


Chapter 3

AI-Based Robotic Frameworks for Sustainable Agriculture Supply Chains

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ABSTRACT

Using robotics in agriculture has transformed supply chain management through automation and precision. Robotics improves agricultural production and distribution costs and reliability. Planting, harvesting, sorting, and packing are optimized by automated methods. However, mechanical or technical failures during assembly might affect system accuracy and reliability. In agricultural supply chains, robotics solves occlusion problems, which complicate fruit picking and product sorting. Advanced deep learning architectures help robots discover and distinguish items in complex situations. These technologies improve precision, reducing waste and increasing throughput. Analysis of robotic systems with and without human involvement shows that automation improves agricultural workflow efficiency and uniformity. In natural environments, robotic arms with computer vision algorithms can locate, detect, and harvest crops despite overlapping objects and changeable conditions.

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1. INTRODUCTION

Robotics is a multidisciplinary field that designs, develops, operates, and applies automated systems. A machine or other technology that can be taught to carry out tasks independently or semi-independently and that frequently imitates human actions or functions is known as a robot. These duties can be as straightforward as moving stuff around or as intricate as performing medical procedures or venturing into space. “Robotics” is the word coined from the term “robot,” which was first used by the Czech playwright Karel Apek in his play “RUR” (Rossum's Universal Robots) in the year 1920. In the play, the term “robot” refers to artificial beings that were made like that of humans through a biological process. However, as time passed, the term's meaning expanded to include mechanical and automated equipment.

Industrial robots are one of the most valuable innovations of our time and may be found in various settings, including warehouses, factories, and industries. Industrial robots can move along three or more axes, are entirely automated, and may be programmed. There are a variety of applications and purposes for industrial robots. The tasks of loading and unloading, arc welding, spot welding, painting, investment casting (Patel, Gupta, & Zhang, 2022), and other similar schemes are examples of applications for industrial robots. Industrial robots, like humans, have a variety of joints, articulations, and manipulators that allow them to be trained to carry out a particular task effectively and practically.

Additionally, industrial robots contribute to realizing cost unity and waste reduction. Because these Industrial Robots are motorized and offer rapid and consistent performance in heavy-duty or repetitive jobs, their primary applications are in the manufacturing, mechanical, and assembly industries. These industries make and assemble things. In various businesses and workplaces, automated robot parts carry out fundamental responsibilities. These robots are constructed from hardy, long-lasting metal, typically steel or cast iron.

1.1 Functionalities of Multiple Robots

Robots with Articulating Joints: The majority of industrial robots are articulating robots. Since they resemble a human arm, they are often called robotic or manipulator arms because of their appearance. Because their articulations have multiple degrees of freedom, the articulated arms have a vast range of movement options.

Rectilinear Coordinate Robots: Cartesian robots, or rectilinear, gantry robots, and x-y-z robots, feature three prismatic joints for tool movement and three rotating joints for their orientation in space. Other names for this type of robot are x-y-z robots. The effector organ tends to move and point in all directions.

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