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Design and Fabrication of Automatic Onion Planting Machine

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Abstract: ***The main objective of the project is to design and fabricate an automated onion planting machine. The onion (Allium cepa L) is one of the commonly used crops which are grown in most of the farms in India and abroad for their consumption purpose and also export purpose. Onion growing farmers undergo hurdles in planting of onion seedlings because of shortage of farming labours during planting onion crops. So, necessity of developing an automated onion planting machine increased. Various physical properties like soil, weather, plant, seedlings, and soil fertility were determined to fabricate the automated onion planting machine. The automated onion planting machine plants onion plants in straight row at a predefined interval between each plant without any human intervention using automation. Automation plays a major factor in developing the automated onion planting machine to save farmers time and labour cost to plant onion plants in a row.***

Keywords - Onion, Planting, Robot.

I. INTRODUCTION

The onion (Allium cepa L) is one of the commonly used crops which are grown in most of the farms in India and also in abroad for their consumption purpose and also export purpose. Onion growing farmers undergo hurdles in planting of onion seedlings because of shortage of farming labours during planting onion crops. This has to overcome.

The basic requirement which has to be considered for an agricultural machine is, they should be suiting all kinds of small farms. They should have simple design. Complex technology should not be used. The planting machine should be versatile so that it can be used in various farm lands. A manually operated template row planter was developed to improve efficiency of plant and to efficiently reduce drudgery which were common in manual planting method. Seed planting is also possible for various sizes of seed at numerous depth and spaces in between the seeds. Also it increased efficiency in seed planting, seed/fertilizer placement accuracies and also it was made of durable and cheap physical material which are affordable for all kind of farmers. The handling, adjusting and operating principles were designed simple so that it can be effectively handled by farmers and other users. [1]

There are various external factors, which affects germination of seed. They also affect seed emergence. Some of which are as follows, Uniformity in seed placement depth, Displacement should be transverse from the row. Distribution of seeds should be uniform. Loose soil should be prevented from getting inside the seedlings. Uniformity in soil covers over the seed and mixing of fertilizer with seed during placement in the furrow. We can achieve the best performance from a planting machine when we consider the above factors. The above factors are to be optimized efficiently by a correct design and we should select the best suited components required on the planting machine which suits the needs of the crop to be planted. The planting machine is a machine which plays a very important role in manipulating the physical environment. Plunger mechanism is a mechanism which is most commonly used for digging and seeding. Here plunger is used as a tool for digging and mechanism based on spring is used for timing seeding which is controlled by farmer. Lever fulcrum mechanism is also used along with cam and plunger to achieve seeding. Plunger's flapper can be used for opening into the cavity while seeding.[2]The onion (Allium cepa L) is one of the commonly used crops which are grown in most of the farms in India and also in abroad for their consumption purpose and also export purpose. Onion growing farmers undergo hurdles in planting of onion seedlings because of shortage of farming labours during planting onion crops. So, necessity of developing an automated onion planting machine increased. Therefore, various efforts were made to develop semi-automatic onion Tran's planter. External properties like weight, height, diameter, moisture contents and strength of compression were determined for onion seedlings. Two metering mechanism i.e. Fingered type mechanism and Plug type mechanism were studied in laboratory with three different travel speeds for different seedlings with different age groups. From the experiment it was noted that mechanism which used plug was actually more suitable for transplanting onion. [3] The results conducted on various experiments showed that the widest spacing had positive effects on germination and percentage of emergence and rate. The seeds with closest spacing had very great positive effects on germination and emergence of plants uniformity and also in ageing or rate of deterioration. It can be said that the closer plant spacing has very less significant effect on quality of onion see. In addition to that, it may also reduce ageing rate during storage under normal conditions. However, the closest within row spacing (almost 2.5 and 5cm) might be very difficult to implement and labourious compared to medium ones (almost 10 cm). So, medium row spacing (almost 10 cm) could be recommended for farmers who need high onion seed yield not compromising the quality in the conditions of similar environment. [4]

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II. MODEL SPECIFICATION

In any electric motor, operation is based on electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion. Every DC motor has six basic parts namely axle, rotor (armature), stator, commutator, field magnet(s), and brushes. In most common DC motors, the external magnetic field is produced by high-strength permanent magnets. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotates with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator.

[5]If we switch the leads, the motor will rotate in the opposite direction. To control the direction of the spin of DC motor, without changing the way that the leads are connected, you can use a circuit called an H-Bridge. An H bridge is an electronic circuit that can drive the motor in both directions. H-bridges are used in many other different applications, one of the most common being to control motors in robots.

It is called an H-bridge because it uses four transistors connected in such a way that the schematic diagram looks like an "H." Arduino programmed is used in onion planting machine to control the machine in its movements and also in placing seeds within a given space. As a piece of hardware, the Arduino can operate either independently (like in a robot), connected to a computer (thereby giving your computer access to sensor data from the outside world and providing feedback), or connected to other Arduino’s, or other electronic devices and controller chips.

Arduino board includes a microcontroller, which is programmed using Arduino programming language and the Arduino development environment. In essence, this platform provides a way to build and program electronic components. Arduino programming language is a simplified form of C/C++ programming language based on what Arduino calls "sketches," which use basic programming structures, variables and functions. These are then converted into a C++ program.

III. CAD MODEL OF THE SYSTEM

The modeling Shown in fig-1 is done using Solid works, and Structural analysis also made for all components and assembly. The onion planting machine is designed in such a way that the user should feel user friendly and should have a compact planting machine. The calculations and the measurements are done for the machine to plant the onion.

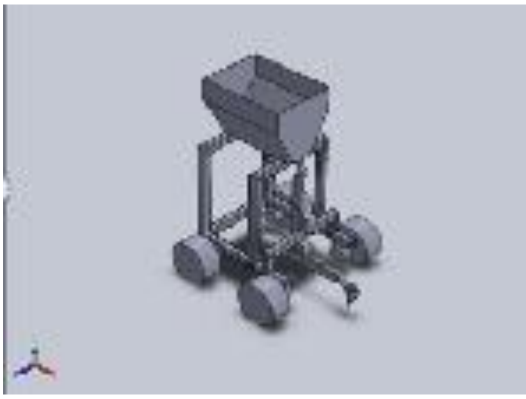

Fig-1 CAD model of the system

IV. DESIGN CALCULATION

WEIGHT:

ELECTRICAL AND ELECTRONICS COMPONENTS:

Weight of Battery= 0.6 kg
Weight of DC Motor = 6*0.15 kg = 0.9 kg
Weight of Servo Motor = 2*0.030 kg = 0.06 kg
Miscellaneous electronics = 0.8 kg
Total weight of Electrical and Electronic components
=0.6+0.9+0.06+0.8
=2.36 kg

MECHANICAL COMPONENTS:
Hopper weight= 0.5 kg
Weight of Frame= 5 kg
Weight of Wheel= 4*0.35 =1.40 kg

Other components weight=1.40+5+0.5 = 6.90 kg
Link 1 Weight = 0.25 kg
Link 2 Weight = 0.40 kg
Gripper 1 Weight = 0.10 kg
Gripper 2 Weight = 0.40 kg
Movable mechanical parts
Weights = 0.25+0.45+0.10+0.40
=1.15 kg
Total weight of Bot =10.41 kg
= 11 kg (Approximately)

LINK 1 MOTOR
Weight acting on the motor 1 shaft is
=Link 1 Weight + Gripper 1 Weight + Servo motor Weight =0.25 + 0.1 + 0.03 =0.5 kg

Force on the Shaft = 0.5*9.81 = 4.9 N ~ 5N
Force is maximum when link is in horizontal position Shaft Diameter of DC motor of above application = 8 mm
Torque required =Force* Radius=5*4
= 0.2 kg mm

LINK 2 MOTOR
Weight acting on the motor 1 shaft is
=Link 2 Weight + Gripper 2 Weight + Servo motor Weight
=0.4 + 0.4 + 0.3 =1 kg

Force on the Shaft = 1*9.81
= 9.8 N = 10N (Approximately)
Force is maximum when link is in horizontal position Shaft Diameter of DC motor of above application = 8 mm
Torque required =Force* Radius=10*4 =0.4 kg mm

WHEEL MOTOR TORQUE
Weight of the Machine =11 kg
Force acting due to weight =11*9.8 =110 N
Since four wheels are similar it is enough to calculate for 1 wheel,
Force acting downward due to weight on one wheel
=110/4 = 27.5N
F_w= 30 N
Friction coefficient between rubber tyre and wet soil μ_s = 0.6
Rolling resistance coefficient,μ_r = 0.04
Rolling resistance, b=P*r/w.
w =30 N
r =75 mm
b =25 mm
P = (w*b) / r
= (30*25)/75
= 10 N
Torque = P*r
= 10*75
= 750 N mm
= 7.5 Kg cm

BENDING MOMENT
Ra=Rb = (5*9.81)/2 = 24.53 N
Mc = Rb*110 =24.53*110=2697.75 Nmm
R_A =R_B=1.23N
Mc =R_B*110 =1.23*110=134.89 Nmm
Weight of Beam 1 = 5.3kg = 5N
Weight of Beam 2 = 5.3kg = 52 N
Weight of Beam 3 = 0.55kg = 5.4 N
FOR ARM 1
Length of onion plant=20 cm
Some control space=2 cm
By pythagaros theorem,
222 =x^2 + x^2
484=2 x^2
x =16 cm
FOR ARM 2
x=16 sin 30°
x=13.86 cm
Coefficient for the onion (μ_1) = 0.3 Fr_1 = μ_1 * F= 0.3 * 40 = 12 N
Coefficient for the onion and side face (μ_2) = 0.2
Fr_2 = μ_2 * F = 0.2 * 40 = 8 N
Total Force required = 20 N
Link 1 torque = 0.2 kg cm
Link 2 torque = 32 kg cm
Total torque required = 32.2 kg cm
M_t = (π/16)τ d^3
d^3 = (16*3*7*103)/(22*125) = 0.122*103
d =5 mm
σ = (0.25)/(π*(5/2)2) = 0.013 kg/mm2
σt = 0.13 N/mm^2
σc = 2.5/(π*42) = 0.05 N/mm^2
σc < σt
Therefore, design is safe.
T = 30 kg cm = 3 Nm
P = (2π*30*3)/60 =10 W
Link material is mild steel
l = 160 mm
w = 150 g
σ_c = (0.1)/(16*b) = (0.1)/(16*.5)
(0.1)/8 = 0.125 N/mm^2
σ_c = 0.0013 N/mm^2
σt = 247 N/mm^2
σc < σt
Therefore, design is safe.
Force for planting the plant = 20 N
Link 2 torque =20*16
Link 2 torque = 32 kg cm
Total torque required=32.2 kg cm
M_t = (π/16) τd^3
d^3 = (16*3*7*103)/(22*125) = 0.122*103
d = 5 mm
σ = (0.25)/(π*(5/2)2) = 0.013 kg/mm^2
σ_t = 0.13 N/mm^2
σ_c= 2.5/(π*42) = 0.05 N/mm^2
$\sigma_c < \sigma_t$
Therefore, design is safe.
T = 30 kg cm = 3 Nm
P = (2π*30*3)/60 =3π =10 W
Link material is mild steel
l =160 mm
w=150 g
σ = (0.1)/(16*b) = (0.1)/(16*.5) = (0.1)/8
= 0.125 N/mm^2 = 0.0013 N/mm^2
σ_t = 247 N/mm^2
$\sigma_c < \sigma_t$
Therefore, design is safe.
COLUMN :
Area (A) = (20*20) – (16*16)
=144 mm^2
Length (L) =240mm = 0.240m
For column both the ends are fixed,
So, n = 4
Critical load (Pc) = (nπ^2EI)/(L^2)
For mild steel, (E) =200*10^9 GPa I = (a_0^4- a_i^4)/12 = (20^4-16^4)/12
Pc = (4*3.142*200*109*7872*10-12)/(0.24)^2
Pc =1077 kN > 26N
Hence design is safe.
l =250 mm
I= (a_1^4- a_2^4)/12=(20^4-16^4) / 12
=7782 mm^4
A=144 mm^2
K_1=7.35
σ_y /2= nπ^2E/(1/k)^2 = 297/2 = 4*π^2*200*1000/(1/k)^2
K_2=0.00433
$K_1 > K_2$
So, the column should be long column.
P_{cr}=(nπ^2EI)/(1/K)^2= (4*π^2*200*103*144)/(1/7.35)^2
= 6.136*10^{10} N
P_{cal} = 26 N
$P_{cr} > P_{cal}$
Hence, Design is safe.

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V. CONCLUSION

This project is made with pre planning, that it provides flexibility in operation.

This project "AUTOMATIC ONION PLANTING MACHINE" is designed with the hope that it is very much economical and helpful to farmers by planting onion plants in a straight row at an interval of 15cm between each plant without human intervention.

This project helped us to know the periodic steps in completing a project work. Thus we have completed the project successfully.

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