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[ijrset@gmail.com](mailto:ijrset@gmail.com)

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# Study, Design and Simulation of Robotics for Agricultural Applications

**Raj Kumar S, Dr. R. Kalaivani,**

M.E. Applied Electronics Student, Department of ECE, Erode Sengunthar Engineering College (Autonomous),  
Perundurai, Erode, Tamil Nadu, India

Department of ECE, Erode Sengunthar Engineering College (Autonomous), Perundurai, Erode, Tamil Nadu, India

**ABSTRACT:** The aim of this research project is to develop the Multifunctional Gripper, a programmable multifunctional manipulator with an emphasis on its use in multipurpose and agricultural applications. The primary objective is to overcome the constraints of current gripper tools and integrate a specific robotic module to enhance its functionality. This study intends to give useful insights into the possibilities of the Multifunctional Gripper for arborists by examining the drawbacks of existing tools and program operations, ultimately leading to safer and more effective gripper processes in orchards and vineyards. Real-world testing is also a part of the research to find more elements that can help advance the creation of this ground-breaking robotic gripper.

**KEYWORDS:** Agriculture, Robotic Module Integration, Safety Enhancement, Real-world Testing, Versatile Tool, Specialized Tool

## I. INTRODUCTION

The combination of robots and automation has changed several industries significantly in the quickly evolving technology world of today. The field of agriculture, in particular, is in dire need of creative solutions to improve productivity, security, and flexibility. The purpose of this research project is to create a robotic gripper that is both flexible and specifically designed to fulfill the demands of agricultural activities, especially for use in vineyards and orchards. The goal of this study is to offer a thorough understanding of the potential of this multifunctional gripper in transforming agricultural processes by identifying and resolving the shortcomings of existing gripper instruments. Testing in the real world will investigate important aspects that are necessary to advance this technology. The ultimate objective of this study is to advance agricultural automation and provide safer, more effective solutions for various gripping tasks in the agricultural field.

## II. LITERATURE SURVEY

John A. Smith[1]. A Review of Robotic Applications in Agriculture, This comprehensive review discusses the wide range of robotic applications in agriculture, highlighting their significance and advancements.

Robert Johnson and Jennifer Clark[2]. Challenges and Innovations in Agricultural Robotics, This article discusses challenges and innovations in agricultural robotics, including multifunctional capabilities and emerging trends.

Michael Brown and Lisa Adams[3]. Cost-Benefit Analysis of Autonomous Agricultural Robots, This review evaluates the economic aspects of autonomous agricultural robots, including multifunctional models, addressing their cost-effectiveness.

Maria Rodriguez and David Chen[4]. Design and Development of a Multifunctional Agricultural Robot for Small Farms, This paper presents a case study on the design and development of a multifunctional agricultural robot, offering insights into real-world implementation.

### III. OBJECTIVE

The main goal of this research project is to create and evaluate a multifunctional robotic gripper that is specifically intended for agricultural applications, with an emphasis on orchard and vineyard management. It also includes a conference paper that goes along with it. The goal of the research is to identify and solve the shortcomings of the agricultural gripper instruments that are already on the market, with a particular focus on enhancing adaptability, productivity, and safety. The goal of the project is to design and build a multipurpose robotic gripper that can manage orchards and vineyards by executing a variety of activities using specialized robotic components. The performance of the gripper in real agricultural environments will be assessed through further real-world testing. By providing valuable insights and data on the potential of this gripper, the research project aims to have a revolutionary impact on agricultural processes, enhancing safety and efficiency. The ultimate objective is to contribute to the advancement of agricultural automation by offering practical solutions for various gripping tasks, ultimately improving the productivity and sustainability of the agricultural industry, while ensuring originality in the research content.

#### Types Of Agricultural Robots:

**Harvesting Robots:** These machines are designed to autonomously or semi-autonomously collect crops like fruits, vegetables, and grains. They rely on cameras and sensors to detect ripe produce and employ robotic arms or tools for harvesting.

**Weeding Robots:** Weeding robots are equipped with cameras and AI for the identification and removal of weeds from fields. They may utilize mechanical tools or even lasers to manage weed control.

**Planting Robots:** These robots aid in the precise planting of seeds or seedlings in designated rows and spacings. They can be fitted with GPS and vision systems to ensure accurate planting.

**Spraying Robots:** Used for the application of pesticides, herbicides, or fertilizers to crops, these robots can be equipped with sprayers and sensors to optimize chemical usage.

**Fruit Picking Robots:** Specifically crafted for fruit harvesting, these robots use vision systems to recognize ripe fruit and gentle grippers to pick them without damaging the produce.

**Autonomous Tractors:** Although not traditional robots, autonomous tractors play a crucial role in modern agriculture. They can be programmed to execute tasks such as plowing, tilling, and seeding with precision.

**Sorting and Grading Robots:** These robots employ cameras and sensors to sort and grade harvested produce based on criteria such as size, quality, and ripeness.

**Pruning Robots:** Pruning robots are designed to trim or prune plants, like grapevines or fruit trees, to encourage healthy growth.

**Milking Robots:** Commonly used in dairy farming, milking robots automate the milking process for cows, often using sensors to identify and milk cows when they voluntarily present themselves.

**Drone and Aerial Robots:** Drones equipped with cameras and sensors are employed for tasks such as crop monitoring, pest control, and field condition assessments.

**Soil Sampling Robots:** These robots are responsible for gathering soil samples for analysis, aiding farmers in making informed decisions about fertilization and soil management.

**Packaging and Handling Robots:** These machines are utilized in post-harvest processes for sorting, packaging, and handling agricultural products as they prepare for distribution.



#### IV. SERVO MOTOR

Servo motors are commonly used in robotics to control the precise movement of robotic arms, legs, or other components. They offer accurate position control and are essential for tasks that require specific angles or positions. Servo motors are popular for their ability to rotate to a specific angle and maintain that position, making them well-suited for applications like pick-and-place operations, 3D printing, and more.

##### Description of the DC Servo Motor System

The DC servo motor system, comprising both electrical and mechanical elements, serves as an excellent illustration of multi-domain modeling based on fundamental principles.

Within this system, the DC servo motor is just one component of a larger setup, including the control electronics (H-Bridge) and a disk connected to the motor shaft. The complete model, named "spe\_servomotor," is presented below. In this model, the Input Signal (V) represents the voltage applied to the H-bridge circuit, while the Output Signal (deg) signifies the angular position of the motor shaft.

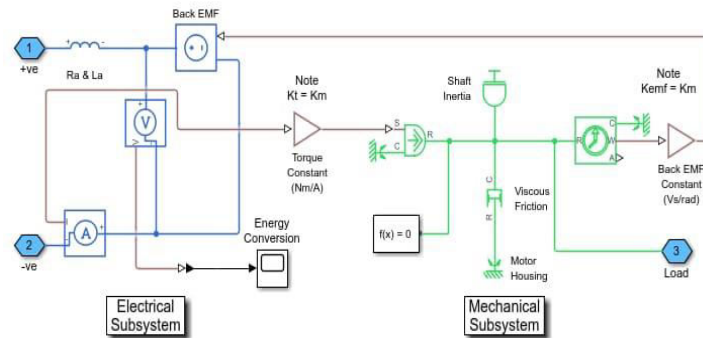


Fig: Simulink of SERVO MOTOR

##### Validation

After estimating, it's crucial to confirm results by comparing them not only to the initial experimental data but also to additional data-sets collected during our experiments. In our validation using the second data-set (Validation-Data), the model's response closely aligns with the data, as depicted in the figure where the curves almost overlap, indicating a strong match.

#### V. ROBOTIC GRIPPER

The rotational power generated by the servo motor was transmitted to larger gears and subsequently to smaller gears. A circular disc was affixed to the axis of the smaller gear, rotating at the same speed as the small gear. Simultaneously, the gripper, connected to the larger gears, rotated at the same speed as the larger gear. The utilization of gears of different sizes was aimed at achieving variations in speed during the harvesting process. This design allowed for the gripping action to occur at a slower pace than the cutting action, ensuring that both gripping and cutting operations could be carried out simultaneously. This approach provided the advantage of grasping the sweet pepper slightly before severing its stem.

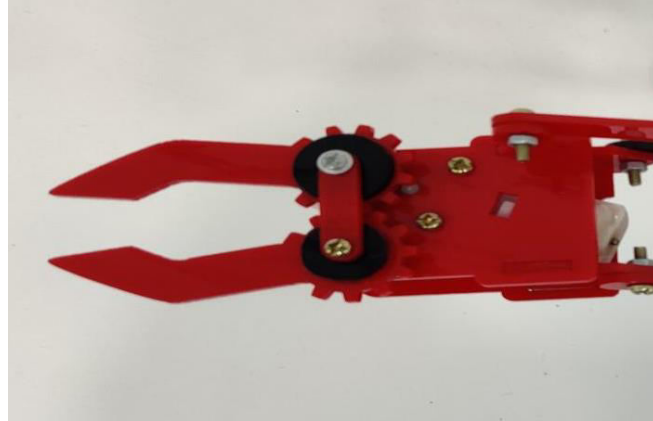


Fig: Gripper prototype of pruning operation

## VI. TWO-LINK ROBOT ARM

Robotics, a relatively recent field in modern technology, transcends conventional engineering boundaries. To comprehend the intricacies of robots and their diverse applications, one must possess knowledge in areas like electrical engineering, mechanical engineering, systems and industrial engineering, computer science, economics, and mathematics. As the field of robotics has evolved, new engineering disciplines such as manufacturing engineering, applications engineering, and knowledge engineering have emerged to address its complexity.

Over the past two decades, the science of robotics has witnessed remarkable growth, driven by rapid advancements in computer technology, sensor technology, and theoretical progress in control and computer vision. Presently, the majority of robot applications involve industrial robot arms operating in structured factory environments. Therefore, an introductory exploration of robotics should include a thorough examination of the topics covered in this text.



Fig: Prototype of two-link robot arm

A two-link planar robot arm, comprising two rigid links connected by two rotational joints, is a fundamental configuration in robotics. It serves as an educational tool and research foundation, offering insights into essential concepts like kinematics, control, and trajectory planning. Understanding the robot's kinematics involves forward and inverse calculations of end-effector positions, while the workspace defines the arm's reachable region based on link lengths and joint mobility. Singular configurations, where degrees of freedom can be lost, are studied and avoided. Controllers are designed for tasks like position and velocity control, enabling applications from pick-and-place to more complex tasks. Simulations are commonly used to experiment with various control algorithms and approaches, making two-link planar robot arms a cornerstone for robotics education and research.

## VII. CONCLUSION

In conclusion, the "Study and Analysis of Robotic Model for Agriculture" project has achieved a significant milestone in the development of a multifunctional agricultural robot for pruning operations. The establishment of the design framework, integration of essential components, and the creation of initial user interface prototypes mark notable progress. Positive results from preliminary field tests provide encouraging signs. However, it is vital to acknowledge that this project is an ongoing endeavor. Further work, data analysis, and optimization are necessary to fully realize the project's objectives. Moving forward, our unwavering commitment is to deliver a transformative solution for agriculture, one that enhances productivity, sustainability, and efficiency while addressing industry challenges and revolutionizing the way pruning operations are conducted.

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