in groups.

Figure 5.6: Rowbot

G. Autonomous Robot Tractor:

This self-steering tractor is extremely accurate and capable of a wide range of manoeuvres. The tractor's direction change is a significant problem in an unsteady and unpredictable terrain. Both advanced computers and simple sensors are insufficient to solve the problems. This robot uses a programming that allows it to change its orientation in response to the terrain.

Figure 5.7: Autonomous Robot Tractor

H. Spray Robot:

The Spray robot is a different greenhouse tool created for autonomous spraying. The robot travels across the greenhouse on a 30 cm-wide pipe rail system. In addition to tomato, cucumber, pepper, and aubergine, it is indicated for use in rose, gerbera, anthurium, alstroemeria, and orchids.

Figure 5.8: Spray Robot

I. Trakur:

A robot called Trakur (fog) is used to spray insecticides in greenhouses. The robot employs a cable that produces an electromagnetic signal, algorithms, and GPS data for navigation.

Figure 5.9: Trakur

J. Vinbot:

This robot contains several sensors that might collect data and help winemakers determine the vineyard yield. The robot, known as VINBOT, uses a cloud network to gather and evaluate 3D data and vineyard pictures.

Figure 5.10: Vinbot

K. Bee Bot:

This little flying robot is used for pollination and is modelled after bees.

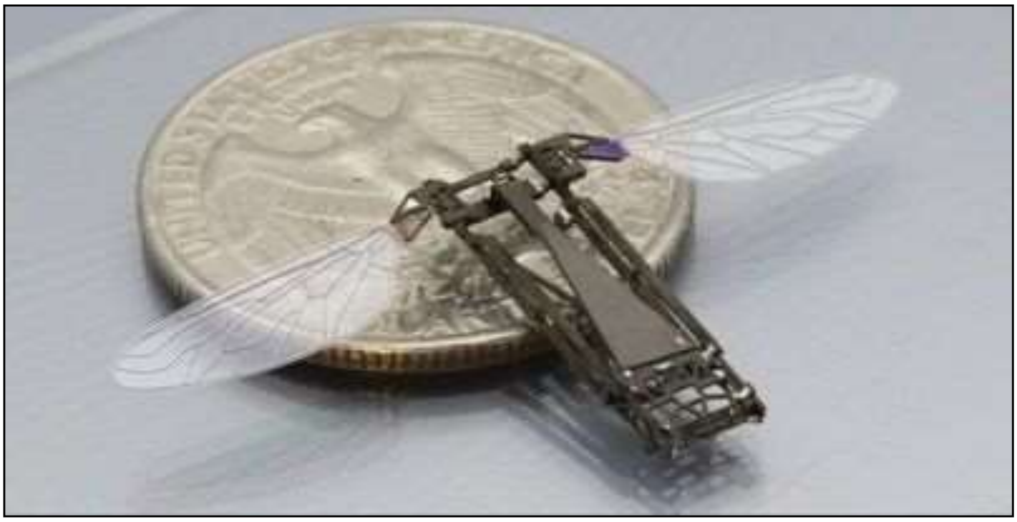

Figure 5.11: Bee Bot

L. Nursery Bot:

The Nursery Bot is the answer to moving potted plants automatically. The robot moves the plants to the desired area using wheels, gripper arms, trays, and sensors.

Figure 5.12: Nursery Bot

M. Ladybird:

Ladybird has methods and tools that enable it to carry out tasks on its own. The robot is employed for monitoring, mapping, categorization, and detection of various veggies.

Figure 5.13: Ladybird

N. Vine Robot:

The robot, which is just a prototype, controls the vines using cutting-edge sensors and artificial intelligence. Data on water quality, productivity, vegetable growth, or grape content are provided by the robot.

Figure 5.14: Ladybird

O. Insect Control Robot for Controlled Agriculture:

This is an autonomous insect control system able to move on a rail in greenhouses.

Figure 5.15: Ladybird

P. Gripper Inspired by Octopus:

This robot arm is moving the vegetables on a party tray back and forth somewhere in a lab. Each piece of broccoli can be wrapped in its blue fingers, which then lift it to a nearby chamber.

Figure 5.16: Ladybird

Q. Pro Packing Robot:

The fruit or vegetable cartons will be filled by this robot. A camera that has been configured to distinguish between the sorted items is part of the machinery.

Figure 5.17: Ladybird

5.5 Conclusion:

Future food security will be greatly maintained by robotics and automation in agriculture. Due to the advanced technology provided by the established system, farmers are now able to complete agricultural tasks quickly thanks to the use of robotics equipment. Because the development of robotic systems in agriculture is generally focused on mimicking the behavior of human labor in the completion of agricultural operations, operations like planting, inspection, spraying, and harvesting will be carried out efficiently with the least amount of operational costs and human labor.

The creation of a reliable and effective agricultural robotic system with the primary goal of producing a high level of agricultural output in order to preserve food security in the future may be accomplished in the future by designing a systematic autonomous agricultural robotic system.

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