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DESIGN AND FABRICATION OF AUTOMATIC SEED SOWING ROBOT FOR AGRICULTURAL FIELD

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Abstract

In Today era is marching towards the rapid growth of all sectors includingthe agricultural sector. To meet the future food demands, the farmershave to implement the new techniques which will not affect the soiltexture but will increase the overall crop production. The aim of thisproject is to design and develop an Automatic seed sowing robot for Chickpeas Seed. TheChickpeas Seed sowing machine is a key component of agricultural field. The varioustechnique used in India for seed sowing and fertilizer placement aremanual, ox and tractor operator. The manual and ox operator techniqueare time consuming and productivity is low.

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Tractor is running on fossilfuel which emits carbon dioxide and other pollution every second. Thisevident has led to widespread air, water and noise pollution and most importantlyhas led to a realistic energy crisis in the near future, in orderto make the development of our farmer as well as nation sustainable andcause less harm to our environment. Now, the approach of this projectis to develop the automatic Chickpeas Seed sowing robot which is to minimize theworking cost and the time for digging as well as operate on clean energy.In this robot proximity sensor is used to convert rotations to distance witha 12V battery, which then gives the necessary power to a DC wiper motor.This power is then transmitted to the shaft to drive the wheels. Andto further reduction of labor dependency, IR sensors are used to manoeuvrerobot in the field. Seed sowing and digging robot will move ondifferent ground contours and performs digging and sowing the seed.

***Key Words*:**Low Cost Automation, Seed Sowing Machine, Chickpeas Seed.

1 Introduction

The major occupation of the Indian rural people is agriculture and both men and womenare equally involved in the process. Agriculture has been the backbone of the Indianeconomy and it will continue to remain so for a long time. It has to support almost 17%of world population from 2.3% of world geographical area and 4.2% of world waterresources.The Seed Planter was an invention thought out in 1699 Proposed by the author [1]. It waslater built and used by author [2]. He started off in law school and then laterin his life studied agriculture. Jethro inherited land in Europe where he practiced hisagricultural study. His seed planter successfully planted seeds in uniform although thiswas improved in 1782, Jethro Tull still takes credit for his extremely helpful invention.The present cropping intensity of 137% has registered an increase of only 26% since1950-51. The net sown area is 142 Mha. The basic objective of sowing operation is toput the seed and fertilizer in rows at desired depth and spacing, cover the seeds with soiland provide proper compaction over the seed. A traditional method of seed sowing hasmany disadvantages. Different types of methods of seed sowing and fertilizer placementin the soil and developing a multifunctional seed sowing machine which can performsimultaneous operations.In order to save the farmers effort and his valuable time, it is important to developthe method which not only saves the time but also saves his efforts. Farmers face theproblem of non-availability of bullocks as well as tractors during the peak period of sowing. Hence, they are tempted to hire them at an increased cost. By making use of automatic operated seed planter, the yield loss can be substantially decreased.The most important advantage of automatic operated seed planter is that - it can be easily driven by a single person as well as it can be driven manually. Currentlymaximum process is done manually which is too much time consuming and require more manpower for large farm areas and the automatic machines available they having too much cost.For reducing manpower, safety and most importantly cost in working automatic seed planter following practices are adopted Simplicity of process. Reduce human efforts. Eliminate steps. Improved accuracy.Researcher conducted [3-8] A punch planter for corn was designed, prototyped, and evaluated for no-till conditions using a commercial seed metering unit. The seed meter was evaluated for seed spacing performance at the vertical position with 2.5 kPa of vacuum,as specified by the manufacturer, and at a 22 degrees incline with 4.0 kPa of vacuum.The prototype punch planter was evaluated at a 22 degrees incline with 4.0 kPa of vacuum.Only small changes occurred in the seed meter performance when speed varied from 1 to 3 m/s. The precision of seed spacing decreased approximately 6.0% when compared with the seed meter results.Author studied [5-10] High precision pneumatic planters have been developed for many varieties of crops, for a wide range of seed sizes, resulting to uniform seeds distribution along the travel path, in predefined spacing. The objective of the present work was to develop a high-resolution optical system for evaluation of performance parameters of pneumatic planters. This paper describes the design, construction and evaluation of the optical system.Researcher studied [9-12] Developed agriculture needs to find new ways to improve efficiency. One approach is to utilize available information technologies in the form of more intelligent machines to reduce and target energy inputs in more effective ways than in the past. Precision Farming has shown benefits of this approach but we can n wmove towards a new Generation of equipment.Author studied [8-15] Sowing is prime operation in cultivation practice of any crop which directly affects production. Therefore, timely sowing is necessary with available sources of power. To achieve these a prototype consisting of seed hopper, metering mechanism, power transmission unit, frame, furrow opener and beam for hitching arrangement was developed. The seed planter was tested for its performance of sowing groundnut variety SB-XI.Author proposed [12-15] the study method by dynamic modeling ofthe technical system tractor - sowing machine, using the specialized software Inventor.The achievement of the dynamic system model assumed in advance the design and the simulation of three different models namely: the dynamic model of working sections ofthe sowing machine, dynamic model of mechanical transmission of the sowing machine and the tractor dynamic model.Researcher conducted [11-15] The critical parameters for plant population with desired planting geometry include uniform distribution and precision placement of seeds. RD efforts in metering of single seeds at predetermined intervals are carried in this paper. Proximity sensor technique-based seed spacing evaluation system that measure time intervals between seeds and transmission ratio between two velocities isuse to determine planter seed spacing uniformity. researcher used [12-15] The basic requirements for small scale cropping machines are, they should be suitable for small farms, simple in design and technology and versatile for use in different farm operations. A manually operated template row planter was designed and developed to improve planting efficiency and reduce drudgeryinvolved in manual planting method. Seed planting is also possible for different size ofseed at variable depth and space between two seed.Discussing the current scenarios of agricultural practices, we found that there is tremendous scope in this field to develop as lack of development is there. By taking this point the machines available in the market are very costly and most of them are manually operated.So, we decided to make an agricultural seed planter in minimum cost as well as automaticallyoperated that it reduces farmers effort and time.Hence, we decided to do effort and use our engineering knowledge for the development of a planter which must be having low cost, simple in construction with greater accuracy.

2 DESIGN AND FABRICATION OF ROBOT.

2.1 Mechanical components and description

Selection of motor.
As our main principle is to reduce the speed and increased torque hence we require a high rpm as well as less costly dc motor. So, we decided to go with this dc wiper motor as it satisfy our design as well as easily available in the market. In which calculated the Power and torque as per our requirement.

Spur gear design and selection.
Calculate forces on teeth of helical gears, including impact forces associated with velocity and clearances.
Step 1. Determine allowable force on gear teeth, including the factors necessary due to angle of involute of tooth shape and materials selected for gears.
Step 2. Design actual gear systems, including specifying materials, manufacturing accuracy, and other factors necessary for complete helical gear design.
Step 3. Understand and determine necessary surface hardness of gears to minimize or prevent surface wear.
Step 4. Understand how lubrication can cushion the impact on gearing systems and cool them.
Step 5. Select standard gears available from stocking manufacturers or distributors.
Step 6. In which calculated the Diametric Pitch (P) - Pitch circle Diameter (PCD) and the Number of Teeth (N).

eed sowing disc and Seed bucket.
S The main purpose of this disc is to dropping the seeds into the field. Description- From the surveys to calculate the distance between two seeds, we have make conclusion that the approximate distance between two seeds is normally 2.5 to 3 inches. So,we decided to make the distance according to that calculation as follows:

Figure 1: Seed sowing disc and hopper

A. Rudder Control

Chickpeas Seed hopper. Storage device is one of the important devices of the system. And is designed accordingto weight sustained by the robot as well as the required capacity for planting. This-component is stationary. To the bottom of this tank seed sowing disc is arranged. This disc serves the function of distribution of the seeds, as for each complete rotation ofthe rotating wheel, only one seed falls from the tank. Number of seeds falling fromtank is varied according to requirements. This disc evenly opens the way to seed hence

planting is done smoothly and accurately. Ploughing arrangement

Digging plates are used to dig the land and to spray the seeds. There are four holes inthe plate. It is used to mount with rod. Digging plates are made of mild steel. Theseplates are mounted in front of the seed container and coupled in the rod with particulardistance using bolts and nuts. By adjusting the bolts and nuts we can vary the positionof plates. Rod is mounted with the bearing mounting plate using bolts and nuts. It canbe easily dismantled and assembled.

Figure 2: Ploughing arrangement

Frame:

Frame is back bone of the equipment. It is made of mild steel. All the sub-parts in theequipment are mounted in the shaft. It is the rigid structure that forms a skeleton to holdall the major parts together. At the bottom end of the frame wheel with seedcontainerassembly is mounted.

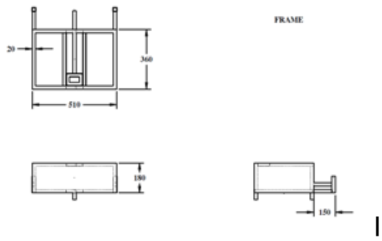

Figure 3: Design of frame

Bearing with cap

The main purpose to use the bearings is rolling bearings use rolling elements to maintainthe separation between moving parts to reduce rotational friction and support radial andaxial loads. The shield protects the working parts of the bearing fromenvironmentaldebris that may be introduced and could reduce the ball bearing speed and lifespan.Rolling bearings are used in a range of applications from agricultural machinery toconveying equipment, robotics, dental equipment, elevators, rolling mills, ship ruddershafts, and aggregate crushers, among others.

Figure 4: Bearing

PIC Microcontroller (16F877A)

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The PIC microcontroller PIC16F877A is one of the most renowned microcontrollers inthe industry. This controller is veryconvenient to use, the coding or programming ofthis controller is also easier. One of the main advantages is that it can be write-eraseas many times as possible because it use FLASH memory technology. It has a totalnumber of 40 pins and there are 33 pins for input and output. PIC16F877A is used inmany pic microcontroller projects. PIC16F877A also have many application in digitalelectronics circuits.PIC16F877A finds its applications in a huge number of devices. It is used in remotesensors, security and safety devices, home automation and in many industrial instruments.An EPROM is also featured in it which makes it possible to store some of theinformation permanently like transmitter codes and receiver frequencies and some otherrelated data. The cost of this controller is low and its handling is also easy. It is flexibleand can be used in areas where microcontrollers have never been used before as incoprocessor applications and timer functions etc. Assembly. The assembly process is elaborated in the following steps -
Step 1. All the components such as gear is oiled so as to remove the metallic chips, dust
Step 2. and other foreign particles.
Step 3. Firstly, attach the front wheels (diameter = 2000mm) to the fabricated frame.
Step 4. Now insert shaft to the frame.
Step 5. Mount the smaller wheels to the back side and front side of the frame for balancing
Step 6. purpose. Step 7. Now mount the bearing (i.e. 6202) to the shaft and for reducing the friction and Step 8. stress.
Step 9. After that mount two motors on both side of the frame (i.e. front and back).
Step 10. After mounting the motors mesh the bigger spur gear with the smaller gear
which Step 11. already attach with the motor.
Step 12. Mount the hopper and seed dropping disc to the middle shaft.
Step 13. Now fix and attach the ploughing arrangement.
Step 14. Mount microcontroller circuit to the frame.
Step 15. Connect the motor connection to the microcontroller with the help of wires.

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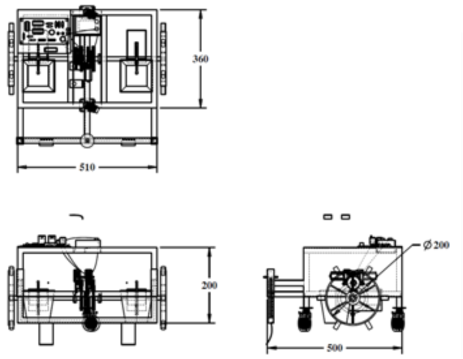

Figure 5 :2D diagram of the final assembly

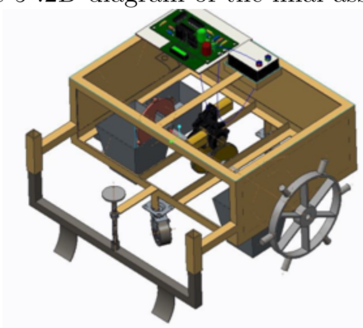

Figure 6 :3D diagram of final assembly

3 METHODOLOGY.

This study begins by studying the requirements andthe existing method of agricultural seed planter. This study will include overviewof the current manual as well as automatic seed planting process and formulationof initial design proposal for the proposed new method of seed planting.

Step 1. The next step to follow will be to carry out extensive literature review to find out about the seed planting process, automation in seed planting and recent developments in seed planting applications. This task is accomplished through accessing the internet, reference books, research papers, technical magazines and others related source of information.

Step 2. After gathering and collecting all relevant information and knowledge about the seed planting processes and automation, the proposal for design of a seed planting machine will be prepared. It will include proposed schematic layout of seed planting machine considering all the requirements of the seed and the planting process.
Step 3. The schematic layout of seed planting machine will be followed by detailed design of various assemblies and sub-assemblies required for manufacturing and fabricating the seed planting machine. After ensuring the functional requirements from the assembly, the material specifications for individual components and the technical specifications of the standard bought out parts will be finalized. Thenthe design will be evaluated for safety and functionality.
Step 4. The next step after the design is finalized will be to manufacture the componentsand fabricate the different sub-assemblies considering their manufacturing suitabilityand requirements such as operations and machines required, selection ofmicrocontroller, receiver and transmitter and the inspection of the parts. Step 5. The next step will be to assemble the subassemblies and join the sub-assemblieson a single platform to assemble the complete seed planting machine. Step 6. The microcontroller is programmed and tested.
Autonomous control algorithm The basic set of instructions that are followed by the Automatic seed sowing robot during operation are as follows-
Step 1. The LCD panel is initialised and programmed to ask for the input values.
Step 2. Now, the inductive proximity sensor is called to check and complete the provided instruction.
Step 3. The relays are controlled and hence the dc wiper motors for displacement of the robot.
Step 4. In each above step the IR sensor function is called and checked for any interruption.
Step 5. If found anything it instructs the robot to stop until the interruption is cleared.
Step 6. Finally, the robot stops after completion of the task.

Working.

Step 1. The LCD display asks for number of rotations the wheel should move in straight and right path simultaneously.
Step 2. As the data is provided, the rotations of the wheels is sensed by inductive proximity sensor.
Step 3. The main drive is given through 12v dc wiper motor which is having low torque and higher RPM.
Step 4. The two spur gears rotates speed decreases and torque increases.
Step 5. Then the motion is transferred to shaft and finally wheels.
Step 6. As the wheels rotates the seed dropping disc also rotates as it is attached with the shaft
Step 7. The plough are make furrows in the soil at the same time the seeds are placed in the field.
Step 8. The distance between two seeds is calculated.
Step 9. In case any obstacle is detected in the defined path of the robot IR sensor senses it and the robot pauses until path is cleared.

Figure 7: Chickpeas SeedRobot

4 RESULT AND DISCUSSION

Testing of the Automatic seed sowing robot. Trail 1-
The power supply was not properly give so it burnt the relay driver circuit. Thebalancing problem existed while testing the robot in soil. Trail 2-
Soil type- Medium soil
Soil depth- 40-45cm
Soil moisture- 20
Average depth of sowing obtained- 1-2cm

Row spacing obtained-25cm
Distance between each seed dropped- 2.5 to 3inch
The Automatic seed sowing robot was tested for 2 rotations i.e., 1m in a straight line and again 1m straight after taking a right turn.
Expected number of seeds to be dropped in soil- 60.

Difficulties faced while testing the robot
Level 1. Straight Line Sowing: It is very necessary for sowing to sow in a straight line.During trials it is not exactly possible to sow in straight line.
Level 2. Uneven Distribution of Seeds Fertilizer: There is uneven distribution of seedsand fertilizer where the land is not properly levelled (at some ups and downs) ordue to big stones in the way.
Level 3. Speed of Operation: For uniform sowing the speed of operation is of prime importance.More uniform the speed of operation, more uniform will be the sowingresulting in higher yield. The speed of operation varies in some scale duringsowing.
Level 4. Opening of Seeds Fertilizers: At some places the seeds and fertilizers hadremained open to atmosphere which is very bad for the germination of the seed.It is due to the improper levelled land or improper functioning of chain employedfor covering the seeds.
Level 5. Non-Uniform depth of seeds sown: The depth of the seeds sown is varied at someplaces. For uniform depth of the seeds the effort applied to the machine shouldbe nearly constant as possible.

Figure 7: Chickpeas SeedRobot

5 Confirmation experiment

The confirmation experiment is conducted It reduces the time and effort. A machine makes work of many workers. Mechanism makes process easier/faster. Use of seed planter machine increase efficiency.

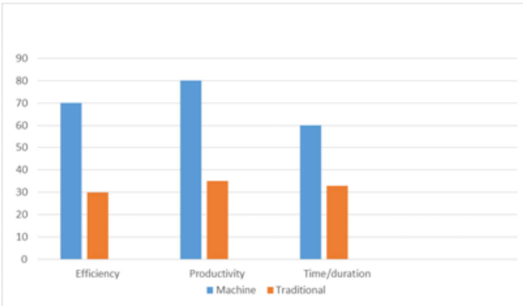

Figure 8: Comparison of machine and traditional methods

The economy is the most highlighting feature of this machine as it does not require anyelectric power is independent of tractor or bullocks which are not affordable to poorfarmers. Farmers face the problem of non-availability of bullocks as well as tractorsduring the peak period of sowing. Hence, they are tempted to hire them at an increasedcost. By making use of manually operated seed cum fertilizer planter, the yield loss canbe substantially decreased. The most important advantage of manually operated seedcum fertilizer planter is that - it can be easily driven by a single person. There is hardlyany problem of manpower in rural areas where the average size of the family is large.Thus, if 2 to 3 people are employed for the sowing operations, the area coverage can beincreased.As far as most of the farmers requirements are considered, this seed and fertilizerplanter is able to satisfy most of them effectively during the peak season. The low costof the machine as well as its ability to carry out sowing fertilizing simultaneously, iscertainly a boon to the farmers thereby saving much of their time. It results in almost60 % saving in operational cost and 15% saving in seed requirements. If the machine iscommercially exploited, it can be proved to be beneficial to poor farmers.

Future Scope:

After carrying out the field trials and observing the results, the scope for the furtherwork is- For better and strong germination of the seeds, the required depth of the seeds tobe sown is to be increased about 8 cm. Thus by employing a different type offurrow opener having more width can be used for obtaining the proper seed depthwhich ultimately increases the yield. As far as ergonomic considerations are concerned, instead of using relays we canuse two different kinds of RF module. Also, an acre meter can be placed on thetop of machine so that area coverage can be known. For more range of remote control, we can use higher capacity RF module to operatethe machine at higher range. For water distribution we can add a small water tank near the back fabrication tosupply the water to the seeds or the fertilizers.

References

[1] Kyada, A. R. Lecturer, LDRP Institute of Technology and Research, DESIGN AND DEVELOPMENT OF MANUALLY OPERATEDSEED PLANTER MACHINE, 2014 5th International 26th All India Manufacturing Technology.

[2] TejminderKaur and Dilip Kumar DESIGN AND DEVELOPMENT OF CALIBRATIONUNIT FOR PRECISION PLANTER International Journal of Computer Science, Engineering and Applications (IJCSEA) Vol.3, No.3, June 2013.

[3] Roshan V Marode and Gajanan P Tayade, DESIGN AND IMPLEMENTATION OF MULTI SEEDSOWING MACHINE, International Journal of mechanical engineering and robotics research, Vol. 2, No. 4, October 2013. Fl. LOGHIN et al, DYNAMIC MODELING OF TECHNICAL SYSTEM TRACTOR

[4] SEED PLANTER, Bulletin of the Transylvania University of Brasov Series II Vol. 5 (54) No. 1-2012.

[5] Alchanatis, V., Y. Kashti, and R. Brikman. A MACHINE VISION SYSYTEM FOR EVALUATION OF PLANTED SEEDS. Agricultural Engineering International: the CIGR Journal of Scientific Research and Development. Manuscript IT 01 005. Vol. IV. April, 2002.

[6] J. P. Molin, L. L. Bashford, K. Von Bargen, and L. I. Leviticus, (1997). DESIGN AND EVALUATION OF A PUNCH PLANTERFR NO-TILL SYSTEMS 1998 American Society of Agricultural Engineers 0001-2351 / 98 / 4102-307.

[7] Simon Blackmore, Bill Stout, Maohua Wang, ROBOTIC AGRICULTURE THE FUTURE OF AGRICULTURAL MECHANISATION 5th European Conference on Precision Agriculture. Ed. J. Stafford, V. The Netherlands, Wageningen Academic Publishers. Pp.621-628.

[8] Sivam, S.P.S.S.,,M.Gopal , S.Venkatasamy, Siddhartha Singh, An Experimental Investigation And Optimisation Of Ecological Machining Parameters On Aluminium 6063 In Its Annealed And Unannealed Form, Journal Of Chemical And Pharmaceutical Sciences. Page No Page (46 53), 2015.

[9] Sivam, S.P.S.S.,,M.Gopal, S.Venkatasamy, Siddhartha Singh 2015, Application of Forming Limit Diagram and Yield Surface Diagram to Study Anisotropic Mechanical Properties of Annealed and Unannealed SPRC 440E Steels. Journal of Chemical and Pharmaceutical Sciences. ISSN: 0974-2115, Page No (15 22).

[10] SIVAM, S. P. S. S. Sivam, S. RajendraKumar, A. Rajasekaran and S. Karuppiah, "Prediction Model of Setting Input Parameters for Turning Operation TI-6AL-4V by Fuzzy Rule based Modeling," 2017 IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI), Chennai, India, 2017, pp. 1343-1349.

[11] doi: 10.1109/ICPCSI.2017.8391929

[12] SIVAM, S. P. Sundar Singh et al.Multi Response Optimization of Setting Input Variables for Getting Better Product Quality in Machining of Magnesium AM60 by Grey Relation Analysis and ANOVA." PeriodicaPolytechnica Mechanical Engineering, [S.l.], 2017. ISSN 1587-379X. https://doi.org/10.3311/PPme.11034.

[13] Sivam, S.P.S.S., Abburi. L.K., Sathiya, M.K. and Rajendra, K. (2016). Investigation exploration outcome of heat treatment on

corrosion resistance of AA 5083 in marine application. International Journal of Chemical Sciences. 14 : 453-460.14 (S2), 2016, ISSN 0972-768X.

[14] S.P. Sundar Singh Sivam, Mrinal Deepak Ji Bhat, Shashank Natarajan, Nishant Chauhan.Analysis of residual stresses, thermal stresses, cutting forces and other output responses of face milling operation on ze41 magnesium alloy." International Journal of Modern Manufacturing Technologies, Pp. No 92-100.ISSN 20673604, Vol. X, No. 1 / 2018.

[15] SIVAM, S. P. Sundar Singh et al.The Grey Relational Analysis and Annova to Determine the Optimum Process Parameters for Friction Stir Welding of Ti and Mg Alloys." PeriodicaPolytechnica Mechanical Engineering, 2018. ISSN 1587-379X. https://doi.org/10.3311/PPme.12117

[16] S. P. S. S. Sivam, S. RajendraKumar, S. Karuppiah and A. Rajasekaran, "Competitive study of engineering change process management in manufacturing industry using product life cycle management A case study," 2017 International Conference on Inventive Computing and Informatics (ICICI), Coimbatore, 2017, pp. 76-81. doi: 10.1109/ICICI.2017.8365247.