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Design and Fabrication of Automatic Seed Sowing Machine with Variable Pitch

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ABSTRACT

The manually operated seed sowing technique faces the problems of seeds to rats, birds and snails. So, it is mandatory to automate the sowing of seed. This sector and a progressive innovation become necessary for raising the demand on agricultural product and its quality. To give a solution to these problems, a microcontroller guided rover for digging, seed sowing and cover seed properly. The robot is drive by high torque DC geared motor fitted with the available rotating shaft. It is pesticide application which enriches Indian agricultural field.

Key words: Seed Sowing, Automated, Robot Vehicle, Microcontroller, DC Gear Motor

INTRODUCTION

India is the land of villages. This being said the major occupation of majority of villages in India is farming. With recent advancements in engineering and technology, there also have been changes in agricultural technology and practices. Though there are advancements people still follow old practices due to the lack of money and high cost of technically advanced agricultural equipment's. According to a study made by ISAE, it is found that hoes, pangas, axes and shovels are the main farm tools used by the farmers in India for agricultural operation [3]. These tools are conventional, time immemorial and no improvement in agricultural practice is adopted. Hence, it is necessary to develop a system which results in drudgery reduction and id user friendly to agricultural community in India.

Sowing is one of the basic operations needed to get better revenue from agriculture. Manual sowing has the problem of not giving adequate spacing between row to row and plant to plant leading to less population of crops than recommended by the agronomists. Also there is the problem of placing the seeds at correct depth and correct soil coverage. Manual sowing is time consuming and costly. Hence, there is a need for appropriate seed drill for sowing. Farmers in India perform agriculture mostly with manual operation. The pain involved in doing each and every operation has to be reduced by the way of introducing simple technology which is not only user friendly to farmers but also is economical for farmers to adopt. Thus this project deals with design and fabrication of a smart seed sowing robot which can sow seeds based on the pitch given by the farmers.

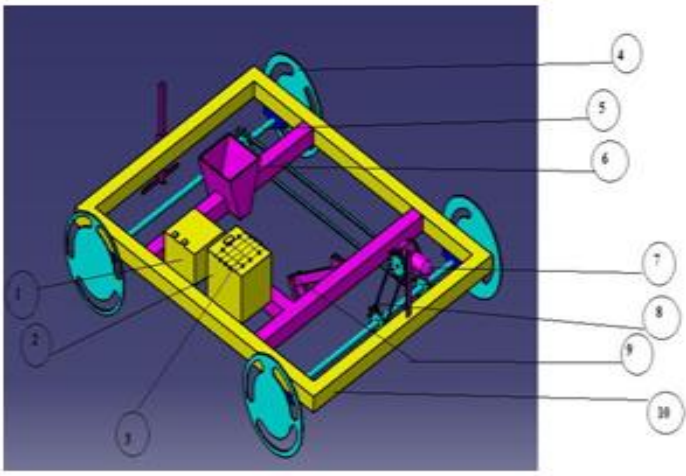
LITERATURE SURVEY

Early planting was done by hand. The seeds would be thrown, or broadcast. This system made it more difficult to weed and harvest the crop. Later a dibber was used for some crops. A dibber was a board with holes evenly spread apart. A stick would be pushed through the holes and then a seed would be placed in the hole made by the stick. This was very effective but also very tedious and time consuming [2]. The idea for dropping seeds through a tube first appeared in Mesopotamia about 1500 B. C. In 1701 Jethro Tull invented the first seed drill. The implement would cut small channels into the soil and the seed would be dropped into the channel. Broadcasting is simply throwing seeds onto the ground. The seed drill had many advantages to the broadcasting system. Less seed was lost to birds or other animals. Finally, with rows, it was much easier for the farmer to weed his crop. Jethro Tull's invention was met with scepticism and not really appreciated or accepted till after his death in 1741. One of the next innovations was a two row seed drill. This was not automatic so the field would have to be marked and then the seeds released by pulling of a lever. Then came the multiple row seed drill [4]. It could be adjusted to the amount of seeds and at what intervals they released into the soil. Which are cost more than the simple machines but most efficient.

Fig.1 Dibber

Fig.2 First seed drill

Fig.3 Two row seed drill



1. Battery 2. Microcontroller 3. Keypad 4. Wheel 5. Shaft 6. Hopper 7. DC Motor 8. Chain Drive 9. Digging Tool 10. Chassis

Fig.4 Conceptual Diagram

METHODOLOGY

The control panel on this vehicle is provided with number of switched to operate the vehicle. The description below gives a brief idea about the operation of this vehicle. When started, the farmer is expected to enter either the pitch or the number of steps using the keypad provided onto the robot. The farmer enters two parameters in this mode. They are -

a) Pitch between seeds
b) No of steps of respective pitch

Once all these are entered properly the vehicle starts its execution, moves by respective pitch, stops opens the servo of hopper, drops the seeds and the cycle continues. If these parameters are not entered properly, there will be an error will be played to alert the farmer that the execution cannot begin unless the parameters are properly entered. After a cycle of seed sowing is complete a message of complete will be given using the different beep tone.

DESIGN AND CALCULATION

As per survey the machine is design of dimensions in order of $24^{ll} * 18^{ll}$ because the line spacing made in the farm is in order of 2ft. – 3ft. Hence to move the machine vehicle in the line spacing made in the farm, it is essential to design made as these dimensions.

Power Calculation

Assume that the machine is runs at the speed of 35Rpm. As per requirements of the machine, the motor is selected is of 12V. Which is having speed of 35Rpm. The motor is of DC geared motor. With current 1.8Amp

$$P = V*I \quad \text{[Where, P = Power of motor (Watt) V = Voltage (Volt)]} \tag{1}$$

I = Current (Amp) $P = 12 * 1.8 = 21.6$ Watt.

The power transmitted by the motor is equal to the power received by the shaft.

Hence, $P = \frac{2\pi nT}{60}$ [Where, n = Speed in RPM, T = Torque in N-mm] (2)

$$21.6 = \frac{2\pi*35*T}{60}$$

$$T = 5.89*10^3 \text{ N-mm}$$

Force exerted in shaft due to motor, $T = F * R_s$ [Where, F = Force (N), R_s = Radius of Sprocket (mm)]
The sprocket is selected from available in market whose, Centre distance between the Sprocket = 180mm, Number of teeth's available on sprocket Z = 12, Pitch of the Sprocket p = 0.625" = 15.875mm.

Diameter of Sprocket $D = \frac{p}{\mathrm{Sin}(\frac{\pi}{2})} = D = \frac{15.875}{\mathrm{Sin}\,(\frac{\pi}{2})}$ Where, p = Pitch of sprocket D = 60.00mm, R_s = 30.00mm

Hence, Force in Shaft, $F = \frac{T}{R}$ $F = \frac{5.89 * 1000}{30}$ F = 192N

Design of Sprocket
Centre distance between the Sprocket = 180mm
Number of teeth's available on sprocket Z = 12 Pitch of the Sprocket p = 0.625" = 15.875mm

Diameter of Sprocket $D = \frac{p}{\mathrm{Sin}(\frac{\pi}{2})}$ = 60.33mm Where, p = Pitch of sprocket =15.875 Select the standard diameter as D = 60mm

Velocity, $V = \frac{PZn}{60*10^3}$ Where, p = pitch, Z = no of teeth, n = speed $V = \frac{15.875*12*35}{60*10^3}$ = 0.11m/s.

By using the diameter and velocity we can easily calculate the required pull and allowable pull.

$$P = \frac{F*V}{10^3*K_l*Ks}$$

Where, F = required force, p = power, v = velocity, K_l = Load factor, K_s = Service factor

$$3.13 = \frac{F*0.11}{10^3*1.1*1}$$

Allowable pull, F = 3135N

$F_a = \frac{F_u}{n_o}$ Where, F_u = Ultimate load, n_0 = Working factor of safety

$$F_a = \frac{17900}{7} = 2257.14N$$

Length of chain in pitches is given by $L_p = 2* C_c * \cos\alpha + \frac{z_1 + z_2}{2} * \alpha$

Where, C_c = center distance in pitch, Cc = 180/15.87 = 11.83 = 12 pitches

$$\alpha = \sin^{-1}\left[\frac{D_2 - D_1}{2c}\right] = \sin^{-1}\left[\frac{60-60}{360}\right] = 0^0$$

L_p = 2*12*cos(0)*(12+12/2) =36 pitches

Length of chain $L = L_p*p$

L = 36*15.875 = 571.5mm Correct center distance
L_p = 2*(C/p)*cos(α)+(Z_1+Z_2/2)+α

36 = 2*(C/15.875)*cos(0)+12 C = 190.5mm.

Design of Shaft
Upward force = Downward force $R_A + R_B$ = 192 N

R_B = 96 N R_A = 96 N Shear force diagram

SF_A = 96 N SF_B = -96 N SF_C = 0 N Bending moment diagram
BM_A = 0 N-mm
BM_B = 192*228.6 = 21945.3 N-mm
BM_C = 0 N-mm
Maximum bending moment in shaft M_b = 21945.38 N-mm

Maximum twisting moment in shaft, $M_t = \dfrac{9550*1000*P}{n}$ Where, P = Power, n = Speed of shaft

$$M_t = \frac{9550*1000*68}{35} = 1.854*10^5 \text{ N-mm}$$

Diameter of shaft,

$$D = \left[\frac{16}{\pi\tau}\left\{(k_b*M_b)^2 + (K_t*M_t)^2\right\}^{\frac{1}{2}}\right]^{\frac{1}{3}} \quad [7]$$

Where, τ = Permissible shear stress, M_b = Bending moment, M_t = Twisting moment, K_b = Shock factor, K_t = Endurance factor.

Select the value of K_b = 1.5 and K_t = 1. The permissible shear stress for steel shaft is τ = 120 N/mm^2.

$$D = \left[\frac{16}{\pi*120}\left\{(1.5*21945.38)^2 + (1*1.854*10^5)^2\right\}^{\frac{1}{2}}\right]^{\frac{1}{3}}$$

D = 19.43 mm = 20 mm.

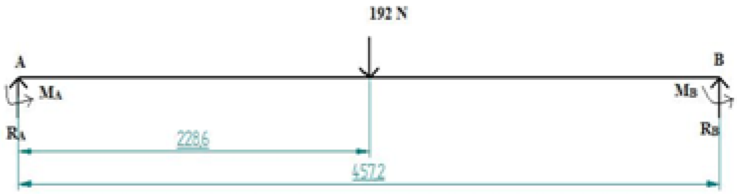


Fig. 5

Fig.5 Chassis

Fig.6 Wheels Clamped to Shaft

Fig.7 Rotary Encoder Connecting to Wheel

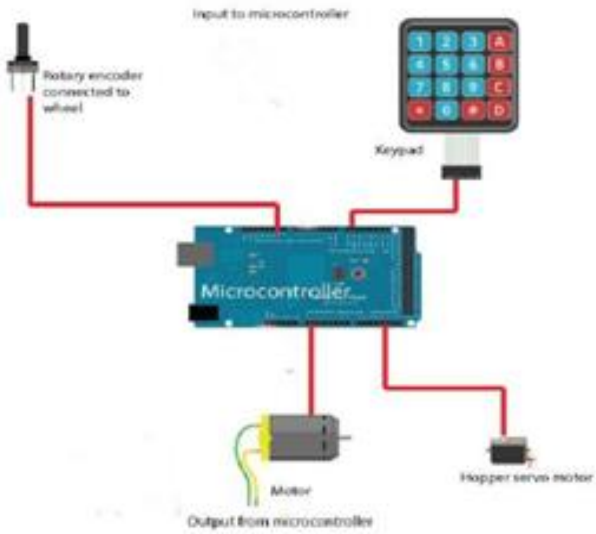


Fig.8 Microcontroller Connections

Fig.9 Actual Model

FABRICATION AND ASSEMBLY

The fabrication of the robotic vehicle began with material survey. The major fabrication part was fabricating the chassis of the robotic vehicle. The chassis form the integral part of the robotic vehicle as it supports all the other components of the vehicle as well as the power train of the vehicle. Material survey was made to study the optimum materials which can be used for chassis. Two such materials were shortlisted. The material to be chosen for the chassis fabrication was to be light weight so as to make the vehicle not too heavy for Indians farmers. However aluminium channels require costlier aluminium welding and thus the other choice was to go for steel pipes. These pipes are not only economical to use but also provide the required strength and can be easily welded. Therefore the chassis was fabricated in steel pipes. The fabricated chassis is as shown in the Fig. [6-7]. After the chassis fabrication was complete the motors were clamped onto the chassis. Wheel clamped on the shaft.

This completed the entire mechanical fabrication part. The electronics included interfacing the rotary encoder to the wheel and then making all the microcontroller connections as shown in the fig.9. The rotary encoder was interfaced to the wheel and then microcontroller connections were made to complete the entire project.

CONCLUSION

From the literature survey it is well specified that the all the machines are designed to seed sowing purpose. These machines are includes digging mechanism, sowing of seed in farm and then cover it with the soil properly. But these machines can do sowing of seed for a same pitch in a row. To overcome this disadvantage here in this project implementing the seed sowing machine for variable pitch. Using of microcontroller in this machine make it as automated for seed sow Machine is design to sow the seed at variable pitch in a row.

In future this vehicle can be added with other sensors such as soil pH sensors and temperature and humidity sensors which are other factors in farming. Also addition of rainfall sensors can be used to detect and calculate the amount of irrigation to the crops in addition to the moisture sensor.

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