Design and Manufacturing of Robot for Digging and Seeding in Agriculture

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ABSTRACT

This paper deals with manufacturing and development of robot in agricultural applications. The main area of application of robots in agriculture is at the harvesting stage, digging, ploughing and seeding. This robot is designed to replace human labor. The jobs involved in agriculture are not straightforward and many repetitive tasks are not required to do, so the agricultural industry is behind other industries in using robots. This paper represents a robot capable of performing operations like automatic ploughing, seed dispensing and pesticide spraying. It also provides manual control when required. The main component here is the microcontroller that supervises the entire process. Initially the robot digs the entire field simultaneously dispensing seeds side by side. On the field the robot operates on automated mode. For manual control the robot uses the Remote controller as control device and helps in the navigation of the robot on the field.

Keywords*: Digging, Microcontroller, Seeding, Remote Controller, Agriculture etc.*

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1. INTRODUCTION

Farmers today spend a lot of money on machines that help them decrease labour work and increase yield of crops. There are various machines that are available for ploughing, harvesting, spraying pesticides etc., however these machines have to be manually operated to perform the required operations and moreover separate machines are used for every functions. The yield and profit returns from employing this equipment are very less as compared to the investment. Another issue is the growing demands of the world's population. Automation is the ideal solution to overcome all the above mentioned shortcomings by creating machines that perform more than one operation and automating those operations to increase yield on a large scale. All kinds of agricultural robots have been researched and developed to implement a number of agricultural productions in many countries, such as picking, harvesting, planting, grafting, agricultural classification, etc. And they gradually appear advantages in agricultural production to increase productivity.

Autonomous agricultural robots are an alternative to the tractors found on fields today. Cultivation tasks like seeding, spraying, fertilizing and harvesting may be performed by autonomous agricultural robots in the future. To reach a full utilization the agricultural robot needs to be a vehicle with some basic capabilities and the possibility to support multiple applications. In the current generation, man power shortage is a major problem specifically in agricultural sector and it affects the growth of developing countries. In India at most 70% of people are dependent on agriculture. The revolutionary invention in agriculture system is becoming an important task because of rising demand on quality of agriculture products and lack of labour availability in rural farming areas.

Today agricultural robots can be classified into several groups: harvesting or picking, planting, pest control, or maintenance. It is unlike the robots that used in factories for building cars. Robots on farms have to operate according to nature. Robots that are used in factories don't have to deal with uneven environmental conditions or changing in environmental conditions.

Commonly digging operation on the field is done by using bull or by tractor and the method of sowing the seeds are by hand. Later, the seeds are sowed through holes in bamboo attached to a plough. For example, sowing seeds in small areas they employ dibbling method i.e., making holes or slits by a stick or tool and dropping seeds by hand is practiced. Later, the multi row traditional seeding devices with manual metering of seeds are quite popular with experienced farmers. It is a large time consuming approach. Besides being wasteful, planting was very imprecise and lead to a poor distribution of seeds. Agricultural robots are an alternative to the tractors found on fields today
Agriculture is humankind's oldest and still important economic activity, providing the food, feeder, fibre and fuel necessary for our survival. The current trend in agricultural robot development is to build more smart efficient machines that reduce the expense of the farmer while still providing one more services and higher quality which is precisely what we have done in this paper. Development of a robot that can perform automated ploughing and seeding operation can be manually navigated by the farmer and stabilizes the humidity in the environment.
Robotics and automation can play a significant role in enhancing agricultural production needs. We can also implement with the advancement in sensors and control systems that allow for optimal resource and integrated disease and pest management. The robot is developed which is used to automate the process of digging and sowing crops such as sunflower, baby corn, groundnut and vegetables like beans, lady's finger, pumpkin and pulses like black gram, green gram etc. and to reduce the human effort.

1.1 PROBLEM STATEMENT:

Design and development of an agricultural robot, which can be able to plough and dispense seeds in agricultural field. The control of this agro-bot should be wireless and can be able to show digging and seeding operations. Fabricate the model operated by wireless control which able to show operations likes ploughing and seeding. Also design and analyse a real time system for this robot to give a solution and propose a model which can be used in real time field.

1.2 OBJECTIVES:

- Design and development of an agricultural robot which can be able to plough and dispense seeds in agricultural field.
- Control of this agro-bot will be wireless.
- Design and analyze a real time system for this robot to give a solution and propose a model which can be used in real time field.
- Analyze the design of plough tool and develop for real time system.
- To propose a low cost but effective real time agro-bot system.
- To demonstrate the working model of this agro-bot.

1.3 SCOPE

By using this robot in the field of agriculture it can help the farmers in the initial stage of agriculture. i.e., during digging and seed sowing. This robot is a small scale effort but the same can be implemented with enormous results in a large scale that benefits all farmers. Apart from ploughing, seed dispensing, spraying pesticides and fruit picking other farming process like harvesting, irrigation etc. can also be implemented in one robot thus making the machine capable of multi-tasking. Also looking forward to learn about and implement agricultural based agro-bots like Nursery bot, Herder bot, Wine bot, Bee bot, and Hamster bots that would qualify the standards from the current precision to autonomous farming methodologies. This robot can be a better substitute for the human who performs the seeding and fertilizing. This robot is very useful for the farmers who are interested to do agriculture activity but facing the labour problem.

2. METHODOLOGY

The assembly of the robotic system is built using high torque DC motor, communication module, relay driver circuit, Battery package, microcontroller which is shown in block diagram below.
When DC motor is started, the vehicle moves along the particular columns of ploughed land for digging and sowing the seeds and its movement is controlled by remote guiding device. The remote control transmitter and receiver is shown in block diagram below.

This system has two main sections, robot section and control section, which are intercommunicated by using communication technologies. The control section as well as robotic section possesses via ploughing unit, seed dispenser, and seed storage, robotic system with motors, microcontroller, and power supply.
The microcontroller is brain of this system, which gives the order of suggestions received to all the networks, and sensible factors processed by their corresponding embedded programs. Robotic mechanism runs by their internal motors and motor drivers that drive the motors in desired directions.

- BLOCK DIAGRAM

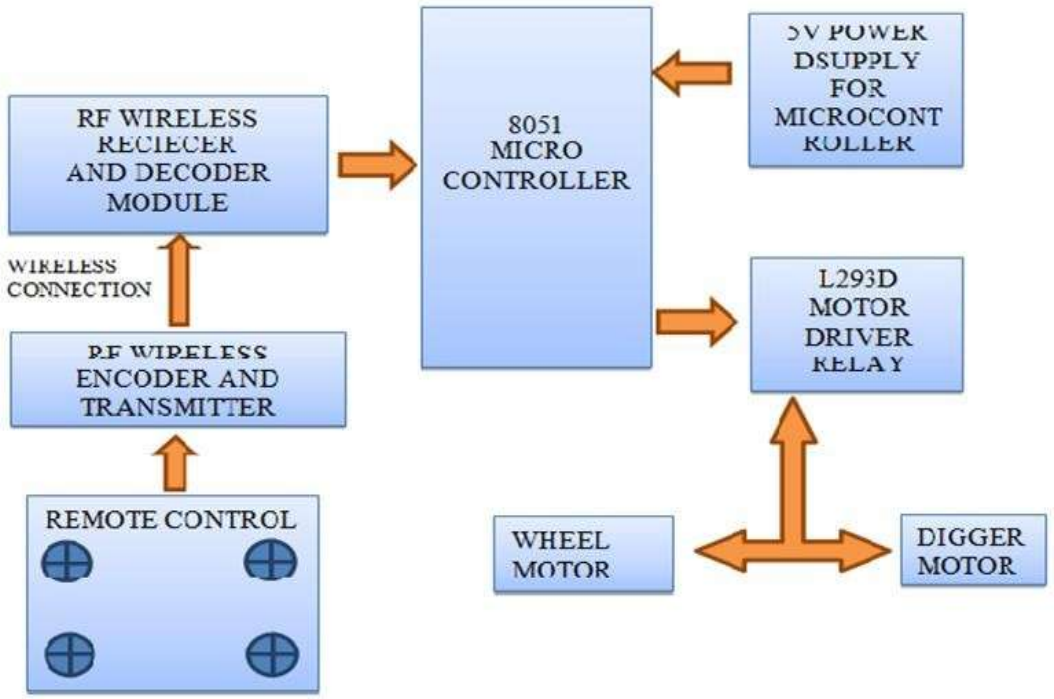


Fig1 Block Diagram

2.1 COMPONENTS

This robot is divided into two modules.

1. Mechanical module.
2. Electronic module.

- Mechanical module:

The mechanical parts of the robot are designed with the help of Pro-E Design Software.
The mechanical module of the rover consists of,

- Seed Storage and dispenser.
- Ploughing unit.
- Chassis.
- Drive unit (DC motors).
- Wheels.

- Electronic module:

It consists of

- 8051 microcontroller
- DTMF module
- L293D motor driver
- Battery

2.2 CALCULATIONS

1. CALCULATION OF SPUR GEAR

Pitch line velocity

$$v = \frac{\pi D_P . N_P}{60}$$

Here,
Dp=m.Tp
Therefore
V=———— ---------- (1)
V=r.ω
=——
r=—
N=100 to130rpm
We have taken N=130rpm.and pitch line velocity is 3 m/s for 130 rpm
r=——
r=0.22m
p=—— --------- (2)
torque(T)=force*R
T=32.37Nm
Therefore, the torque value use in equation no. (2)
p=————
p=440.67W
Select 20-degree full depth Involute gear for that teeth on pinion is18.
T_p=18
Therefore, the torque value use in equation no. (1)
V=————
=————
V=122.52mm/s
V=0.122m/s
Assuming steady load conditions and 8-10 hrs. of service per day.
Service factor is given by
Cs=1
We know the design tangential tooth load
W_T=–*C_s --------- (3)
=——*1
W_T=361.04N/m
&
Velocity factor,
C_v=— for 20-degree full depth involute gear
C_v=———
We know that tooth from factor for the pinion,

Y_p=0.154——— ----- (4)

=0.154———

Y_p=0.1033

Tooth from factor for the gear

Y_G=0.154——— ------- (5)

=0.154———

Y_G=0.137

60*p=120*0.1033

60p=120MPa for this 20-degree involute

60_G=100*0.13

=13.7

($60p*y_p$) is less than (60_G*y_G)

Therefore, pinion is weak.

Using lewis equation to the pinion.

$W_T=6_{\omega p}*b\pi*y_p$ ------- (6)

$= (60_{p*}C_v) *b\pi*y_p$

b=10m

———=120(———)*10*bπ*0.1033

Face width according to m=2 or 4

b=10*m

b =10*4

b=40

Therefore, pcD of the pinion

$D_p = m*T_p$

=4*18

D_p=72mm

$D_G=m*T_G$

=4*54

D_G=216mm

Therefore,$T_G = 3T_p$

Take b=10m

W_T = –

=———

W_T=1806.02

W_T = ——————— --------- (7)

=———————

Ww = DP.b.Q.K ------ (8)

P_c=—

T=number of teeth

Q=—

Q =1.5

Ww=36*10*1.5*1.4

Ww=3024N

$Ws=\sigma_e*b*\pi*m*y_p$

Where,

σ_e = flexual endurance limit for cast iron is 84MPa or 84N/mm^2

Therefore, static tooth load or endurance strength of the tooth
Ws=84*40*π*4*0.1033
Ws=4361.63N
Ws&Ww are greater than W_D
Therefore, design is safe.

2. DC MOTOR SELECTION

- Specifications

Voltage =12v
Current=7.5 amp

- Voltage=current*resistance ---------- (1)

12=7.5*R

R=—

R=1.62 ohm

The major constraint on motor operation is thermal
$P_{dis}=I^2*R$ ---------- (2)
Heat dissipated= current through the motor squared, multiplied by the terminal resistance
$P_{dis}= (7.5)^2*1.6$
$P_{dis}= 90$

force required to move
weight on motors assume 10 kg
F=10*9.81
F=98.1 N

Torque required for motor
T=f*r ------ (3)
Assuming wheel radius 40 mm
T=98.1*0.04
T=3.924 Nm

power

p= ——— ------ (4)

P=— (where v= 12 volt, and R= resistance 1.62) ----- (5)

=——

P=88.8888watt
P=90 watt
To find RPM of motor

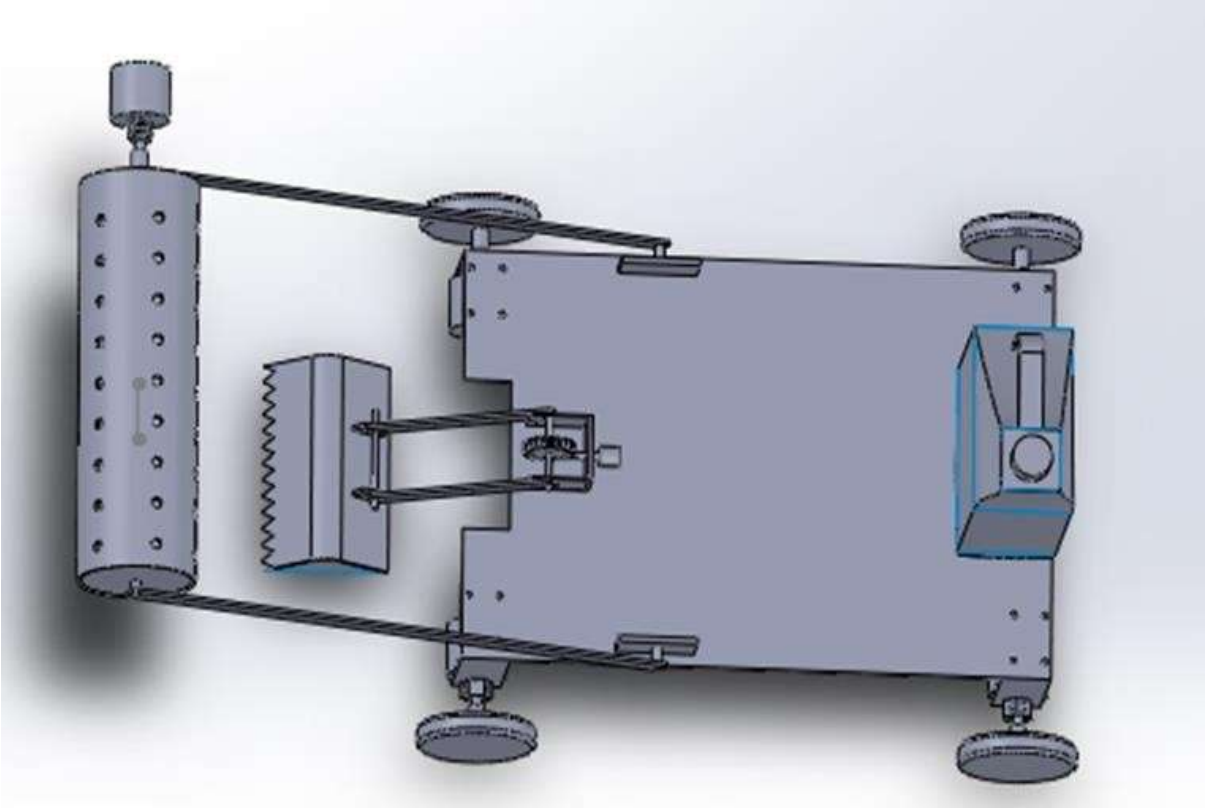
90=————

N=219 rpm --- maximum

- Specifications

RPM=100 rpm
5 kg torque-DC motor
Voltage-12

2.3 PROPOSED MODEL



3. CONCLUSION

We made an effort to overcome some problems in agriculture. The rapid growth in the industries is influencing the labours that are situating in the villages to migrate to the cities. This creating the labour problem in agriculture. The wages for the labour is also more. As the prices of commodities such as food grains, fuels, cloths and other essentials of daily life is increasing rapidly the labours demand for the more wages from the owners. By using this robot in the field of agriculture we can help the farmers in the initial stage of agriculture i.e. during the seeding and fertilizing. This robot can be a better substitute for the human who performs the seeding and fertilizing. This robot is very useful for the farmers who are interested to do agriculture activity but facing the labour problem.

ACKNOWLEDGEMENT

I would like this opportunity to express my honour, respect, deep gratitude and genuine regard to my guide Prof. R. S. Sewane, for giving me all guidance required for my project apart from being a constant source of inspiration and motivation. It was indeed my privilege to have worked under her.

I would like to place on records my sincere thanks to Prof. A.P. Pandhare, Head of Mechanical Engineering Department and all the staff members of the department for their constant encouragement and kind help during my project.

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