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Prototype Gantry System For Polyhouse Application

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Abstract: This work presents the design and implementation of a Gantry System, which performs capture a photo of plants and spray the fertilize on plants. Fertilization spraying manually is the inefficient flaws and it became less productive, slow and non-flexible processing when it comes to manual mechanism. To overcome this problem a 3-axis rectangular plane gantry system is introduced, which can perform the capture a photo of plants and spray the fertilize on plants application quickly and efficiently. The system comprises of gantry robot with a conveyor system, and completely controlled by programmable logical controller. The conveyors carry's the tray on which the fertilizer is spray with the help of the gantry robot. The robot is move in the direction of X, Y, Z, Axis. Which can help to rich any point of the playhouse.

1. INTRODUCTION

Gantry robots are also called Cartesian or linear robots. Gantry robot consists of manipulator mounted on to an overhead system that allows movement across a horizontal plan. Gantry robots are widely used for special machining tasks such as are cutting where robot motion covers large surfaces. Palletizing,3d printers,Warehousing. Robotics is a very fast-growing technology and has been widely used in a variety of applications to reduce human effort and to save time. The vast majority of today's commercially available robots possess one of four basic configurations: Cartesian,Cylindrical, Polar and Jointed-arm configurations. Cartesian robots, sometimes calledgantry robots, they are mechatronic devices that use motors and linear actuators toposition a tool. They make linear movements in three axes, X, Y, and Z. Gantry robotsystems provide the advantage of large work areas and better positioning accuracy. Gantry robots are easier to program,with respect to motion,because they work withanX,Y, Z coordinate system.

The system indented for the most general application scope ranging from industrial application to more specific application such as medical tasks. For the accurate analysis,the Cartesian coordinate robot has been chosen with 3 degrees of freedom, working in X, Y and Zaxis. Due to the need of a modular structure so that,the component softhe robot can be easily substituted and removed without disturbing the whole structure. For instance, in this system, we have added an end-effecter in Z axis which is now act for pick and place mechanism that can be replaced easily with some different actuator according to the requirement. In any case the supportive structure should be cost effective and easy to control which led to the choice of a gantry robot. Gantry robot is a robot used for many applications such as material handling, tray loading, material loading, etc. The function that our robot is focusing on is pick and place operation which will help to decrease the repeated action by a human. This gantry robot consists of 3 axis X, Y, And Z respectively which helps it to move with speed, agility and accuracy. With the use of 3D printing this robot is more compact and lighter as compared to a traditional design of a gantry robot and with the inclusion of IOT the robot can work with just a single command after it is programmed for a certain task.

Generally, the basic aim of this project is to solve a problem that mostly become a challenge to the, more specifically on pick and place station, by design an automated system which can be manufactured domestically and have simple control system which can be operated by low technical requirements.

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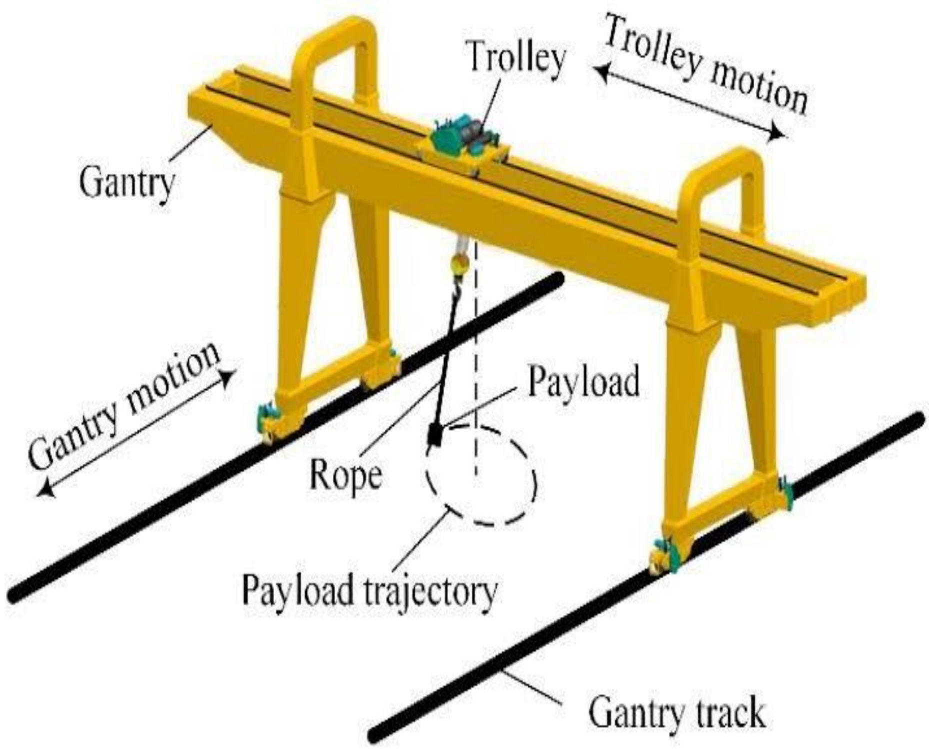
In recent years, robotics in agriculture sector with its implementation based on precision agriculture concept is the newly emerging technology The main reason behind automation of farming processes is saving the time and energy required for performing repetitive farming tasks and increasing the productivity of yield by treating every crop individually using precision farming concept.



A gantry robot can handle items at high-speed perfect accuracy, and repeatability. The robot can be supplied with a special designed gripper or with a standard flange for installation of your own gripper. The Gantry robot can be delivered as a standalone unit or as an integral part of a complete material handling system.

1.1 Polyhouse Farming:

A house or structure made of transparent material such as glass or polyethylene whereplants grow and develop under controlled climatic conditions is a polyhouse or a greenhouse. As per the need, the structure size will vary from small shacks to large-sized buildings. Overall,as the house prevents the greenhouse gas from escaping, a greenhouse is a glasshouse whose interiors are warm when exposed to sunbeams. So, the temperature inside is survival-friendly and comfortable for the plants when it's cold outside.

Many people get confused between polyhouse and greenhouse. Polyhouse is a greenhouse of sorts, or we may say it's a smaller greenhouse version where polyethylene is used as a cover. Polyhouse farming is a common greenhouse technology in developing countries like India due to its low construction and easy maintenance costs. Another greenhouse technology where wood is used as the cover is Lath Building. Compared to the greenhouse, the poly house is cheaper but the latter is longer-lasting than polyhouse.

2. LITERATURE SURVEY

Awad Eisa G. Mohamed and Mohammed Elhassan Development kinematic modelling and analysis of 3 pneumatic gantry robot. June 2020, volume 5, issue 6, 646-650

Robot kinematics is mainly falling in to two types: forward and inverse kinematics. Forward kinematics is also known as direct kinematics. In forward kinematics, the length of each link and the angle of each joint are given, and we have to calculate the position of any point in the work volume of the robot [1]. In inverse kinematics, the length of each link and position of the point in work volume is given and we have to calculate the angle of each joint. To accomplish a task in an application, we need to control the position and orientation in various coordinate systems such as world, work piece to tool. In order for a robot to go to certain place at certain orientation conveniently, it is necessary to know the relationship between the joint coordinate system and some other systems, such as base or tool systems. Robots are used in many industries like automobile, semiconductor, electronics, aerospace food and beverage, pharmaceutical, consumer goods, plastics, construction, and medical devices. However, the use of robots for metallurgical operations such as hot-metal ladle handling, heat treatment etc. is rather limited due to many environmental and safety reasons In the present work, the development of forewordkinematic modeling and simulation for the pneumatic robot. After the definition of the manipulator movement, the kinematics parameters are obtained for the specified path. Then these data are solved by MATLAB, which results are used to determine the end- effectors extremity position and velocity.

Shubhi Thatere Parbbpree t Arora Yajush Sharma Roushan Kumar RajGaurav Mishra et. al [1] developed a gantry robot,to performs pick and place mechanism and also detect the obstacles coming in its path. A 3 axis rectangularplane gantry robot with a conveyor system, and completely controlled byprogrammable logical controller. Surinder Pal [2] developed a model of a gantrymechanism and it is controlled by use of GUI which can be assessed through internet.Elaryan M et. al [3] developed gantry robotic cell for automatic storage and retrievalsystem. The system can sort out the objects based on size with built in images. Thecell consists of a 3 DOF robotic arm with a gripper attached at the end of the verticalmotion assembly. A conveyor belt is developed to move the objects either in thestorage and retrieval modes. Sweety Dutta et. al [4] discussed about seed sowingrobot. The robot goes to the starting points and makes a hole as per the calculatedvalue and seed is dispensed only one at a time. Abdul Rahman et. al [5] developedautomatic seed sowing machine for sowing of onion seeds. The seeds are sowed in a proper sequence. From this it can be concluded that gantry robot can be used forsowing purpose.

3. METHODOLOGY

The flow chart shown in Figure illustrates the process flow of conducting the static test on the base frame design in Solid works software. Initially, the assembled drawing of the base frame designed is prepared by connecting all the parts included in the base frame design. Then, the static test function is selected in order to start the experiment on the base frame structure. After that, the material of the base frame is chosen from the list provided in the database of the Solid works software. Some specifications of the materials can be edited and need to be edited if the material used having different specifications. Then, the fixtures for the base frame are applied. Fixtures that available in the software are such as fixed geometry, fixed hinge and roller/slider. Then, the load is applied to the base frame structure. The value of the load is based on the total base frame weight and driver's weight, multiplied by the desired factor of safety. After that, mesh is created. Meshing is a process of splitting the geometry of the design into small and simple shaped called finite elements. The finer the elements will increase the accuracyof the data obtained from the experiment. After the meshing is done, the test is started and the result for the test is obtained. There is a function of creating a report from Solid works software, therefore a report for the test is generated.

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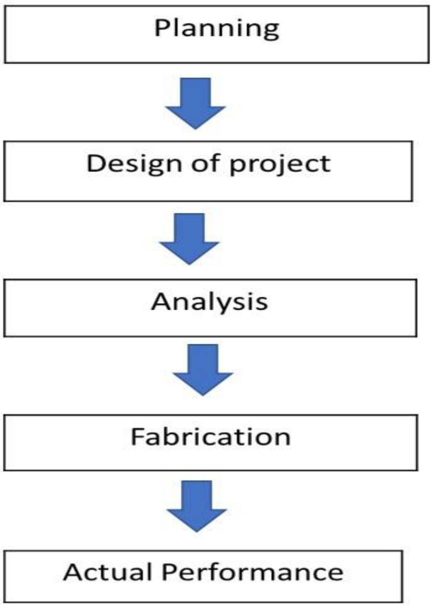
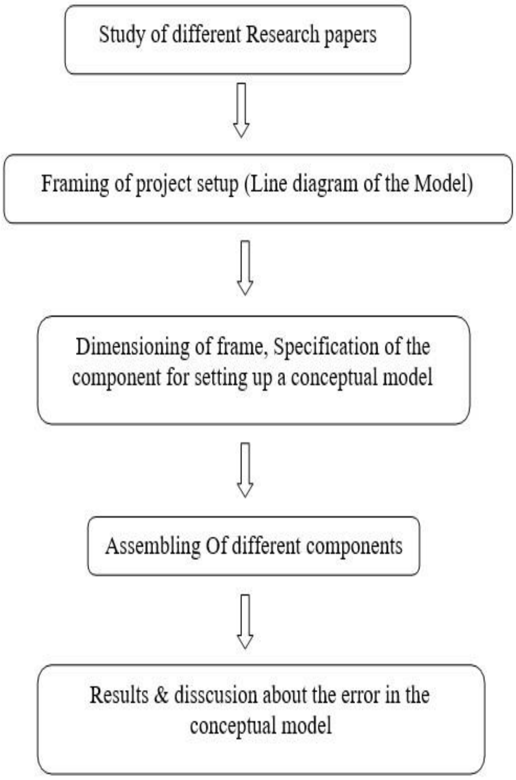


3.1 Methodology of Design & Analysis

A parameter study is done to evaluate the most crucial parameters for FE analysis of axial ball bearings. The parameters that are evaluated are mesh density, contact stiffness, osculation, load level, geometrical nonlinearity and material nonlinearity. The studies are performed by means of the FE software Ansys. The accuracy of finite element analysis depends on different parameters such as element type, boundary condition and how the loads are applied etc. Therefore the FE model is nothing else but an approximate realization of the reality. The parameter study can be done by physical tests. However it will increase the cost, time and resources consumed and therefore FE analysis is more suitable choice, at least for parameter evaluation.

3.2 Working Process:



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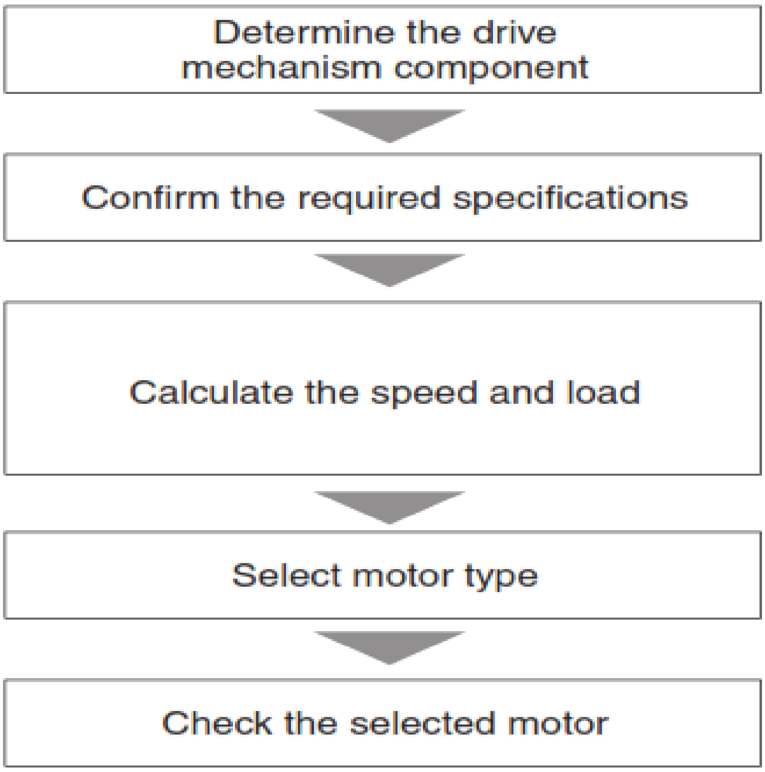
4. CALCULATION

Motor Selection:
This section describes certain items that must be calculated to find the optimum motor for a particular application. Selection procedures and examples are given.



1. First, determine certain features of the design, such as drive mechanism, rough dimensions, distances moved, and positioning period.
2. Confirm the required specifications for the drive system and equipment (stop accuracy, position holding, speed range, operating voltage, resolution, durability, etc.).
3. Calculate the value for load torque, load inertia, speed, etc. at the motor drive shaft of the mechanism. Refer to page 3 for calculating the speed, load torque and load inertia for various mechanisms.
4. Select a motor type from AC Motors, Brushless DC Motors or Stepping Motors based on the required specifications.
5. Make a final determination of the motor after confirming that the specifications of the selected motor/gearhead satisfy all of the requirements (mechanical strength, acceleration time, acceleration torque etc.)

Power Calculation:
Torque = Force X Radius Spur gear
Human force required for rotating the disk = 225
N Where,
Torque = Force x Radius
= 225x 75
= 16875 N – mm

The vital application of this motor are Pan/ Tilt camera, auto shutter, welding machines, water meter, grill oven, Floor cleaning machine, garbage disposers, household appliances, Slot machines, Money detector, automatic actuator, coffee machine, Towel dispenser, lighting , Coin refund devices, Peristaltic pump and many more.

The supply voltage range is 10-12V with the polarity markers at the base of the motor.The overall body of the motor is made up of metal. The motor has a D type shaft with a shaft length of 21mm and a diameter of 6mm.

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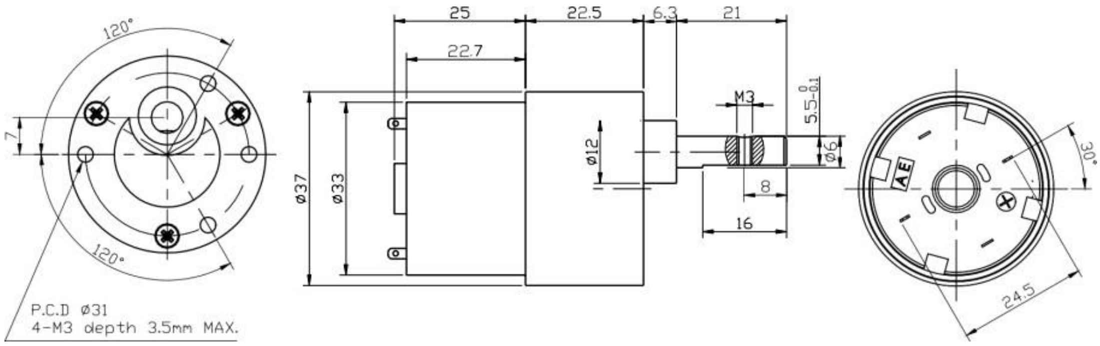
Feature Points	Voltage(V)	Current(A)	Input power(W)	Torque (N.m)	Speed(RPM)	Output Power(W)	Efficiency (%)	Time(s)
No Load	12.78	0.041	0.529	0.000	11.0	0.000	0.0	0.000
Eff. max	12.74	0.120	1.527	0.467	8.1	0.396	26.0	25.09
P_{out} max	12.70	0.194	2.463	0.908	5.3	0.508	20.6	37.13
Torque max	12.63	0.337	4.256	1.760	0.0	0.000	0.0	0.000



5. CONCLUSION & FUTURE SCOPE

Conclusion:

The project was completed in stipulated time and met all the objectives. As part of the final trials, we have started growing the first batch of crops with the automated farming robot. The first column has spinach, second has radish and the last column has tomatoes. The robot has planted these plants autonomously without any human intervention and it will continue to water then for the next few weeks.

Future Scope:

The project has three main objectives: sowing, irrigating and maintaining adequate soil moisture levels. This automates the typical farming process where a person would sow the seeds manually, water them once or twice a day and check soil moisture through visual inspection. However, this process can be further improved to create the optimum growing conditions for plants. Here’s a list of updates which can be further added on to the automated farming robot.

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