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Design And Analysis of Seed Sowing Mechanism for Agriculture ROBOT

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Abstract:

Agriculture is the primary source of income for nearly 70% of Indians. As a result, India's agricultural system should be advanced in order to reduce farmers' efforts. Crop sowing, weeding, cutting, pesticide spraying, and other operations are all conducted in the agriculture sector. Primary and significant operation is seed sowing in agriculture field. Seed sowing work was repetitive task, which required more human effort. Hence the scope of developing machinery to reduce the efforts of farmers is very necessary. Present study is an attempt to make the design and development of Agriculture Robot for seed sowing application. Agriculture Robot consists of seed sowing mechanism and robot. A four blade rotor van is key component in seed sowing mechanism, with the help of motor rotor drive shaft. Rotor van blade is design and perform analysis with different materials to get deflections and stresses. Entire model is made by computer aided design then develop the model. Seed sowing mechanism and robot is interface properly. As it moves down the aisle, the robot uses its keen sensors to level itself with the slots. When the robot reaches the trough, it send signal to activates motor with a rotor. The distance travelled by the robot is calculated using data from the wheel encoder. This knowledge is help to trigger the seed sowing mechanism, allowing the crop's inter-seeding travel to be reduced. Proposed seed sowing agriculture robot will useful to farmers to solve agriculture problems.

Keywords*:* Computer Aided Design (CAD), Agriculture, Agriculture Robot, seed sowing mechanism, Rotor vane blade.

I. INTRODUCTION

Smart agriculture is one of the most important sources of income and has contributed significantly to the battle against poverty and hunger[1].Seeding, Plough, planting, weeding, spraying, and harvesting are all considered to be one of the most time-consuming tasks in agriculture and farming. In many ways, robotics has aided in enhancing the quality of our lives. However, implementing robots in agriculture, typical field activities, remains a big issue to scientists, researchers and

engineers. Robots will assist to plant more precisely, water more precisely, and manage weeds and pests with better precision. All of this leads to higher-quality products, lower-cost food, and less labor.

Agricultural robots basically working in either self-operated or semi-autonomous systems that can handle issues at various stages of the system. Agricultural robots have been effectively deployed for repetitive operations, such as land preparation, water irrigation and spraying, trimming, harvesting, monitoring, and other duties, in order to minimise the farmer's workload and optimise process times and costs[2]. Grafting and cutting, harvesting and transplanting, precision spraying and irrigation, fruit and vegetable harvesting and spotting, and colour classification are just a few of the activities that robots in greenhouses undertake. A multi-purpose flexible robot may do multiple tasks in a crop in certain occasions, enhancing horticulture and floral production and harvesting procedures. Because the vast majority of commercial robots are still being built as prototypes, there are few commercial robots working on agricultural challenges to date. The most crucial aspect of crop production is seed sowing. The goal of seed sowing is to plant seeds in rows at the specified depths and spacing, then cover them with soil and compact them properly, resulting in germination. [3].Farmers use a variety of seed-sowing techniques, including traditional methods such as sowing by hand.

Objective of the present study is to design a better mechanism for seed sowing agriculture robot. After design the mechanism developing the proposed agriculture robot for seed sowing application.

II. PROPOSED MODEL OF AGRICULTURE ROBOT

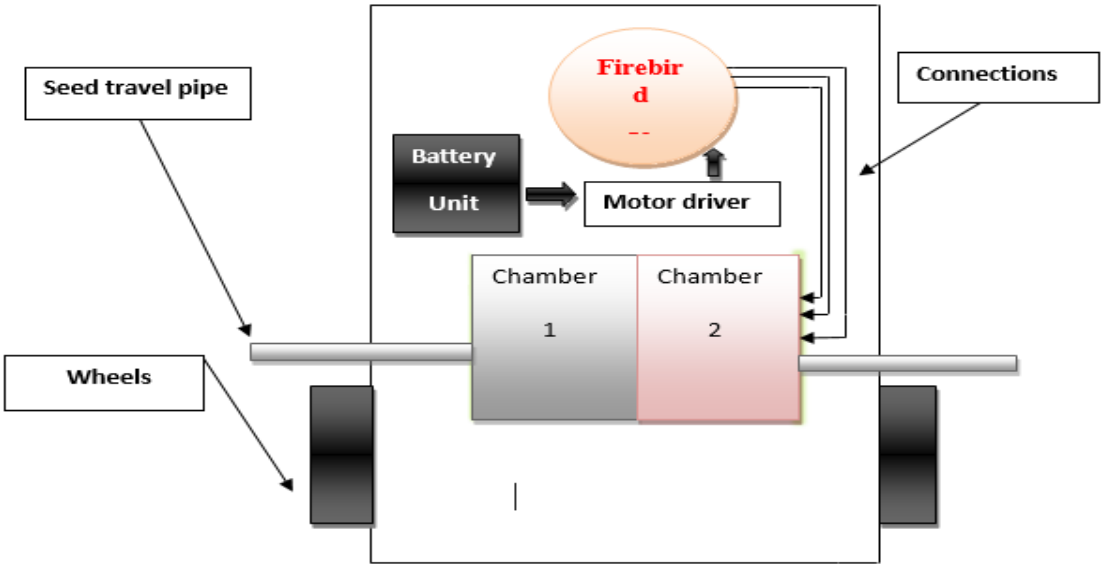

Fig 2.1 Concept model of seed sowing agriculture robot

Agriculture robot consisting of major components like mechanical set up with proper seed sowing mechanism, programmable advanced robot with sensors can be control. Components in the proposed model of seed sowing agriculture robot as shown in fig 2.1. It also includes a

rechargeable battery that is attached to motors as an output device and to the robot. Chamber 1 and 2 of the mechanism pick and transfer seeds to their proper locations. Each chamber has its own rotor shafts that are linked together. Internal communications should be made with male to male wires connecters, roughly. Sensors and encoders are used to maintain proper coordination between wheels for ease of operation in the agricultural field. Seeds would be dropped using a mid-van rotor with a sensor and microcontroller at a precise position.

III. DESIGN AND ANALYSIS OF SEED SOWING MECHANISM

3.1 Parts of seed sowing mechanism

Seed sowing mechanism required with key components to operate agriculture robot. Proper concern with different conditions considered while designing the mechanism to execute proper task. Hence this robot is able to plant the seeds in the desired trajectory. Seed sowing agriculture robot consisting of following parts. The exterior shell is the most important portion, as it has an inlet for pouring seeds over the top. The second component is the rotor body, which contains two seed-dropping ports, one on the left and one on the right side of the robot. The third component is the mid van, which is made up of blades that will take the seed from the tank and drive it through the outlet rotor body at the precise time and displacement. Computer Aided Design (CAD) software CATIA V5R24 was used to design and assembled of seed sowing robot. From literature [3, 4, 5, 6] different approaches were studied for design the seed sowing mechanism.

The assembly of the base part, robot body, and rotor van blade is completed. The base part is attached to the rotor body, and the rotor van blade is connected to the rotor body with roller bearings. The dome upper side of the base component features an entrance hole for pouring seeds, which also serves as an inlet. The extend arm on the outside of the rotor body allows the seed to be dropped on the appropriate side for the system's outflow. The seed is collected from the bottom of the tank by the four blades of the rotor van, which rotates until the blade reaches the outlet, where the seed is flung. To drop the seeds on the right and left sides of the rotor body, a similar arrangement was attached on both sides of the rotor body. The fireboard V ATMEGA robot assists in the operation of the mechanism. The encoder on the wheel will aid in the accurate execution of the seeds for dropping. Shafts and bearings, as well as additional material, will be used to complete the product.

3.2 Design and Finite Element Analysis of Rotor Van Blade:

Seed sowing mechanism in agriculture robot consists of different components in it. Rotor blade is key component in the Seed sowing mechanism to collect seed from dump and drop through outlet [8, 9, and 10]. Fig.3.1 shows the design specifications of rotor van with four blades length and thickness details mentioned and with the help of CAD software rotor van blade was designed as shown in figure.

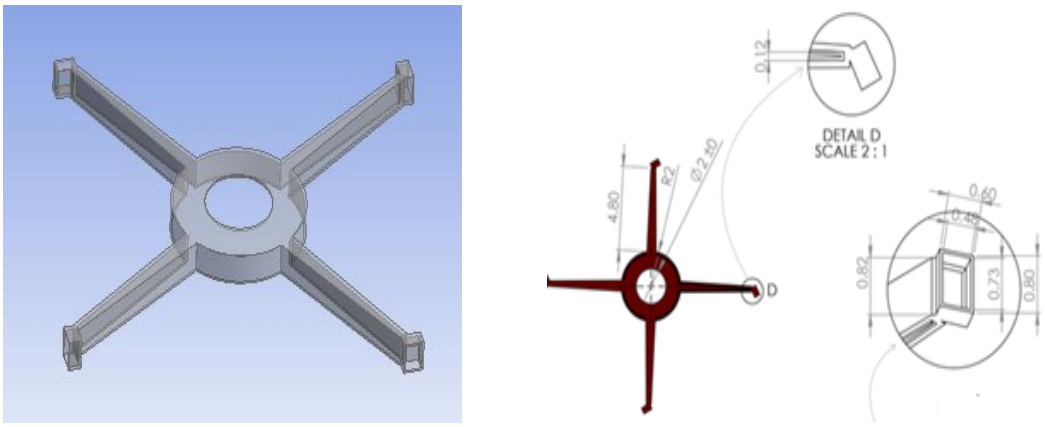

Fig 3.1. CAD model of Rotor Van Blade and design specifications of Rotor van with four blades

ANALYSIS of Rotor van blade

Finite Element Analysis is a key tool to deal various types of analysis. To conduct Finite Element Analysis we have to perform sequence of steps. Firstly design the required model in a CAD software with exact specifications and save the file in desired format to transfer to analysis software [10]. Now open the analysis software import the design then assign the material to the designed model. Perform Mesh to the model and important criteria in FEA analysis results are depends on type of mesh selected. Meshed model of rotor van is shown in Fig.3.2. Assigned boundary conditions to model as shown Fig.3.3 real boundary conditions are assumed and applied. After completion of all the sequences next is to solve the problem. Based on basic equation F=[K].[Q] software solve the model for each element in the model. Finally in post processing results section extracted results from the model for interpreting the model. In the present study ANSYS 18.1 is used for conducting Finite Element Analysis.

Static structural analysis conducted to test the structural stability of the rotor van blade by analyze stresses and deflections. In ANSYS workbench file is created and rotor blade model imported, structural steel material is assigned, followed by assigning boundary conditions center of rotor applied moment 5 N-mm then solved the model. The results are collected in Post processer like deformations and stresses. By similar way material changed for rotor van model to Aluminum and Copper results extracted.

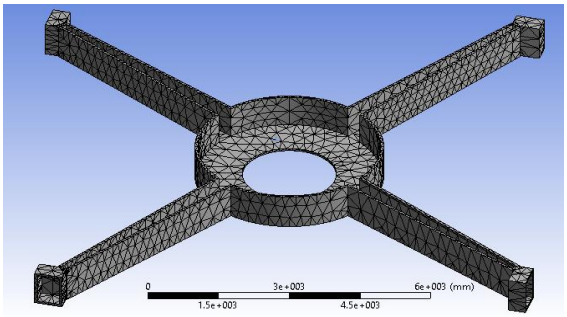

Fig.3.2 Finite Element Model of rotor blade.

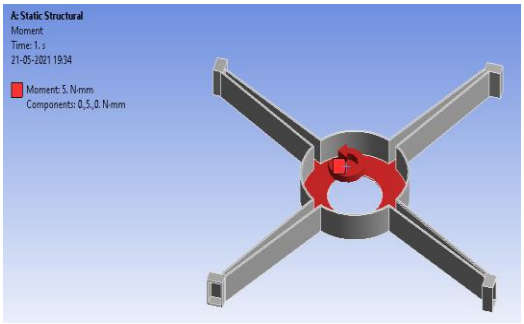

Fig 3.3 Boundary conditions of rotor blade

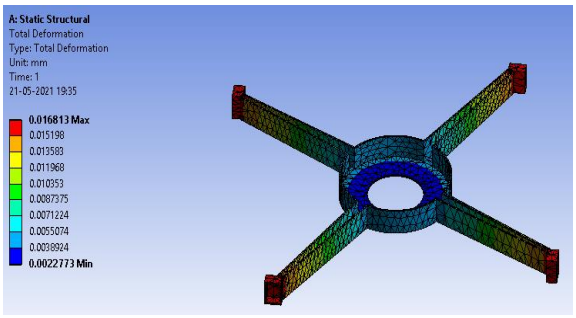

Fig.3.4 Total deformation of rotor blade.

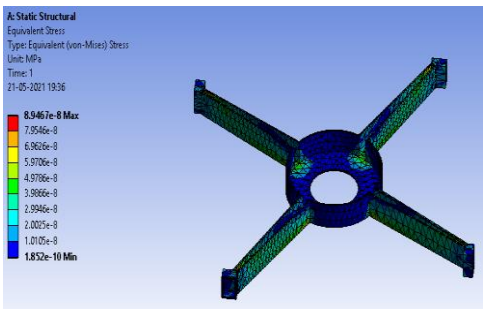

Fig 3.5 Von-moises stress of rotor blade.

The total deformation obtained was a small value approximately and 0.0168mm was the maximum deformation that rotor blade can undergo was shown in Fig.3.4. Maximum stress of 8.9467e-8MPa was observed at the interior of the rotor blade in Fig 3.5 and minimum stress obtained is 1.852e-8MPa on the exterior side. Table 3.1 shows results of deformations and stresses of structural steel, Aluminum and Copper. All the materials got good results with in allowable range only. Based on cost criteria Aluminum material is recommend for rotor blade design.

Table 3.1 result of deformation and stresses of different materials

S.No	Material	Deformation(mm)	Stress (MPa)	Remarks
1.	Structural steel	0.0059	8.8976e-8	Within allowable values
2.	Aluminium	0.0168	8.9467e-8	Within allowable values
3.	Copper	0.0108	8.9617e-8	Within allowable values

3.3 Seed sowing Agriculture robot

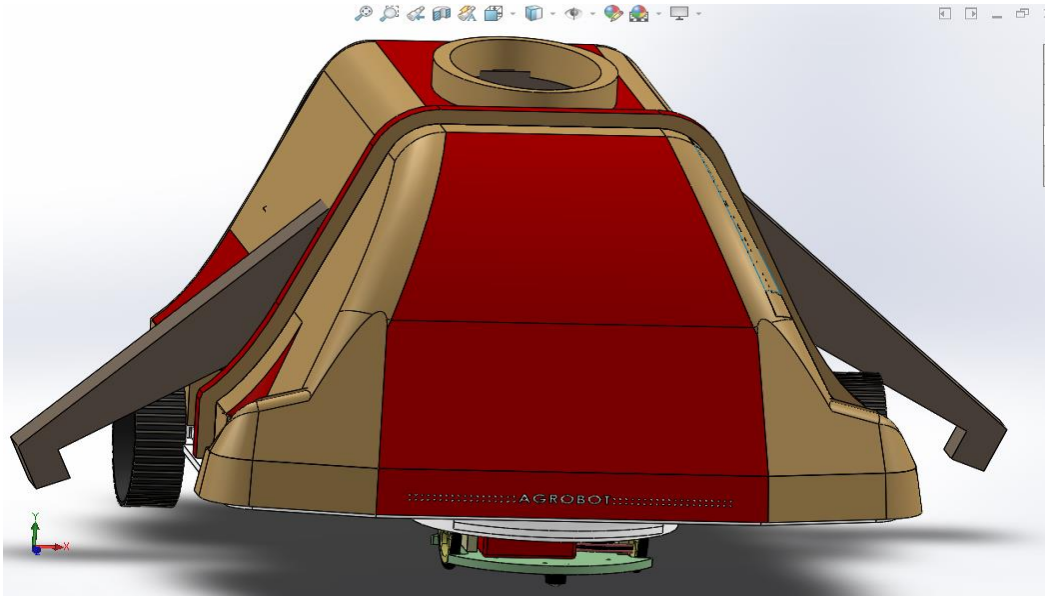

Fig 3.6 CAD model of seed sowing Agriculture ROBOT

Figure 3.6 shows complete model of seed sowing Agriculture roobt desiged with the help of CAD software. Agriculture robot consists of seed sowing mechanism and fire board V robot[11,12]. Robot attached seed sowing mechanisum. Robot attached in the front wheel position, Robot guide the seed planter with the help of back wheels which depend the direction of front wheel . Main body is attached seed sowing mechanism which is top side entrance inlet and both sides of robot outer tubes as outlets for dropping the seeds simultaneously. Based on Encoder wheel rotation was counted and estimated distance in the trajectory with the help of robot. One complete rotation of wheel counted and based on the information program was written. The task was completed using an arduino chip with black line follower programme.

IV RESULTS AND DISCUSSION

In agriculture sector seed sowing is important task in farming lots of effort human need to put at this work. A technological based revolution is very much reuired in indian agriculture. The proposed seed sowing agriculture robot has imortant components like base part, rotor arrangement, rotor blade and a programmable robot. Components were analyzed in concept stage of the design then made the final list of components to make seed sowing mechanisum. Agriculture robot was made by using CAD modeling software then develop the proposed model. Rotor van blade is key component it was deesigned by using CATIA software and performed analysis by using ANSYS software. To get bettrer rotor blade analysis was conducted with structural steel, aluminium and copper materials. Model wsa meshed and applied boundary conditons then solved. Results were extracted like deflections and stresses of all the materials. Based on analyis results aluminum was better because of its low cost. Later all components were designed and assembled. Finally Fire Bird V robot was attached to seed sowing mechanisum [13,14] and the black line sensor, motors, seed picking mechanism motors, and the time interval of the rotating frames in milliseconds were all written as program and successfully executed. as shown in figure 4.1

Fig 4.1 Prototype of Agriculture ROBOT executing the task

Difficult situation faced while excuting seed sowing mechanisum with robot were firstly drop the seeds one by one at a time and not to drop too many. Secondly weight of seed sowing mechanism not gone to act as extra burden to robot, because of additional weight the root performance deteriorated. Lastly while taking curvature trajectory speed must be reduced. Selected mechanism was good to deliver seeds one by one at exact locations. The proposed mechanism was very simple enough for implement in a robust operations. Various mechanisms were studied, such as a vacuum-based pick and place robotic hand and a robotic arm with mechanical gripper. Power consumption and complexity were more this reason rejected them. An easy and reliable mechanism consisting circular wheel with buckets and servomotor attached to a flap made to perform the task of delivery reliably and efficiently. However following factors, aligning the robot was difficult while sharp sensors are extremely delicate and impossible to rotate the wheels in precise numbers. Finally after repeated trails seed sowing mechanism worked well with the help of robot. Present developed prototype was good in normal trajectory, need to work out on different trajectories with faster operations.

Conclusion

Through this study an effort was made to overcome seed sowing problems in agriculture field. Human work is more and feel tedious because seed sowing is repetitive task. Present scenario available of labor source for agriculture work also very limited. The demand of wages for the labor was also high. These factors influencing the farmers to move towards technological advancements in agriculture. Present study would help to farmers in the seed sowing. Technology shows for better replace of human effort to perform the seeding operations. Model consist of mainly seed sowing mechanism and robot. Seed sowing mechanism arrangement have base part, rotor and rotor van blade. Rotor van blade is key component in sees sowing mechanism, so the rotor van with four blades was designed by using CATIA software. Analysis of rotor blade was also performed order to estimate stresses and deflections to rotor blade. Analysis were conducted on by using structural steel, aluminum and copper materials. Three materials got under allowable limits only that means design is safe. Aluminum material was recommended because of its low price. Then complete system was made by Computer aided design software. Prototype of seed sowing mechanism was developed. Except for the section where the user gives the order to start sowing the seeds, the device is fully automated. The fact that it has sharp sensors for moving through the troughs, as well as a white line tracer, makes it suitable for use in a greenhouse. The knowledge from the sharp sensor can be used to navigate independently if the line is missed or stained. Finally seed sowing mechanism was design and developed, a fully programmed robot was attached to mechanism. Based on encoder information wheel distance program was written. Successfully seeds were drop at desired location with the help of proposed model.

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