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Tree Climbing Robot with Pesticides Spraying and Video Streaming in Real Time Using Microcontroller

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ABSTRACT: This design and fabrication of a coconut tree climbing and spraying mechanism. The device features a hexagonal base frame that provides support for all its components. It is equipped with three DC motors that drive nylon tires with rubber grippers for climbing. Additionally, a specially designed remote-control unit is mounted on the frame. Power is supplied to the motors via flexible wires connected to a battery. This movement of DC motors and they spraying pump is controlled by an Infra-Red-operated 8-channel relay systems. To address the change in diameter of the arecanut tree as the device moves up and down, a screw-loaded mechanism is implemented to exert the necessary tension for gripping the tree securely. This innovation helps ensure stable climbing regardless of variations in the tree's diameter. Agricultural tasks such as tree pruning and identifying pest and disease problems often necessitate human climbers, posing significant safety risks. The device aims to mitigate these risks by providing a safer alternative for performing such operations. This fully automatic system should possess the capability to automatically navigate towards the tree, securely clamp onto it, and commence of climbing without the need any manual intervention. This level of automation is crucial for enhancing efficiency and safety in agricultural operations, particularly in tasks such as arecanut tree climbing and spraying.

KEYWORDS: Climbing-mechanism, Agricultural-robotics, Labour-saving technology, Tree maintenance, Sensor-equipped climbing etc.

I.INTRODUCTION

Researchers globally are actively engaged in the development of climbing machines, with many designed to ascend regular structures such as poles and walls. However, only a select few can effectively navigate and climb trees due to the challenges posed by irregular surfaces and variations in diameter along the trunk's length. Tree climbing necessitates heightened agility and maneuverability, presenting additional hurdles for product usability. Moreover, the bark of certain trees may lack the strength to support the weight of conventional climbing devices, further limiting their applicability in tree climbing scenarios. These complexities underscore the necessity for specialized solutions tailored specifically for tree climbing applications.

The towering heights of trees like coconut, arecanut, and palm trees pose significant challenges for harvesting fruits and nuts as well as for maintenance activities. Traditional manual climbing methods are not only risky but also labour-intensive, especially considering the increasing scarcity of agricultural labour in recent years. A unique tree climbing mechanism specifically designed for such tall trees is imperative to address these challenges. For instance, in the case of arecanut trees, which can reach heights of 60-70 feet, climbing is essential for various maintenance tasks such as preventive spraying against fungal diseases and harvesting. The frequency of climbing can be as high as five times a year, making it a labour-intensive and potentially hazardous task. Therefore, the development of innovative climbing mechanisms tailored to the unique characteristics of these tall trees is crucial for enhancing efficiency, safety, and sustainability in agricultural practices.to pay using Ether, the native forex of Ethereum. The Solidity and the EVM (Ethereum Virtual Machine) offer a very flexible environment for creating decentralized apps. The rich ecosystem of developer tools and tried-and-true best practices.

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II. SYSTEM MODEL AND ASSUMPTIONS

The arecanut tree climbing and spraying machine operates based on the fundamental principle of friction, specifically the relative lateral motion between two solid surfaces in contact. This machine is designed with a base frame featuring six nylon wheels, each driven by a high-torque geared motor. The machine itself is hexagonal in shape, with hinges provided on each link to accommodate variations in the size of the tree being climbed. To ensure adequate grip on the tree, a screw mechanism is employed to adjust the pressure exerted by the wheels against the tree trunk, adapting to changes in tree size. This mechanism allows the machine to effectively climb trees of varying diameters while maintaining stability and traction.

The frame of the arecanut tree climber is designed to be opened up and positioned across the tree trunk. The setup includes connected wheels that facilitate the climbing process. When the relay is switched on, the motor rotates the shaft, causing the wheels to rotate in a clockwise direction. The friction between the drive wheel and the bark of the tree enables the machine to ascend along the tree trunk. In this tree climbing machine, power is sourced from a 12V battery, which energizes the drive motors, enabling them to propel the machine upwards. This design allows for efficient and controlled climbing of arecanut trees, providing a practical solution for agricultural tasks such as spraying or spraying or harvesting.

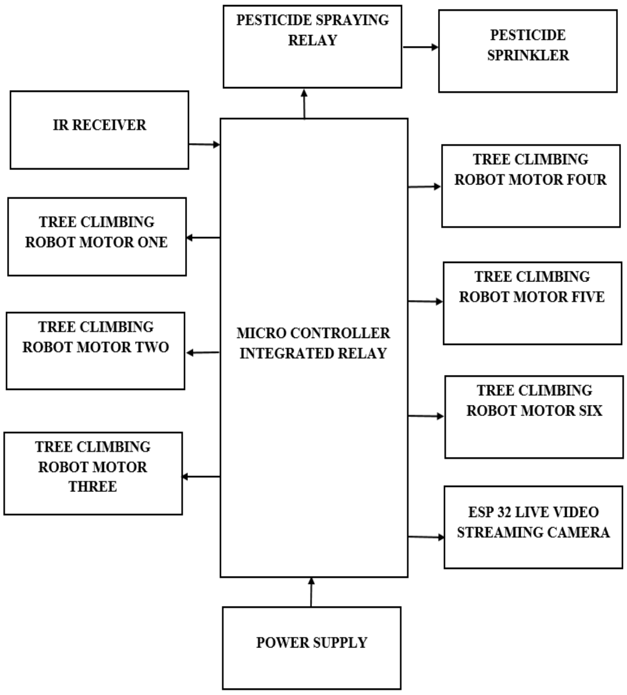

Fig. 1 System Model

The movement of the arecanut tree climber along the length of the tree is facilitated by a relay system. Contact friction between the wheels and the tree is crucial for maintaining stability, and this is achieved with the help of screws and grippers on the wheels. The design ensures that only the wheels, made of nylon, come into contact with the tree, preventing any damage to the bark. As the setup reaches the top of the tree, the motor can be stopped by pressing a key on the relay remote-control unit. At this point, the tension of the spring aids in retaining the machine at the desired height, providing stability and ensuring safe operation. This system allows for efficient and controlled climbing of arecanut trees without causing harm to the tree itself.

After reaching the desired height atop the tree, the wiper pump motor is activated by another key press on the relay. This motor powers the pesticide spraying mechanism, which disperses the pesticide onto the tree. The water pump is supplied with a 5V voltage for this operation. Once the spraying is completed, the pump is stopped, and the entire setup is brought back down by changing the polarity of the switch. This action reverses the direction of rotation of the drive motor, causing the wheels to rotate in the opposite direction. As the machine descends to the ground, it can be safely

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detached from the tree and then attached to the next tree for further spraying operations.

The system operates using two separate power sources: a 12V battery exclusively for powering the motors and a 6V battery for all other components, regulated by a power supply. An LCD screen displays the current status of the device, providing real-time information to the user. Control over the sprayer is facilitated through a Bluetooth-enabled smartphone application. Users can remotely send commands to turn the sprayer on or off as needed. The system utilizes motorized roller mechanisms to climb the arecanut tree, controlled by the commands received via Bluetooth. Additionally, a sprayer fitted to the system enables the remote spraying of pesticide onto the arecanut trees. This feature allows for precise and efficient pesticide application while providing the convenience of remote control via smartphone.

III.METHODOLOGY

Define Requirements and Objectives Clearly outline the requirements and objectives of the tree-climbing robot project. This includes specifying the desired functionalities, such as climbing ability, pesticide spraying mechanism, and real-time video streaming capabilities.

Select Microcontroller Platform Choose a suitable microcontroller platform for controlling the robot's operations Consider factors such as processing power, available input/output ports, and compatibility with sensors and communication modules.

Design Mechanical Structure Design the mechanical structure of the robot to enable climbing on tree trunks and branches. Consider factors such as stability, weight distribution, and attachment mechanisms for the pesticide spraying system and cameras.

Integrate Pesticide Spraying Mechanism Develop and integrate a pesticide spraying mechanism into the robot's design. This involves selecting appropriate spraying components (nozzles, pumps, tanks), designing the delivery system, and ensuring precise and efficient spraying control.

Implement Real-time Video Streaming Integrate cameras and communication modules into the robot's design to enable real-time video streaming. Select suitable cameras with appropriate resolution and field of view, and choose communication protocols for transmitting video data to remote operators.

Develop Control Algorithms Develop control algorithms for the microcontroller to manage the robot's movements, pesticide spraying, and video streaming processes. This includes algorithms for motor control, navigation, obstacle detection and avoidance, and video encoding and transmission.

Test and Validation Conduct extensive testing and validation of the tree-climbing robot in simulated and real-world environments. Test the climbing capabilities, pesticide spraying accuracy, and video streaming performance under various conditions to ensure functionality and reliability.

Iterative Improvement Iterate on the design and functionality based on testing feedback and user requirements. Make necessary adjustments to the hardware, software, and control algorithms to optimize performance and address any issues identified during testing.

Documentation and Reporting Document the design, development process, and testing results in a comprehensive report. Provide detailed information on the methodology, implementation details, and performance evaluations for future reference and dissemination.

IV.SURVEY DESCRIPTION

This survey seeks to gather insights from a diverse spectrum of perspectives, including robotics aficionados, agricultural experts, environmental advocates, and tech enthusiasts alike. Whether you bring expertise in robotics, agriculture, or harbor a keen interest in technological progressions, your opinions will play a crucial role in refining this pioneering initiative.

We're excited to invite you to participate in our survey focused on the development of an advanced Tree Climbing Robot

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integrated with Pesticides Spraying and Real-Time Video Streaming functionalities, all orchestrated through a sophisticated Microcontroller system. Your input is pivotal in sculpting the design, operational features, and potential applications of this cutting-edge technology.

Existing Practices We're keen to understand current methodologies employed in tree inspection, pesticide dissemination, and monitoring within agricultural or relevant domains.

Technological Integration Your insights into the potential impact and feasibility of integrating robotics, pesticide spraying mechanisms, and live video streaming capabilities in tree management processes.

User Interface Preferences Your preferences regarding the user interface design for controlling and monitoring the robot, emphasizing ease of use, accessibility, and intuitiveness.

Safety and Environmental Considerations We value your perspectives on ensuring the safety of the robot during operation, its ecological footprint, and any ethical considerations inherent in its deployment.

Future Prospects Explore potential avenues for future applications beyond agriculture, such as environmental surveillance, emergency response scenarios, or other industries where this technology could be instrumental.

V.FUTURE SCOPE AND DISCUSSION

Autonomous Navigation Future versions of the robot could incorporate advanced AI and machine learning algorithms for autonomous navigation. This would enable the robot to identify optimal paths for climbing trees, avoiding obstacles, and efficiently spraying pesticides.

Advanced Sensors Integration of more advanced sensors, such as LiDAR (Light Detection and Ranging) or advanced cameras with computer vision capabilities, could enhance the robot's ability to perceive its environment and make informed decisions.

Precision Agriculture Beyond pesticide spraying, the robot could be equipped with additional sensors for monitoring plant health, detecting pests and diseases, and even performing targeted treatments. This would enable precision agriculture practices, leading to increased crop yields and reduced environmental impact

Multi-Robot Collaboration Future systems could involve multiple tree climbing robots working collaboratively to cover larger areas more efficiently. These robots could communicate with each other to share data, coordinate tasks, and optimize their collective performance.

Environmental Monitoring In addition to agricultural applications, similar robotic platforms could be used for environmental monitoring in forests and other natural ecosystems. They could collect data on tree health, biodiversity, and environmental conditions, helping researchers and conservationists better understand and manage natural habitats.

Energy Efficiency Advancements in energy-efficient components and power management systems could extend the operational autonomy of the robot, allowing it to work for longer periods without recharging or refuelling.

VI. RESULT AND DISCUSSION

Robot Design a robot capable of climbing trees. This would involve creating a sturdy chassis with climbing mechanisms such as tracks, wheels, or legs that can grip onto the bark of the tree securely.

Pesticide Spraying Mechanism Integrate a pesticide spraying system onto the robot. This could include a tank for holding the pesticide, a pump system for spraying, and a sprayer mechanism.

Real-time Video Streaming Choose a suitable camera and wireless transmission system to stream video in real-time. The camera should be mounted on the robot to provide a view of the tree and surrounding area. You'll need a microcontroller capable of handling the video data and transmitting it wirelessly.

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Microcontroller Selection Choose a microcontroller with enough processing power and I/O capabilities to control the robot's movements, manage the pesticide spraying mechanism, and handle the video streaming. Popular choices might include Arduino, Raspberry Pi, or specialized microcontrollers designed for robotics applications.

Sensor Integration Consider integrating sensors such as proximity sensors or cameras for obstacle detection and navigation. These sensors can help the robot navigate around branches and other obstacles on the tree.

Software Development of the software to control the robot's movements, manage the pesticide spraying, and handle the video streaming. This would involve programming the microcontroller and possibly developing a user interface for remote control and monitoring.

Testing and Iteration Test the robot in a controlled environment to ensure that it can climb trees safely, spray pesticides accurately, and stream video reliably. Iterate on the design and software as needed to improve performance and reliability.

Safety Considerations Ensure that the robot is equipped with safety features to prevent accidents, such as emergency stop buttons and fail-safe mechanisms. Also, consider environmental and human safety when using pesticides.

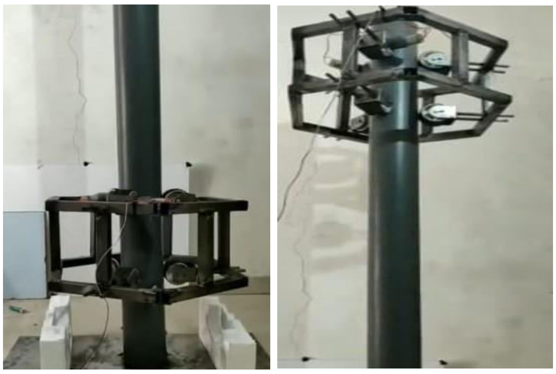

Fig. 2 System Overview Result

VII.CONCLUSION

The design of the robot, virtual analysis of the design concept, development of electronics compartments was done. When considering areas where it is dangerous for human, this mobile robot can be used. The design can be taken as the basic concept for improvements in the seed harvesting and maintains in-trees like coconut and palm tree the study conducted above can be used for fuming and harvesting the tall trees in a safe manner.

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