FARMING PLANTATION ROBOTIC VEHICLE

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ABSTRACT

In an era marked by technological advancements in agriculture, the Autonomous Robotic Planting System with Mobile Control project represents a fusion of modern innovation and sustainable farming practices.

This project revolves around the development and deployment of a 4-axis robotic planting system controlled through a user-friendly Android application.

The system aims to optimize the planting process by providing precise control, efficient navigation, and real-time decision-making capabilities, ultimately contributing to enhanced crop yields and resource conservation.

The Autonomous Robotic Planting System with Mobile Control project is a testament to the marriage of cutting-edge technology and sustainable agriculture, providing a powerful tool for farmers and agricultural enthusiasts.

With its intuitive mobile interface and autonomous capabilities, this project stands as a beacon for the future of precision farming, supporting efficient, eco-friendly, and data-driven cultivation practices.

Keyword: - *Robot, Project, System, Robotic Vehicle, Farming*.

1. INTRODUCTION

The rise of farming robots is a response to the pressing challenges facing the agricultural sector. These remarkable machines are equipped with cutting-edge technology that enables them to operate with precision and efficiency. They can navigate fields autonomously, using advanced sensors and GPS technology to optimize their routes and avoid obstacles. One of the key benefits of farming robots is their potential to address labour shortages. With a growing global population and a decline in the number of individuals willing to engage in physically demanding farm work, the automation of tasks such as planting, weeding, and harvesting becomes essential to meet the demand for food production.

Farming robots have a positive impact on sustainability. They can apply fertilizers and pesticides with pinpoint accuracy, reducing overuse and minimizing the environmental footprint of agriculture. Their ability to monitor crop health in real-time allows for more efficient resource allocation and a decrease in waste Climate change poses significant challenges for agriculture, with extreme weather events becoming more common.

Farming robots can help adapt to these changes by offering flexibility in operations. They can work in adverse weather conditions and are not dependent on seasons, ensuring a more reliable food supply. In the context of global food security, farming robots have the potential to enhance agricultural productivity.

By optimizing crop management, they can increase yields and reduce food shortages. Additionally, their adoption can enable the cultivation of marginal lands, expanding the areas available for farming.

Agriculture-related tasks are now very expensive, time consuming, and challenging to complete. Robot farmers are one of the cutting-edge technologies that will transform the agriculture industry and deal with its problems. it is anticipated that the combined cost of agriculture and technology will be almost 400 million tonnes.

The arm's light material task and the mobile base's ability to move instantly in any direction would be ideal for any industrial application.

Agri-robotics can adapt to changes in farm scales, crop varieties, soil moisture content, growth patterns, and greenhouse chambers (GHC), glasshouses, vertical farms, and hydroponic closed and open systems.

2. IMPLEMENTATION

2.1. CONCEPTUAL DESIGN

This robot is an articulated manipulator with four degrees of freedom, and revolute joints at every joint. Because the mechanism was made for testing purposes, the mechanical design was chosen based on the requirements that the mechanism may be used on an experiment table. Additionally, it was found that the restricted rotation angle for all joints depends on a range from 0 to 180. Figure 1 shows the assembled side of the robot manipulator after 3D printing, whereas Figure 2 shows the drawing of the developed mechanism designed using SOLIDWORKS.

Manipulator components are designed for prototyping and printing once transformed from CAD to STL format. These parts emulate real robot arms to ensure aesthetics, industrial design, and formality akin to a reputable robotics firm. The SW2URDF plugin greatly simplifies the conversion of the design to ROS, facilitating control initiation.

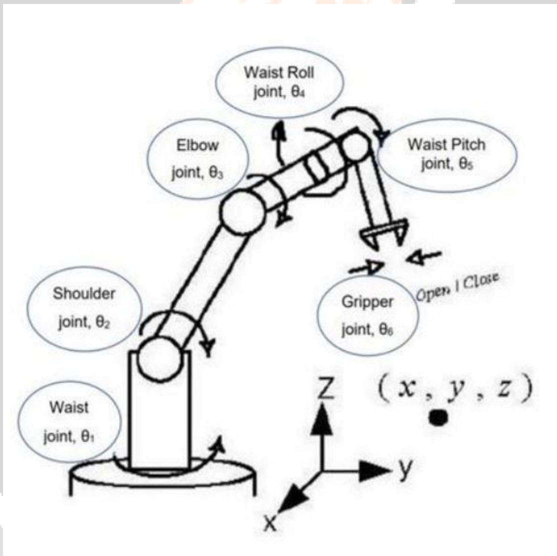

Fig -1: Design of Robotic Arm

Robotic graspers are mechanisms enabling robots to pick up and secure objects. When evaluating a gripper, the gripping strength is a critical factor. Gripping strength refers to the force applied by the gripper onto the object, facilitating precise grasping. This force varies under different conditions:

- When the gripper is at its minimum aperture.
- When the gripper is at a medium aperture.
- When the gripper is at its maximum aperture.

The minimum gripper aperture defines the smallest object size that can be grasped.

Figure 2 illustrates the workspace of the robotic arm. The arm operates within a revolute manipulator setup, characterized by axes representing degrees of freedom (DOF). In this particular project, the mobile robot possesses a 4-DOF Configuration.

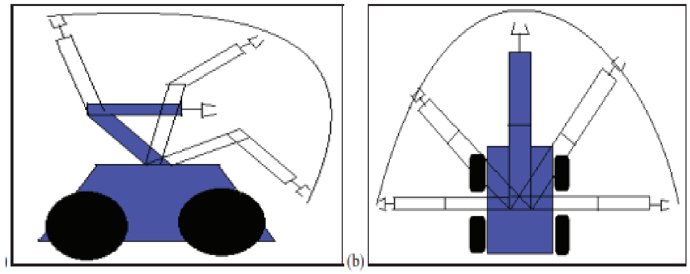

Fig -2: Moving Direction

2.2 TECHNICAL REVIEW ON DESIGNED ROBOTIC ARMS

Studies	Issue (Problem)	Method	Advantage	Disadvantage
Low cost platform for automatic control education	Education based development only	It is an on open hardware	Low-cost platform for automation	Open hardware is a risk because of incompatibility
Development of a multi-purpose, modular, low cost robotic arm for education and unmanned platforms	For education proposes and a low cost robotic arm	Modular robotic arm	3D printable and low cost, multi-purpose	Specific operations with programmed motors need skilled engineers
Self-calibration of a biologically inspired 7 DOF robotic arm with cable driven.	The design of a 7 DOF robotic arm with cable-driven movements is limited to only one direction at a time.	Cable driven method.	Its 7 degree-of freedom robotic arm, which is excellent for the robot to be only more flexible.	Cable driven methods act as a disadvantage as it is not feasible, because of the movement of the robotic arm.
Multiple-Degree-of Freedom Counterbalance Robot Arm Based on Slider-Crank Mechanism and Bevel Gear Units	High probability of locking. Requires high precision control for rotation of pre- specified angles.	Slider crank mechanism	Slider crank mechanism decreases the gravitational torque.	It is not feasible, as the slider causes vibrations during the movement
Design Analysis of a Remote Controlled "Pick and Place" Robotic Vehicle	High standard of maintenance required	Pick and Place.	This design is useful in dangerous places or work areas, its more accurate and faster for complicated and complex duties	Precise programming needed (time, training, specialist knowledge).

Chart 1-: Technical review on designed robotic arms

Typically, every autonomous system comprises three fundamental components: mechanical, electrical, and software. The interplay among these elements significantly influences the reliability, quality, scalability, and cost-effectiveness of the autonomous system. Hence, it is crucial to ensure that the three components of automation systems are intricately designed to coalesce seamlessly through an integrated design approach.

2.3 ROBOTIC VEHICLE ANALYSIS

The illustration depicts the wheel motion of the vehicle. The vehicle is capable of moving in forward and reverse directions, as well as making right and left turns.

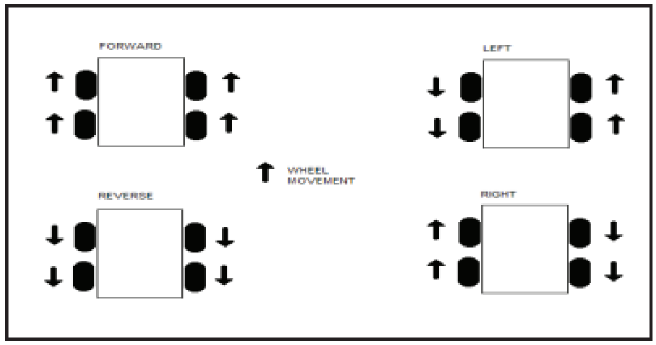

Fig -3: Wheel movement of vehicle

The waist motor facilitates rotation of the entire robotic arm around its base, spanning an angle $^{\theta}1$ between 0 and 180 degrees within the servo motor's range of rotation. The shoulder motor bears the greatest load in the robotic arm, supporting its weight while moving up and down based on angle $^{\theta}2$. The elbow motor enables smoother maneuvering of the robotic arm. Waist roll motor rotation allows the arm to pivot on its axis between 0 and 180 degrees, denoted by angle $^{\theta}4$. The waist pitch motor controls the vertical movement of that joint. Finally, the gripper motor serves as the end effector of the arm, interacting with the environment solely by opening and closing to grasp objects.

2.4 FLOW CHART OF ROBOTIC ARM

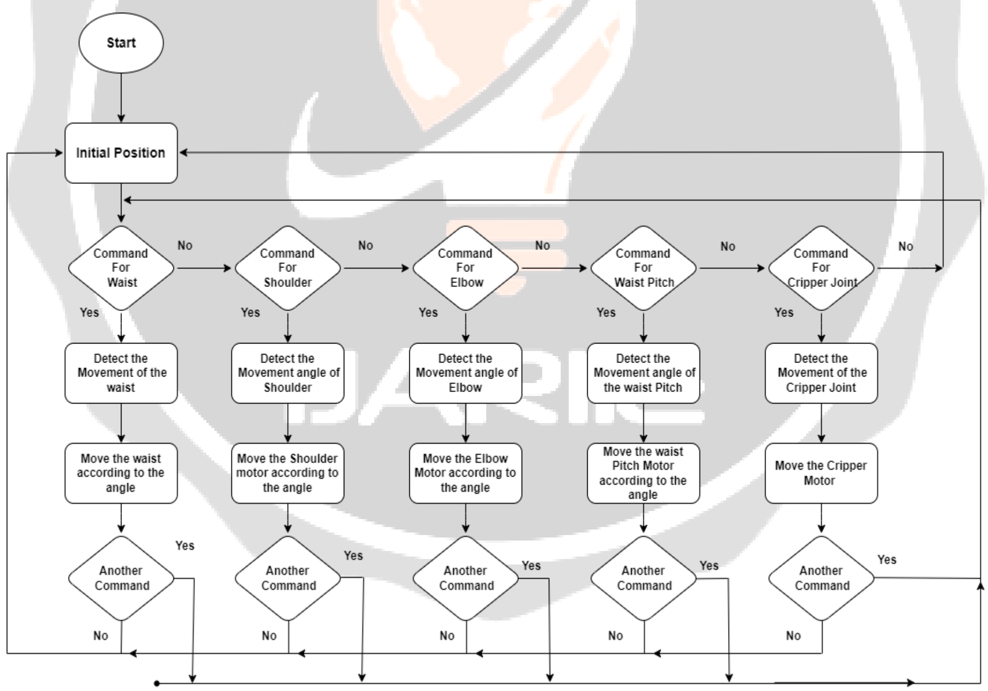

Chart –2: Flow Chart of Robotic Arm Designed

Fig.2 depicts the flow chart representing the operation of the designed robotic arm controlled by NodeMCU. This diagram outlines the entire sequence of actions involved in the operation. Upon initiation, the robotic arm assumes its initial state. Valid commands trigger specific motor movements, with each motor responding accordingly. Upon completion of a command, the robotic arm reverts to its initial state, awaiting further instructions to repeat the process continuously until power is deactivated.

3. WORKING

The robotic arm under development will be entirely managed by the Arduino platform. Hence, comprehending the programming aspects of the Arduino micro-controller and its operational procedures is crucial. The mechanical components entail the assembly of the robotic arm's body parts, while the electronic components involve configuring the motors, organizing motor wire connections, integrating the NodeMCU module, and developing the website interface. This robotic arm comprises five SG90 servo motors, each affixed to various body parts, along with a NodeMCU and an I2C module.

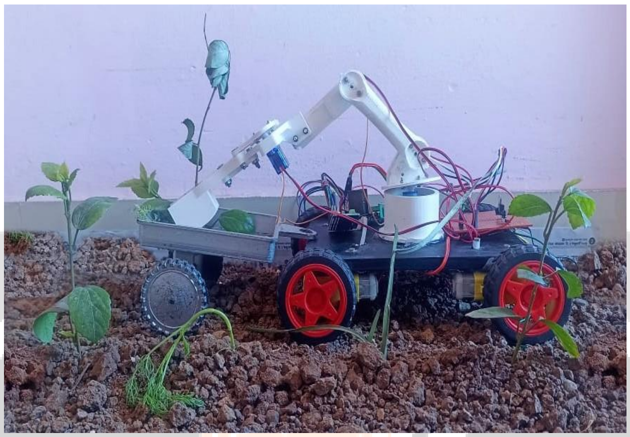

Fig -4: Robotic Arm Vehicle

For effective communication between the user and the robotic arm, a means of transmitting user commands to the robotic arm is essential. In this study, a NodeMCU module facilitates this communication, enabling interaction between web users and the robotic arm. Users transmit commands via the website to the Arduino through the NodeMCU, which then orchestrates the corresponding movements using the robotic arm's motors. Precision in programming is imperative to ensure precise control of each servo motor and its associated motion. The application is designed with sliders, each linked to a specific motor movement; adjusting the sliders on the application prompts corresponding movements in the motors.

4. METHODOLOGY FLOWCHART

The flowchart explains the step-by-step procedure followed to attain the final objective. The formulated methodology is shown in Fig.

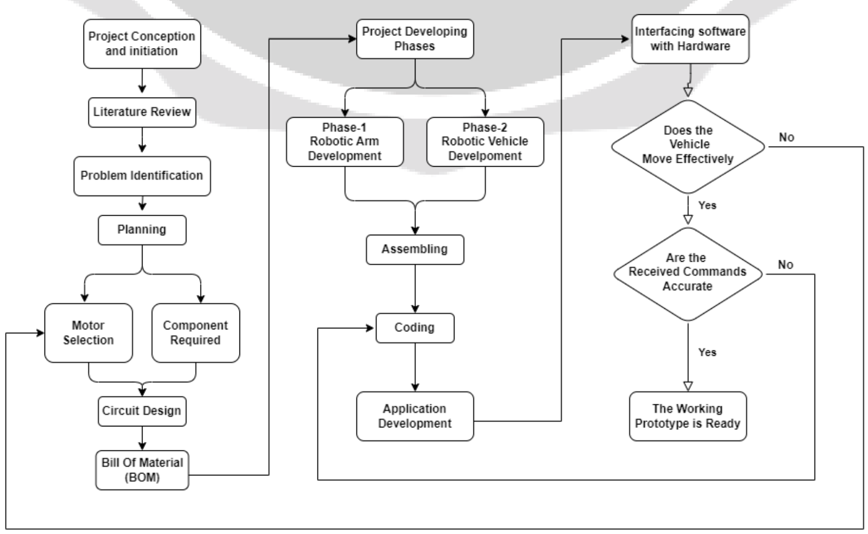

Chart -3: Methodology Flowchart

The initial phase involved identifying the issue through a review of diverse publications. Subsequently, planning commenced as the first step, encompassing calculations for necessary materials. Selection of suitable materials followed. The circuit design was finalized, accompanied by cost estimation. The project was partitioned into two phases, each executed sequentially, including coding. An application was crafted to oversee robot control. Integration of the developed mechanical components with the software ensued, culminating in rigorous testing of the robot to detect any discrepancies.

4. ADVANTAGES

Increased Efficiency: - Robots can work around the clock, performing tasks without breaks, leading to higher productivity and reduced time required for various farming operations.

Labour Savings: - By automating repetitive and labor-intensive tasks, farming robots reduce the need for manual labour, alleviating labour shortages and allowing human workers to focus on more skilled and strategic activities.

Optimized Resource Usage: - Farming robots can utilize resources such as water, fertilizers, and pesticides more efficiently by applying them only where needed, resulting in cost savings and reduced environmental impact.

Remote Monitoring and Control: - Robots equipped with sensors and cameras allow farmers to remotely monitor field conditions, make real-time decisions, and adjust operations from a distance, enhancing overall management.

Scalability: - As farms grow in size, deploying multiple robots can help maintain operational efficiency without a proportional increase in labour requirements.

5. LIMITATIONS

Dependency on Technology: - If robots experience technical failures, such as sensor malfunctions or software glitches, it can disrupt farming operations and require rapid technical support.

Technical Complexity: - Operating and maintaining robots demands specialized technical skills, training, and expertise, which might pose challenges for some farmers.

High Initial Investment: - Implementing farming robots requires significant upfront costs for purchasing, installing, and maintaining the robotic equipment and associated infrastructure.

Risk of Job Displacement: - While robots reduce the need for manual labour, concerns arise about potential job displacement for farm workers who might need to transition to more technical roles**.**

6. APPLICATIONS

Planting and Seeding: - Robots can precisely plant seeds at optimal depths and spacing, ensuring consistent germination and plant growth.

Weeding and Pest Control: - Robots equipped with cameras and sensors can identify and target weeds, reducing the need for herbicides. They can also help monitor and control pests.

Fertilization: - Robots can apply fertilizers with precision, adjusting the amount and timing based on soil conditions and crop needs.

7. FUTURE WORK

Some future possibilities for this project include,

• **AI and Machine Learning Integration: -** Future farming robots could leverage advanced AI and machine learning algorithms to make real-time decisions based on data from various sources, optimizing tasks like planting, irrigation, and pest control.

• **Swarm Robotics: -** Collaborative groups of small robots could work together in a coordinated manner, enabling efficient tasks such as pollination, weed control, and soil sampling.

• **Biomimicry:-** Robots designed to mimic natural movements and behaviors of animals could enhance pollination, mimic natural pruning techniques, and improve crop health.

8. CONCLUSION

After successfully implementation of this system we may conclude that; by meticulously designing and refining these robots, we'll harnessed the power of technology to optimize the consumption of vital resources such as water, energy, and fertilizers as Plantation and Seeding Robotic System have does essential tasks.

While on one side, precision is crucial for picking and placing objects, particularly in specific applications, on the other hand, the incorporation of mechanism wheels diminishes the turn ratio, consequently decreasing the time required to execute a task. Additionally, this feature empowers the vehicle to makeover efficiently within confined spaces.

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