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Modeling approach of agricultural cantilever sprayer boom leveling system

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Abstract - *Now a day in agriculture precision is required; that the spraying nozzles for the crops should be at a stipulated distance generally the distance would be like .5m to .7m.the sprayer boom is to be place nearer to plant heads while pouring chemical droplets in the crop field. Thus we can assure that the quality of the chemical droplets which must be distributed over the crops. This project we make a model liked prototype in which the agricultural sprayer combines four rod linkage mechanism and electro hydraulic circuit auto level circuit which will be used for auto correction of the linkage. And the dynamic analysis of the sprayer boom is also done in this project. The hydraulic circuit is designed and simulated in the automation studio package. So we can use for any type of length which we want to use and designing of hydraulic circuit will be done*

***Key Words*: Sprayer cantilever beam, electronic hydraulic circuit, proteus, simulation, automation studio 6.2**

1. INTRODUCTION

The utilization of pesticides in harvest creation has been expanded and it is an essential part for more than 50years. Presently a day's synthetic drop insurance still stay crucial field operation, giving an enhanced situation to ideal plant development, applying chemicals is a sensitive method since if the excess chemical is deposited which may cause death of the crops so the optimum amount of chemical so that the crops would be alive. And overdose not only causes harm to the crops but also for the environment such as emission or a gas release which is toxic in nature. So it is very essential for to keep the machinery accurate, i.e. sprayer cantilever beam for a evenly precise spraying

The showering of the concoction is identified with the separation that is kept up between the spouts and yields we can see shape the above figure. At the point when is separation is little similar to territory wedge is headed to the trolley or the tractor which we utilize the sprayer may over measurements the amount may occur in a few regions and the compound fixation there is very high which may harm the harvest even and wastage of the concoction is finished. The tractor or the vehicle which we use cannot be guarantee of the steadiness and vibrations are most common in this type of vehicles in this rough situation the deposition may not be takes place evenly and uniformly and some crops may not even get the chemical and the chemical quantity will be high for some and low for some crops

Now a days the sprayer cantilever beam has a width of 20m 25m depending in the crop which we can decide the size of the boom. When the boom is large sprayer boom cantilever flexible behavior of spray booms are important, when the length is smaller inclination causes more as we know short booms are less affected with the inclination but when the beam is so long the effect will be more. In order to give exact position and spraying for the crops we can guarantee in two methods which we can reduce the vibrations and also inclination. Vibrations can be reducing with effective suspensions. The leveling should be possible with the hydro powered circuit. This venture a four bar linkage suspension consolidated with an electro- hydro powered framework will be utilized for cantilever shaft we will demonstrate with the recreations and furthermore model which would be shown.

1.1 Model of the boom sprayer leveling system

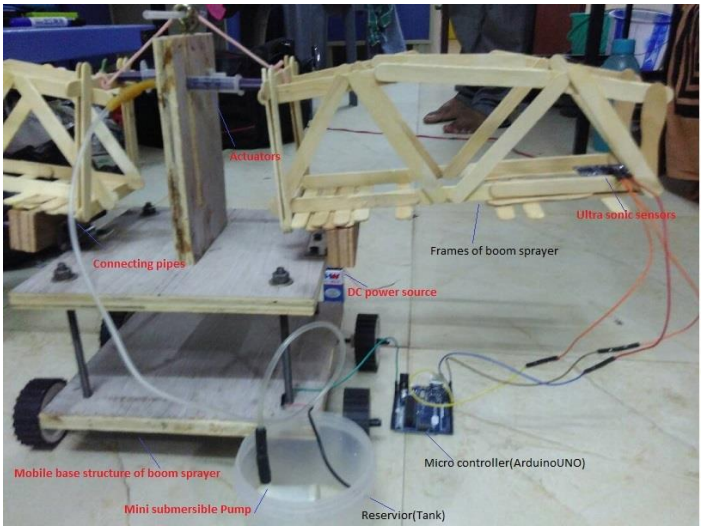

Fig -1: Prototype of the boom sprayer leveling system

Above figure who's the prototype and the circuits a for electrical mechanical (hydraulic) electronics circuits is also shown separate.

Table -1: Components used in the model

Component name	Quantity
Double acting hydraulic cylinder	02
Pumps	03
UV sensors	02
Battery	03
Microcontroller	01
Pipe connectors	15
3 way valve	01

1.2. Electrical circuit for controlling of boom sprayer leveling system

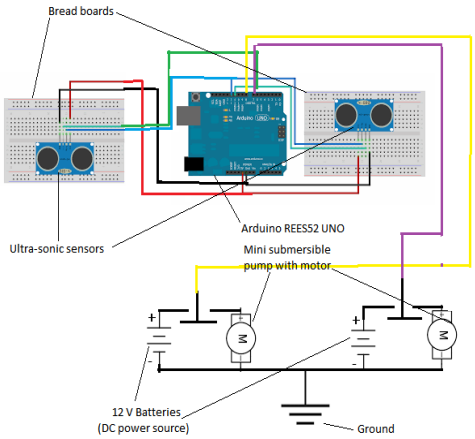

Fig -2: Electrical circuit for controlling of boom sprayer leveling system

1.3. Model for actuating mechanism of boom sprayer using Automation Studio 6.2

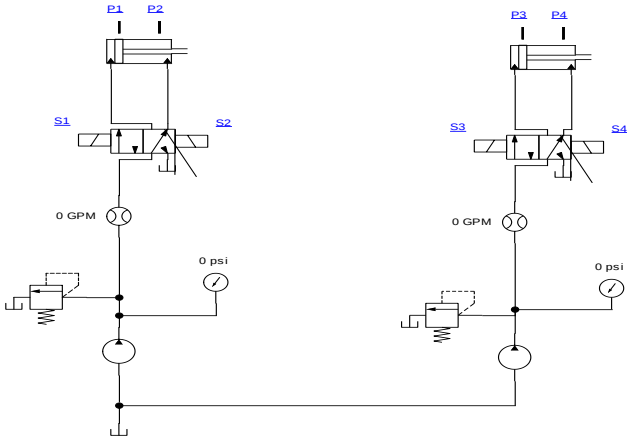

Fig -3: Circuit diagram for actuating mechanism

Table -2: Components of the circuit diagram

Component Name	Quantity
Coil	1
Directional Valve	2
Double-Acting Cylinder	2
Fixed Displacement Pump	2
Flowmeter	2
Hydrostatic Reservoir	3
Line	18
Normally Closed Push-Button	1
Normally Open Contact	9
Normally Open Push-Button	1
Pressure Gauge	2
Relief Valve	2
Sensor Ref. (Bidirectional)	4
Solenoid, DC/AC	4

2. COMPONENTS DESCRIPTION

2.1. Micro controller

The micro controller used in the prototype is Arduino REES52 uno R3 model, processor is ATmega328. Arduino is a tool for connecting to computers and making interface with physical system and used to make sense and controlling the physical system using the embedded programming. It's an open-source platform for developing the software environment.

2.2. Ultra –sonic sensors

Fig -4: Electrical circuit for controlling of boom sprayer leveling system [6]

The ultra-sonic sensors are used in the prototype for balancing the wing of the boom sprayer. For measuring distance from the ground ultra-sonic sensors is used as input for micro controller. The principle of ultra-sonic sensors is simple the source propagates the ultra-sonic sound and it is get strikes the object and return back to sensor and it is received by the receiver according to the time span between the travel from source to receiver it will calculate the

distance of the object placed. The ports for the used ultra-sonic sensor is

- Trigger-For generating the ultra-sonic sound
- Echo-it is used to receive the sound pulse return back from the object
- Vcc-It is voltage source.
- Gnd-Ground connection

2.3. Mini submersible pump

Submersible Pump Motor is operated between the voltages 2.5 to 6V power supply. It will give up to $2*10^{-3}$ m^3/sec discharge at current of 220mA.A submersible pump is a type of completely sealed pump device and it is works based normal pumps are pull the water by suction lift but these pumps are worked by pushing the water. It is useful for pumping of the water in the prototype making we are using the water other than the hydraulic oil so we are used this type of pump.

2.4. Frames (wings) of the boom sprayer

The actual frames are used for the boom sprayer is around 12m to 20m length, and they has facilitate by folding approximately half of the length and it is supposed to be used frames of both sides are of same length for making static balance of the boom sprayer. It should be low weight and they are to be absorbing the shock loads due to the dynamic movement of the vehicle and uneven surfaces. For achieving the above requirements Mild steal material.

2.5. Sprayer boom

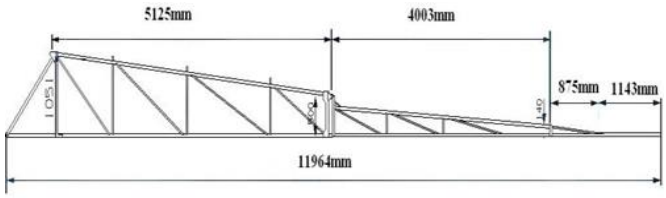

Fig -5: Frame (wing) boom sprayer [1]

The boom sprayer is welded with empty steel tubes. The external frame will use round tube with diameter of 1.58 inch and with inside diameter of 1.35 inch, the frame is made of empty rectangular steel tube with breadth of 1.34 inch and length of 0.8 inch, and thickness of 0.08 inch (Figure. 3). The aggregate length of boom is around 473 inch. What's more, it can be isolated into two 236 inch booms and boom1 and boom2 which can be folds together to decrease separating.

From FEA (finite element analysis) the most extreme disfigurement at the boom tip is 0.5 inch. In down to earth application and the accompanying investigation we can disregard this distortion and consider the boom as unbending body. The most extreme stress in the beam is 440 N/mm^2 which is in the security extend. Boom1 has a weight of 577 N. The gravitational arm to the pivot point is 81.86 inches; for beam2, the weight is 348N while the gravitational arm is 294 inches without folding is to be done [1].

3. CONTROL SYSTEM MODELING

3.1. Determination of the hydraulic actuating cylinder

Since the vehicle went moderately in the field than we can take the inclinational speed in a little range. Therefore we can utilize static investigation on the framework. The cylinder rod of the piston is in equal level to the upper edge of frame of the sprayer boom and the main thrust of the chamber applies along the bar guiding course. At the point when the framework achieves the static harmony the chamber ought to applies a compel of F to adjust the attractive energy of the sprayer blast. We set a wellbeing allowance approximately 20% and after that we will get the driving force F of 4500 N.

Give the working territory of the cylinder a chance to be A, cylinder diameter is D, and the distance across of the cylinder rod bed. We can pick an impeller-sort pump having pressure force of 100 bar, the capacity of the pump is of 0.06-0.1 liters/revolution, and the rotating rate is the range of 700-2100 RPM. The incited pressure force is Pi=2*Ps, and F=A* Pi. We can decrease the working range of the pump ought to be 2.65 $inch^2$. In view of this we pick the diameter across of the cylinder D is 1.97 inch and the measurement of the cylinder rod diameter d is 1.5 inch

3.1.1. From the geometric figuring

At the point when the separation of the sprayer boom starting from the earliest stage 1m and making the tip of the sprayer boom touching earth needs to stretch out stroke to be 4 inch; The opposite side of the wing of the sprayer boom rising up the cylinder is to be retracting up to 3.5 inch. In this way the aggregate working stroke ought to be 8 inches.

3.2. Determining the calculations of valve

We utilize the relative servo valve to make hydraulic controlling system.100 bar is the outing pressure of the hydraulic pump and our initiated drop of pressure is Pi=F=476 bar. Than Pressure is

- Pressure drop in relational valve is ΔPv and ΔPv = Ps – Pi = 524 bar.
- Less than 500 milli seconds of response time is required.
- The oil supply is to be V1=0.974 l when the cylinder in extraction mode.
- The oil supply is to be V2=1.765 l when the cylinder is in retraction mode.

4. SIMULATION OF MODELS

4.1. Simulation model for controlling the boom sprayer leveling system using proteus design suit

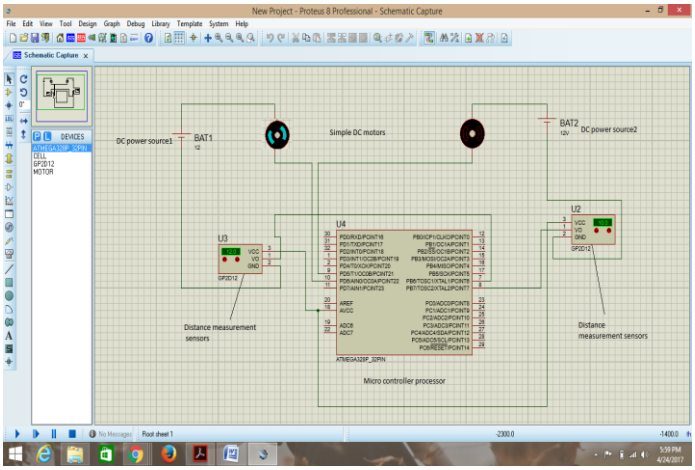

Fig -6: Proteus model of controlling the boom sprayer leveling system

4.2. Simulation hydraulic circuit using Automation studio 6.2

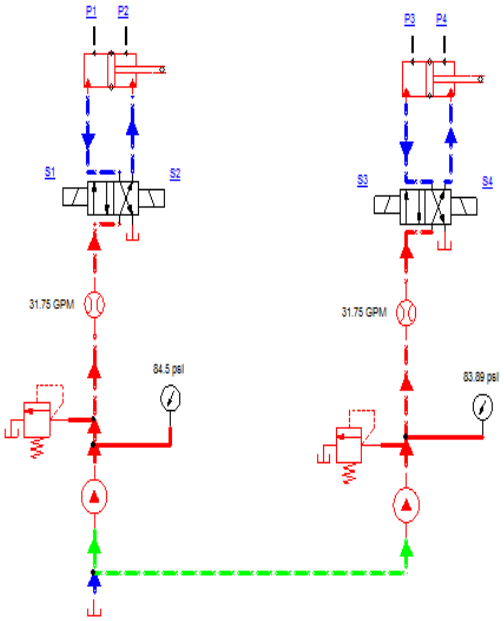

Fig -7: Simulation diagram for actuating circuit

5. SIMULATION RESULTS

Position plots for the actuating cylinders (left) for the actual values

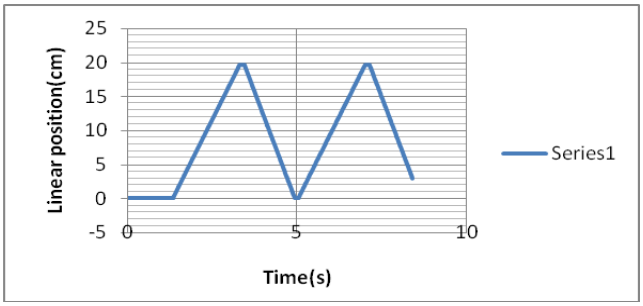

Chart-1: Linear position plot for left cylinder

Position plots for the actuating cylinders (Right) for the actual values

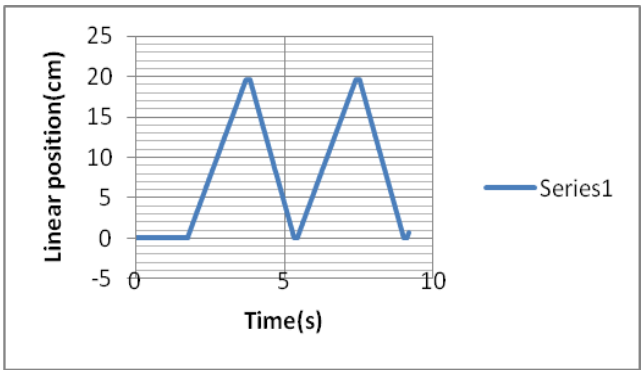

Chart-2: Linear position plot for left cylinder

6. FUTURE SCOPE

This project can be extended and made fool proof and robust in many ways. Firstly the systems can be changed as per requirement the activation system can be done in feedback type. And on great advantage when the required amount of chemical is feuded for plants at start of the process there would be an nitrogen sensor and some chemical sensors which can be used to detect the minerals and nitrogen percentage in the soil and it can be fed through micro controller and certain amount of chemical can be transferred through the stop and start of the valves. And one more added advantage if the crops belong to fruits. The ripening and condition of fruits can be monitored by placing an camera over the boom and which can be done through image processing in this way we can also know that how many fruits got ripened. And condition of them can be monitored if they are ripened or rotten.

7. CONCLUSION

The main aim of this project is to eliminate the vibrations and leveling of the beam this can be achieved by hydraulic linkage which is designed and controlled through a microcontroller as the length of the beams are long so that small variation of the angle may cause a fatal change in the spray pattern so this compensation systems worked effectively the working is

demonstrated in the prototype and it is giving the required results and the response of the system.

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[4] Automation Studio™ Educational Edition designed by FamicTechnologiesInc. http://www.famictech.com/edu, is a leading circuit design and simulation software solution for teaching technical and engineering programs. It offers intuitive design, simulation, and system.

[5] E.A.Brewer,C.N.Dellarocus,A.Colbrook,W.E.Weihl "proteus: a high-performance parallel-architecture simulator" masaachusetts institute of technology Cambridge,MA,USA@1991

[6] HC-SR04 Ultrasonic Proximity sensor.