INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.6 Issue.4, April 2018
Pg: -01-12

Design and Development of Vacuum Seed Sowing Robot

Pavan Khedkar[1], Govind Khandare[2], Akash Gaikwad[3], Pallavi Ukirade[4], Mr.A.Y. Deogade[5]

[1,2,3,4] Student, Mechanical Engg. Dept., JSPM' s Bhivarabai Sawant Institute of Technology and Research, Wagholi, Pune, Maharashtra, India

[5]Assistant Professor, , Mechanical Engg. Dept., JSPM' s Bhivarabai Sawant Institute of Technology and Research, Wagholi, Pune, Maharashtra, India

[3]Department & university, Country

[1]khedkarpavan50@gmail.com; [2]2nd author email; [3]ashvindeogade009@gmail.com

Abstract— ***This project suggests improvement in agriculture processes like automatic planting of seeds on ploughed land by using robot. We have developed a robotic vehicle having four wheels and steered by DC motors. The seed planting mechanism is fitted on the vehicle to plant the seeds in uniform manner. The enhanced agriculture robotic system architecture gives us the opportunity to develop a complete new range of agricultural equipment based on small smart machines. The machine will cultivate the farm by considering particular rows and specific column at fixed distance depending on different seeds. The obstacle detection problem will also be considered, sensed by infrared sensor. Assembly language is used in programming the microcontrollers. The whole algorithm, processing, monitoring are designed with dc motors, sensor and encoder circuit.***

Keywords—Automatic, Robot vehicle, Agricultural equipment, Smart machines, Infrared sensor

I. Introduction

In the current scenario most of the countries do not have sufficient skilled manpower specifically in agricultural sector and it affects the growth of developing countries. So it's a time to automate the sector to overcome this problem. Day by day more labour are found in farming and more cost required on labour/day. So this machine reduced effort, cost of seed sowing.

The Indian nurseries often used conventional seeding operation takes more time and more labour. The seed feed rate is more but the time required for the total operation is more and the total cost is increased due to labour hiring of equipment. The conventional seed sowing machine are less efficient and time consuming.

Today' s area is marching towards the rapid growth of all sectors including the agricultural sector. To meet the future demands, we have to implement the new techniques will increase the overall Production. As day by

IJRAME

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.6 Issue.4,
April 2018
Pg: -01-12

day the labour availability becomes the great concern for the farmers this machine reduces the efforts and total cost of sowing the seeds and fertilizer placement. Theoretical studies regarding pneumatic equipment for sowing small seeds in cups, highlighting the advantages of this type of equipment with superior parameters obtained from the considered crops.

Equipment can be used in narrower spaces, being easily to handle and use, of driving the vacuum generator can be done electrically. By using this equipment, the productivity will increase, the space of establishing the seedlings will reduce, and the seeds norm will diminish. The germinating, rising and development space of plants is assured, equipment can be automated and built by minimum costs.

II. OBJECTIVE

- To reduce the human effort and increase the yield.
- Use of renewable energy.
- In addition, saving in cost of operation time, labour and energy.
- Proper seed placed.
- Not require any labour cost.
- Stop wastage of seeds.
- Work can be performed more efficiently than traditional methods.

III. PRESENT SITUATION

The present situation of the plant nursery and their way of working are discussed as below. Nursery is the part of agriculture. So as in farm the feeding of all parts of seeds are not feasible because in the farm proper environment will not present, the wastage of seeds are possible. Also the chances of falling of unnecessary seeds during sowing are possible.

Hence in the nursery by maintaining proper environment required for growing of plants care is taken. After growing of plants those plants are taken and then they are used to plant in farm. For this the plants are produced by using a tray which has number of holes as per the requirements in those whole the coco-peat powder is used to fill half of the hole and is followed by the seeds in those holes. Again the powder is filled. As per requirements of customers the nursery produces different kinds of plants. Now a days in Nursery seed feeding is done manually which effects on productivity of the Nursery. The seed feeding activity takes more time which results in fewer plantations of the seeds.

IV. PLANT GROWING STRUCTURES IN GREENHOUSE PRODUCTION

The duration of crop in greenhouse is the key to make the greenhouse technology profitable or the duration of production in greenhouses should be short. In this context, use of containers in greenhouse production assumes greater significance. The containers are used for the following activities in greenhouse production. Rising of seedlings in the nursery. Growing plants in greenhouses for hybrid seed production of flowers. Growing plants

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.6 Issue.4,
April 2018
Pg: -01-12

for cut flower production. Growing potted ornamental plants. Advantages of containers in greenhouse production. Increase in production capacity by reducing crop time.

High quality of the greenhouse product. Uniformity in plant growth with good vigour. Provide quick take off with little or no transplanting shock. Easy maintenance of sanitation in greenhouse. Easy to handle, grade and shift or for transportation. Better water drainage and aeration in pot media. Easy to monitor chemical characteristics and plant nutrition with advanced irrigation systems like drips. Selection of suitable containers depends upon the crop to be produced in greenhouse, plant characteristics like crop stage, duration, vigour, growth habit, root system, etc. Generally long duration, deep rooted and vigorous crop plants require bigger containers compared to short duration, shallow and less vigorous ones. The containers provide optimum condition for germination of seed and growth and development of transplants

➢ Seedlings

Seeds normally transplanted because much better results are gained when seedlings are raised in a nursery. There are three methods of raising seedlings in the nurseries which can be used.

(a) (b) (c)

Fig. 1 (a) Sowing on seedbed (b) Sowing in the plug/ pro trays (c) Sowing in the poly house

➢ Advantages of Nursery Management

- It is possible to provide favourable growth conditions i.e. germination as well as growth
- Better care of younger plants as it is easy to look after nursery in small area against pathogenic infection, pests and weeds.
- Crop grown by nursery rising is quite early and fetch higher price in the market, so economically more profitable.
- There is saving of land and labour as main fields will be occupied by the crops after 1 month. More intensive crop rotations can be followed.
- More time is available for the preparation of main field because nursery is grown separately.
- As vegetable seeds are very expensive particularly hybrids, so we can economize the seed by sowing them in the nursery.

V. DESIGN CONSIDERATIONS

- **Bernoulli's principle**

Bernoulli's principle can be applied to various types of fluid flow, resulting in various forms of Bernoulli's equation; there are different forms of Bernoulli's equation for different types of flow. The simple form of Bernoulli's equation is valid for incompressible flows (e.g. most liquid flows and gases moving at low Mach number). More advanced forms may be applied to compressible flows at higher Mach numbers (see the derivations of the Bernoulli equation). Bernoulli's principle can be derived from the principle of conservation of energy. This states that, in a steady flow, the sum of all forms of energy in a fluid along a streamline is the same at all points on that streamline.

This requires that the sum of kinetic energy, potential energy and internal energy remains constant. Thus an increase in the speed of the fluid – implying an increase in both its dynamic pressure and kinetic energy – occurs with a simultaneous decrease in (the sum of) its static pressure, potential energy and internal energy.

If the fluid is flowing out of a reservoir, the sum of all forms of energy is the same on all streamlines because in a reservoir the energy per unit volume (the sum of pressure and gravitational potential ρ g h) is the same everywhere. Bernoulli's principle can also be derived directly from Isaac Newton's Second Law of Motion. If a small volume of fluid is flowing horizontally from a region of high pressure to a region of low pressure, then there is more pressure behind than in front. This gives a net force on the volume, accelerating it along the streamline.

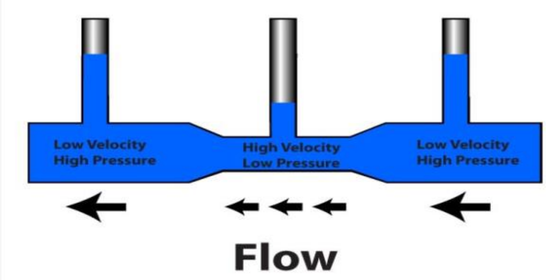

Fig.2 Bernoulli's Principal of fluid flow

Vacuum pump works on the Bernoulli's principle. Due to formation of vacuum in pump seed gets sucked through nozzle. Entry of seed in nozzle is avoided by proper selection of nozzle. As nozzle is selected in such a way that nozzle diameter is less than seed diameter.

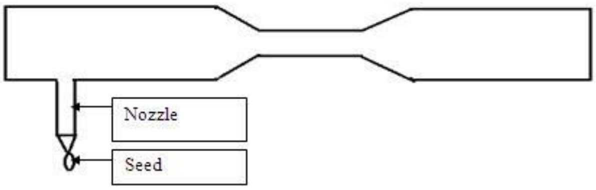

Fig.3 Working of vacuum pump

Diameter of seed = 7.7 mm
Area of nozzle is calculated as follows

$A = \pi/4 \times d2$
$= \pi/4 \times (0.0077)2$
$= 0.0465$ mm

Mass of seed is measured by using electronic weighing machine which is given as follows

Mass of seed = 0.2 gm
Weight of seed = 0.2 × 9.81
= 1.96×10-3 N
Force required (F) = weight
= 1.96 ×10-3 N
Pressure = Force/Area
(1.96 x10^-3)/0.0465
Pressure required = 0.4215 MPa

As the diameter of seed changes pressure (Vacuum) required also changes.
Thus we have selected Vacuum Pump having operating pressure of 0.1-0.6 MPa.

2. Motor calculations:
w = [total weight that has to slide (includes weight of slider and pneumatic cylinder)] = 100 gm
R= reaction to W
μ (coeff. of friction) = 0.76 (between aluminium & S.S)
F (frictional force) = μR
=0.76 X (0.1 X 9.81)
= 0.7455N
d (dia. of pulley) = 40mm = 0.04m (From Std. Book)

Now, required torque to rotate pulley is given as,
T= F X r = 0.7455 X 0.02 = 0.01491 Nm = 0.1519 kg-cm
Thus, considering optimum performance, motor selected as- 5 kg-cm torque

3. Pneumatic Cylinder (Double Acting)
Available
Stroke= 25 mm
Mass of seeds = 0.00126 kg
Mass of nozzle and mounting assembly = 0.5 kg
Total weight= (0.00126 + 0.5) x 9.81 = 4.9173606
Compressor given Pressure = 2 bar

Pressure = total weight/ Bore area
200000 = (4.9173606)/ Area

Area = 0.000024587m2
Therefore, Diameter = sqrt ((0.000024587 x 4)/ Pi)

Diameter = 0.005590259 m = 5.6 mm

Cylinder selected:
Stroke 25 mm
Bore diameter 10 mm

- **Electronics system**

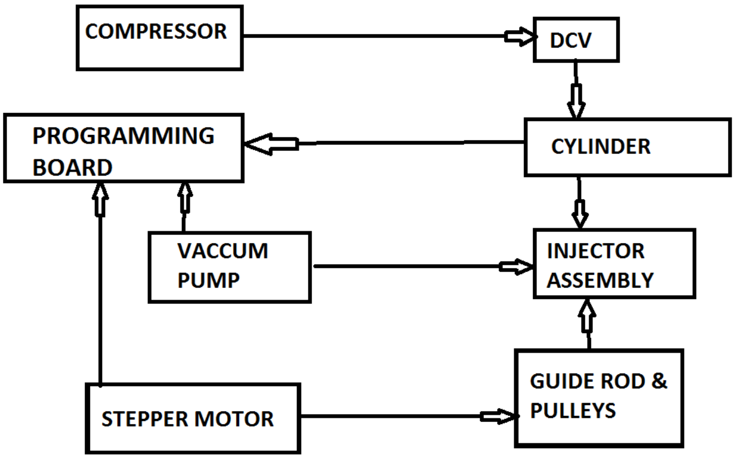

Fig. 4 Working of vacuum pump

- **Stepper motor**

A stepper motor or step motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any feedback sensor (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed. Switched reluctance motors are very large stepping motors with a reduced pole count, and generally are closed-loop commutate

There are two basic winding arrangements for the electromagnetic coils in a two phase stepper motor: bipolar and unipolar.

IJRAME

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.6 Issue.4,
April 2018
Pg: -01-12

Fig. 5 Stepper Motor

- **Unipolar Motors**

An unipolar stepper motor has one winding with centre tap per phase. Each section of windings is switched on for each direction of magnetic field. Since in this arrangement a magnetic pole can be reversed without switching the direction of current, the commutation circuit can be made very simple (e.g., a single transistor) for each winding. Typically, given a phase, the centre tap of each winding is made common: giving three leads per phase and six leads for a typical two phase motor. Often, these two phase commons are internally joined, so the motor has only five leads.

Fig. 6 Bipolar Motor

- **Bipolar Motors**

Bipolar motors have a single winding per phase. The current in a winding needs to be reversed in order to reverse a magnetic pole, so the driving circuit must be more complicated, typically with an H-bridge arrangement (however there are several off-the-shelf driver chips available to make this a simple affair). There are two leads per phase, none are common. Static friction effects using an H-bridge have been observed with certain drive topologies.

IJRAME

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.6 Issue.4, April 2018
Pg: -01-12

- **Arduino**

Controller is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

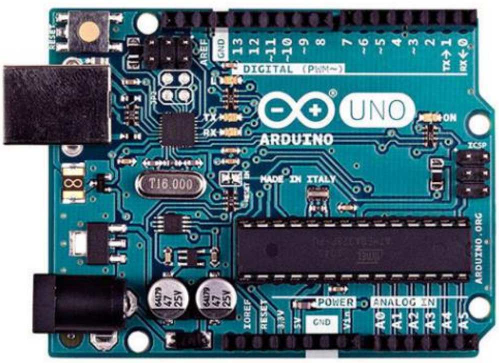

Fig. 7 Arduino controller

- **Mechanical Parts**

  - **Air compressor**

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air

IJRAME

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051

Vol.6 Issue.4, April 2018
Pg: -01-12

compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

Fig. 8 Air Compressor

- **Directional control valve (Solenoid Operated)**

Directional control valves are one of the most fundamental parts in hydraulic machinery as well as pneumatic machinery. They allow fluid flow into different paths from one or more sources. They usually consist of a spool inside a cylinder which is mechanically or electrically controlled. The movement of the spool restricts or permits the flow, thus it controls the fluid flow.

These valves make use of electromechanical solenoids for sliding of the spool. Because simple application of electrical power provides control, these valves are used extensively. However, electrical solenoids cannot generate large forces unless supplied with large amounts of electrical power. Heat generation poses a threat to extended use of these valves when energized over time. Many have a limited duty cycle. This makes their direct acting use commonly limited to low actuating forces.

Often a low power solenoid valve is used to operate a small hydraulic valve (called the pilot) that starts a flow of fluid that drives a larger hydraulic valve that requires more force.

A 5/2 way directional valve from the name itself has 5 ports equally spaced and 2 flow positions. It can be used to isolate and simultaneously bypass a passage way for the fluid which for example should retract or extend a double-acting cylinder. There is variety of ways to have this valve actuated. A solenoid valve is commonly used, a lever can be manually twist or pinch to actuate the valve, an internal or external hydraulic or pneumatic pilot to move the shaft inside, sometimes with a spring return on the other end so it will go back to its original position when pressure is gone, or a combination of any of the mention above.

IJRAME
INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING
WWW.IJRAME.COM
ISSN (ONLINE): 2321-3051
Vol.6 Issue.4, April 2018
Pg: -01-12

Fig.9 Solenoid operated DCV

VI. CONSTRUCTION AND WORKING

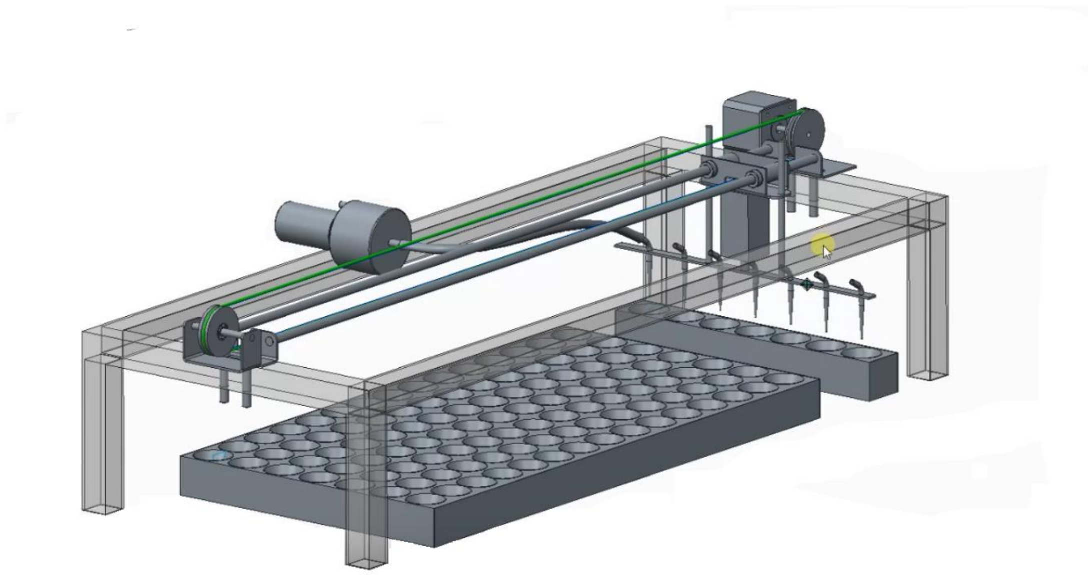
Fig. 10 Assembly of Vacuum Seed Sowing Machine

The vacuum seed sowing machine consists of basic frame on which various mechanical standard components are mounted viz. vacuum pump,5/2 solenoid operated DCV, stepper motor, pneumatic cylinder ,pulleys with guide bar and rubber wire. The portray is placed on the ground under the assembly.

There are two pulleys (one made up of stainless steel and other is an idler pulley made up of nylon) which are connected using rubber wire. The injector assembly has pneumatic cylinder which is welded to the plate that contains seven nozzles. This assembly is made to slide on the two guide bars with the help of linear bush. Also, the extreme position of this assembly is exactly above the storing tray.

Vacuum pump and DCV are bolted on either side of frame. A compressor gives the motive power for the operation of the system. The cylinder movement is controlled by the compressor. The extreme position of the injector assembly is obtained by the setting of the guide ways. Initially at the starting position the cylinder is retracting. When the signal is given by the solenoid operated DCV, the cylinder extends.

The vertical movement is controlled by the cylinder and the horizontal movement is controlled with the help of the stepper motor. This extension of the cylinder gives forward motion to the plate on which the nozzle are mounted. At this position the vacuum pump is started which creates vacuum and the seeds in the storing tray are sucked in the nozzles. The cylinder then retracts. The horizontal forward motion is created by the pulleys which are connected to the stepper motor. After reaching the first row cavity of the portray the cylinder extends and the suction is disabled and the seeds are placed in the portray. This process is followed by each and every row cavity and the portray is filled with the seeds. The entire positioning of the setup is programmed using the electronic system.

VII. Conclusions

In this project we develop a system which is based on pneumatic system for seed sowing. This system helps to minimize the wastage of seed and make proper seed sowing. In this project we also control the seed sowing rate. It uses Arduino program for controlling the seed sowing and also control the distance between two seeds.

As compared with the traditional method this system is far better than the older one. It minimizes labour cost, time as well as wastage of seeds.

References

1. B.B.Gaikwad, N.P.S. Sirohi (2007).*Design of a low-cost pneumatic seeder for nursery plug trays.*
2. B.Mursec, P.VIndis, M.Janzekovic, F.cus, M.Brus (2008), *Testing of quality of sowing by pneumatic sowing machines*, Journal of achievements in materials and manufacturing. Volume26.
3. Adisa A F, Braide F. G,*Design And Development of Template Row Planter*, Transnational Journal of Science and Technology August 2012 edition vol. 2, No.7
4. R. Joshua, V. Vasu and P. Vincent, *Solar Sprayer - An Agriculture Implement*, International Journal of Sustainable Agriculture, 2 (1): 16-19, 2010 ISSN 2079-2107”
5. R. Eaton, R. Eaton, J. Katupitiya, S.D. Pathirana (2008), *Autonomous farming: Modeling and control of agricultural machinery* in a unified framework,15th international conference on mechatronics and machine vision in practice, New Zealand.

6. Simon Blackmore, Bill Stout, Maohua Wang, Boris Runov (2005), *Robotic agriculture – The future of agriculture mechanism,* Agro Technology, the royal veterinary and agriculture University.

7. Mohd Taufik Ahmad, *Development of an automated mechanical intra-row weeder for vegetable crops*.

8. Prof. Pranil V. Sawalakhe , Amit Wandhare, Ashish Sontakke and Bhushan Patil, *Solar Powered Seed Sowing Machine*, Global Journals of Advanced Research in Mechanical Engineering, Vol-2, Issue-4, PP.712-717, 2015.

9. Kachman S D; Smith J A (1995). *Alternative measures of accuracy in plant spacing for planters using single seed metering*. Transactions of the ASAE, 38(2), 379– 387