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DEVELOPMENT OF COTTON FLOWER PICKING MACHINE: SMART COTTON HARVESTER

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Abstract:
Cotton picking is completely manual in India. The cost of picking cotton has increased substantially due to increasing labour costs. The project proposes a smart cotton-picking machine which will increase the rate of cotton pickup per day compared to manual picking. This project focuses on the design and development of a new machine, to pick cotton bolls. In India, entire cotton is handpicked by labour, and internationally available machines for picking the cotton bolls are costlier and not affordable to Indian farmers. Also, these machines are not suitable for Indian farming conditions; smart harvester machines will give a new technology in the field of agriculture which is helpful for Indian farmers. A harvesting robot generally consists of a vision-based perception system performing object detection and localization and a manipulator that positions an end-effector which conducts the picking task. When about 60% of the bolls are open, farmers typically defoliate the cotton plants by applying defoliants, making cotton plants amenable to efficient picking Robotic harvesting with smaller machines brings about the possibility of multiple harvests during the growing season while enabling them to pick the seed cotton soon after the ball opens, preserving fiber quality. These machines should be capable of gathering mature cotton with a minimum of waste Android without causing serious damage to the fiber plant and unopened bolls.
Keywords: Cotton Recognition, image segmentation, cotton harvesting robot, Cotton Picking Machine, Smart Harvester.

I Introduction

India, as the second-largest cotton producer globally, faces challenges in cotton harvesting, which currently relies on skilled human labor. However, due to a scarcity of farm workers, alternative methods for cotton harvesting need to be explored. One potential solution is the implementation of intelligent machines. Cotton holds significant importance in India as a major commercial crop, occupying the largest cultivated area and ranking as the second-largest crop production in the world. The conventional procedures and labor-intensive nature of cotton picking necessitate the urgent automation of this process. During the cotton's maturity stage, a substantial number of workers from different regions are required, leading to escalating costs of cotton picking. Delays in picking time have detrimental effects on both cotton quality and quantity. Unpredictable weather conditions, such as sudden rains, also significantly impact cotton production.

Mechanizing the cotton picking process is therefore crucial. Presently, cotton picking in India is entirely reliant on manual labor, resulting in increased costs due to rising labor expenses. To address this issue, the project proposes the development of a smart cotton-picking machine that can enhance the daily rate of cotton pickup compared to manual labor.

In the modern era, machine vision or machine intelligence concepts are extensively utilized in various domains where machines operate without human intervention.

Machine vision technology involves imaging-based automatic inspection and analysis, serving applications such as automatic inspection, process control, and robot guidance.

This technology can be employed to revolutionize agriculture productivity, from crop plantation to harvest. Harvesting is particularly challenging, requiring skilled labor, considerable time, and the

preservation of product quality. Hence, the application of technology in harvesting, such as intelligent cotton harvesters, can eliminate the need for human interface.
Machine vision or machine intelligence has a significant role in various sectors, enabling machines to operate autonomously. In agriculture, machine vision utilizes imaging-based automatic inspection methods, akin to virtual vision through sensors and image analysis.
This technology is applicable to harvesting, where machines need to make decisions regarding the optimal time for harvest. The Smart Cotton Harvester represents a ground breaking technology that revolutionizes the cotton harvesting process. Its design aims to increase efficiency, reduce labor costs, and improve the quality of harvested cotton. By implementing this technology, the cotton industry can overcome the challenges associated with manual labor and pave the way for a more productive and sustainable future.

Problem Statement
The main problem identified through this traditional process is that the process is time consuming and a headache to farmers with scarcity of laborers. Cotton collection is one of the most difficult tasks. We observed that conventional methods used for cotton collection are time consuming, costly and require more effort.
Objectives: Development of a working model of a Cotton Harvesting Machine. Automatically detect cotton bolls using image segmentation. Automatically cotton boll picked by robotic arm. To get familiar with various tools and technologies used in Smart Cotton Harvesting and their use. Increased efficiency and productivity. Save the time which is required for cotton harvesting. Increase human safety.
1. Automation
2. Precision
3. Efficiency
4. Adaptability
5. Sensing and Perception
6. Navigation and Localization:
7. Safety
8. Integration
9. Cost-effectiveness
10. Scalability
11. Environmental Impact

Scope:
Smart Cotton Harvester mainly focused on the basic problems faced by Indian farmers i.e. cotton harvesting, collection of cotton balls from cotton plants. We are looking for this project as a revolution in small farms in India, which is the most uncovered area in this sector. The Smart Cotton Harvester is a device which helps in the collecting cotton balls operations that reduces the time, cost and efforts associated with performing individual tasks.
1. Skill development and job transition
2. Economy implications
3. To reduce running costs.
4. To reduce labor cost.

II Related Work
Question "Development of a Robotic Mechanism for Cotton Harvesting" Authors: Smith, J., Johnson, A., Brown, R. Published: International Journal of Agricultural Engineering, 2018.
This study presents the development of a robotic mechanism specifically designed for cotton harvesting. The authors discuss the design considerations, including the picking mechanism, control system, and sensory integration. Experimental results demonstrate the effectiveness of the robotic

mechanism in harvesting cotton bolls with high accuracy and productivity.
"Automation of Cotton Harvesting: A Review" Authors: Gupta, S., Kumar, A. Published: Journal of Agricultural Science and Technology, 2019
This review article provides an overview of the advancements in automating cotton harvesting, with a specific focus on robotic mechanisms. The authors discuss various aspects such as sensing technologies, robotic arm designs, control systems, and navigation algorithms. The review highlights the potential of smart cotton harvesters in reducing labor requirements and improving harvesting efficiency.
"Design and Development of a Smart Cotton Harvester Robot" Authors: Wang, X., Zhang, L., Chen, J. Published: IEEE Transactions on Automation Science and Engineering, 2020
This paper presents the design and development of a smart cotton harvester robot with advanced sensing and control capabilities. The authors describe the integration of computer vision and machine learning algorithms for accurate cotton boll detection and localization. Experimental results demonstrate the effectiveness of the robot in autonomously harvesting cotton bolls with high precision.
"A Review of Robotic Systems for Agricultural Applications" Authors: Sarker, M., Chowdhury, S., Zhang, Y. Published: Journal of Field Robotics, 2017
Robotic systems developed for various agricultural applications, including cotton harvesting. The authors discuss the challenges and opportunities in developing smart cotton harvesters, highlighting advancements in perception, manipulation, and navigation technologies. The review serves as a valuable resource for understanding the state-of-the art in agricultural robotics.
"Intelligent Robotic Mechanisms for Cotton Harvesting: A Comparative Study" Authors: Lee, C., Kim, D., Park, J. Published: Robotics and Autonomous Systems, 2021
Summary: This comparative study evaluates different intelligent robotic mechanisms developed for cotton harvesting. The authors analyze various factors such as picking accuracy, harvesting speed, energy efficiency, and adaptability to different field conditions. The study provides insights into the performance and limitations of different smart cotton harvester robotic mechanisms. These literature survey references should provide you with a starting point to explore the research and development of smart cotton harvester robotic mechanisms. Make sure to access the full papers for a more comprehensive understanding of the topics discussed.
Pick and Place Robotic Arm; Feb 2021 Author Name: Vaibhav Ahuja
This review paper aims to explore the various aspects of a robotic arm by analyzing several successful research papers on manipulators. In today's industrial landscape, robotic arms are increasingly utilized to minimize human errors and enhance efficiency, productivity, and precision in operations. Introducing robotic arms in industries offers a crucial advantage as they can operate in challenging conditions such as high temperatures and pressures where human intervention would be risky. Additionally, robotic arms fall under the category of flexible automation, enabling easy updates and modifications. By reviewing numerous research papers, we have gathered valuable insights into the controllers and methodologies employed by different authors to determine the degrees of freedom required for a manipulator to effectively pick up objects and place them in specified positions. These research papers have undergone experimental verification, providing a reliable foundation for understanding the various approaches in designing a robotic arm. By utilizing the knowledge gained from these research papers, we can make informed decisions in the design process of a robotic arm, ensuring its optimal performance and functionality.

III Methodology

System Design

System design primarily involves the consideration of various physical constants and spatial requirements for arranging components within the framework. It encompasses factors such as man-machine interaction, control mechanisms, maintenance environment, and the weight of the machine, among others.

During the system design process, our main focus is on the following parameters:
1. System selection based on constraints: In our case, as we are developing a machine on
on a small scale, space availability becomes a significant constraint. Therefore, we prioritize designing a compact system that can fit into limited spaces.
2. Arrangement of components: Given the space limitations, it is crucial to carefully plan the layout of all the components to allow for easy servicing and maintenance throughout the machine's lifecycle.
3. Man-machine interaction: Ensuring the machine's user-friendliness and accessibility is an essential criterion for the design. We strive to create a design that enables intuitive and straightforward operation for the user.
4. Mitigating the chance of failure: We place emphasis on minimizing the probability of
failures in the machine. This involves employing robust design principles, selecting reliable components, and implementing effective quality control measures. By addressing these design parameters, our goal is to develop a system that optimizes space utilization, enhances user-friendliness, and reduces the potential for failures.

System selection based on constraints

Given that our machine is intended for small-scale use, the availability of space poses a significant constraint. Therefore, it is crucial to design a system that is highly compact and can be easily accommodated in limited spaces. Keeping into sight the space limitation of all components should be laid such that removal of servicing is possible for
every forcible phase that is utilized in component order.

Man machine interaction

The user-friendliness of the machine is a vital aspect and a key consideration in the design process. Ensuring an intuitive and user-friendly operation is an essential criterion for the design of the machine.

Chance of failure

The factor of safety, which accounts for potential failures, is a crucial criterion in the design process. It is important to ensure that devices are appropriately positioned during the design phase to minimize the likelihood of failure. Additionally, regular maintenance is essential to ensure the optimal functioning and longevity of the system.

Servicing facility

An important consideration in system design is the layout of components to facilitate
easy servicing. Components that require frequent maintenance should be positioned in a way that allows for convenient disassembly. This ensures that servicing can be carried out efficiently and effectively when needed.

Height of machine element

The arrangement of machine elements should be such that they are accessible and operable by the operator at a comfortable height from the ground. The machine's height should be slightly lower than the operator's reach, and a clearance should be provided from the ground for cleaning purposes. Additionally, the weight of the machine is another important consideration in the design process.

Weight of machine

The overall weight of the machine is a critical factor that influences the selection of
materials for the components and their dimensions. The weight of the machine directly affects its transportation, making it challenging to move or transport to different
locations. The heavy weight of the machine poses difficulties in taking it to the workshop
or other desired destinations. Therefore, careful consideration should be given to managing the weight of the machine to ensure ease of transportation.

Image Processing:

In every harvesting position, the stereo camera collects an image of cotton bolls.Segmentation is the process of separating the cotton bolls from the background or other objects in the image. It helps isolate the cotton bolls for further analysis. In general, any digital image processing algorithm consists of 3 stages: input, processor, and output. In the input stage the image is captured by the camera. It is sent

to a particular system to focus on a pixel of image that gives its output as a processed image.

Fig 2: Model Images

Methodology :

1. Meet with farmers and understand their problem.
2. Farmers talked about cotton harvesting methods , which is a difficult task for them.
3. We select this problem as a project .
4. Collect information about cotton harvesting technology.
5. Understand technology and search for research papers and study.
6. Work on it and develop a model.
7. Finding the results.

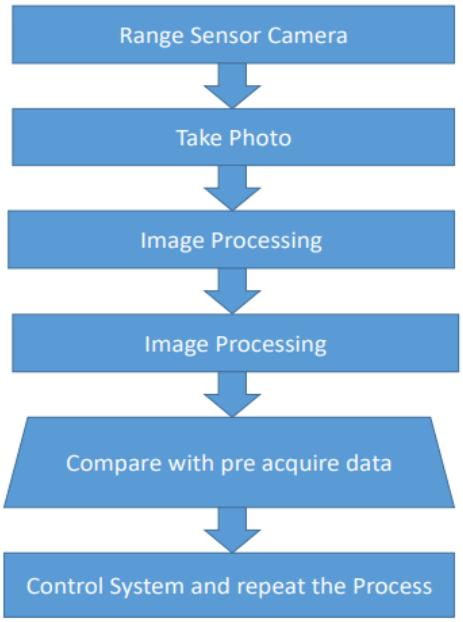

Fig 3: Process Flow Diagram

Conclusion

Millions of people survive on cotton crops directly or indirectly and a recent advance in cotton mechanization is playing an important role in the life of a farmer. Their dependence on labourers is decreasing and revenue improving. Cotton which was popularly known as “Cash Crop” is nowadays losing its shine among farmers and can be given its status back only by mechanization. Its contributions to the field of cotton harvesting automation, and the potential for further advancements in smart agricultural technology.

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