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Development of Automatic Pesticide Sprinkler Robot for Agriculture

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Abstract : In recent era of technology, robotics technology is growing as part of agriculture development pesticide of farm required for more production in food and process industries. In this thesis was incorporated to developed prototype model of pesticide sprinkler robot which gives spray of specific quantities of pesticide either side by side of farming seed which protect from insect. So proper selection of each every mechanical and electronics component for making prototype model of robot as per input given by farmer as simple way it can operated at any condition. After selection of different component to assemble all component as per need and by using CAD tool like Solidworks 2016 for making 3D Model for better understanding all component for analysis purposes. By using simulation mode to analysis of base plate which most critical component due to overall weight comes to that so justified practically it will be stable or not for that analyzed with using standard Finite Element Analysis (FEA) in Solidworks 2016.

IndexTerms **- Agriculture, Robot, FEA, Solidworks, Static Analysis.**

I. INTRODUCTION

India is agrarian economies and most of rural populations depend on agriculture to earn their livelihood. The farming methods at present are manual or semi-automatic with high involvement of labourers. In the recent years, the number of labour availability is reducing continuously along with increase in their wages. There is a requirement of higher productivity. Hence the device is to be designed which helps farmers to overcome the stated problem. Automated Robots can provide us the solution.

II. LITERATURE REVIEW

Punit Kanse, Kaustubh Masekar, Chetan Pokale [1] were represented to create an intelligent spraying robot that will decrease pesticide use and human health damage, allowing farmers to be protected and labour intensity can be reduced. The robot will have full route planning and navigation systems, as well as driving control, spraying mechanism and system construction and obstacle avoidance with multi- sensor module integration. The spray robot will be designed, including obstacle avoidance, spraying, and sensor integration simulations and analyses. It is used not only to track motion and monitor orientation, but also to compensate for path errors to achieve good stability and reliability. Meanwhile, the spraying system will be improved to eliminate leaks and prevent repeated spraying, with automatic sprays varying according to the target. This project proposes a pesticide spraying system which will help farmers in field of agriculture. Farmers' workloads are reduced, as are health issues. Successfully constructed a robot that can travel on rough surfaces as well as carry a sufficient load of compressor and other equipment. Successful in creating a robot with a strong enough structure to resist the field's challenges. Sure, once this idea is presented in a way that is appropriate for the Indian market, it will undoubtedly aid in lowering the 15% molality rate found in Indian formers associated with agricultural spraying operations. Projects like this inspire people to pursue agriculture as a full-time or part-time occupation. This is critical in developed countries, particularly India, where agriculture is the economic backbone.7

Vijay A. Kotkar, Anuja A. Ghute, Shweta A. Bhosale, Kiran T. Hajare [2] was presented a farming residue a most powerful sector of an Indian financial management system both regarding the benefaction to gross domestic product (GDP) and the source of utilization to the billions of people across the country. Agriculture is an agribusiness of the farmer that take part in the Indian financial management system. More than 75 percent of farm households depend on agriculture for their livelihood. But pest infestation in crops is a serious problem that slows down the growth of agricultural production. Crop disease identification in the agricultural sector is essential to deal with such problems. This present paper provides a technical solution to solve the type of issue in which the CNN algorithm is used to diagnose crop diseases and involves automatic pesticide spraying to spray pesticides on the affected crops locally. The system is based on pesticide sprays. The design deals with three modules image acquisition, image pre-processing, image segmentation, feature extraction, and classifications, and automatic spraying pesticide on the crop. The suggested system can work from a distance with a laptop with the help of a VNC viewer and Python IDLE.

Jaya Priya S, G R Anagha, K R Megha, Harshitha B S [3] had represented the design and development of robot that is used in the field of agriculture. The robot helps the farmer to perform soil levelling, seed sowing, water and pesticide sprinkling, soil levelling and cutting the crop. It is mainly designed to minimize the labour of farmers in addition to increasing the speed and accuracy of the work. We are using an android application to provide the input to the robot. By using Bluetooth, we are establishing a connection between the robot and the application. As per the user instructions the robot will perform the operations. Our Multipurpose autonomous agricultural robot has successfully implemented and tested for various functions like soil levelling, seed sowing, cutting, pesticide and water spraying and digging. It is developed by integrating agricultural robot with Embedded C programming. Using relays for movement of the agricultural robot makes the system easy to move and handle. This also helps from the harmful effect of handling chemicals by the hand. Usage of conventional source of energy has been a prominent means of power supply. Thus, by the usage of the multipurpose robot in the agriculture field makes the productivity higher to the mark with less cost efficiency and helps in modernizing agriculture sector with a remarkable result.

Nishad S. Bargir, Aman S. Vadagaonkar, Kishor M. Kamble, Amol R. Patil, Prof. Mr. Vishal Metkari [4] had represented critical in meeting the population's food needs. There are numerous applications in agriculture where the rate of adoption of new technologies is delayed. Pesticide spraying machines are one of the key applications where modernization is sluggish. Pesticides can be evenly distributed on farms by implementing new innovative techniques in this field. Which lowers pesticide wastage and so minimizes loss of inputs applied on farms, lowering production costs. We employ cutting-edge pesticide spraying technology to achieve increased output with little input. Nowadays, Indian farmers use antiquated spraying systems and pasties, resulting in pesticide waste and potentially harmful health consequences. Not only have innovations and ideas been developed in this field, but they are not well suited to Indian farming conditions. For agricultural purposes, a robot is being developed. An A robot is a concept that, once optimized, can be used in agricultural spraying operations to improve product performance and cost. We are confident that if this concept is presented in a way that is appropriate for the Indian market, it will assist to reduce the 15% modality rate seen in Indian formers, which is linked to pollution It will, on the other hand, assist in lowering the 15% modality rate seen in Indian formers linked to agricultural spraying operations.

Klayani Ashtikar, Rishabh Sonawane, Pooja Kute [5] had represented one of the important occupations in a developing country like India is agriculture. It is very important to improve the efficiency and productivity of agriculture by replacing laborers with intelligent machines like robots using latest technologies. We tried to implement like new strategy to replace humans in various agriculture operation like detection of presence of pests, spraying of pesticides, spraying of fertilizers, etc. there by providing safety involves designing a prototype which use simple cost-effective equipment like raspberry pi, camera, dc motors and terminal equipment which is an aid to the farmers in various crop field activities.

P. Rajesh Kanna, R. Vikram [6] had represented the device for exact pesticide spraying equipped for managing nebulous shapes and variable article targets. The gadget incorporates a solitary splash siphon engine with a consequently separate flexible spraying utilizing ultrasonic sensors, all mounted on a pan tilt unit. The site-explicit spraying gadget plans to splash explicit targets while diminishing the utilization of pesticides. The proposed framework includes the advancement of an article explicit sprayer arrangement. The created gadget intends to diminish pesticide application by spraying singular targets explicitly by setting the item separation of the spraying as per the objective. The spraying device is equipped for decreasing the measure of pesticides connected. Real reserve funds rely upon the spraying lengths, target size, and appropriation. We trust that such a device can be utilized in present day farming and can be joined with an automated sprayer exploring independently along yield fields. Such a gadget will add to decreased pesticide application.

Siddhi S. Mane, Nikita N. Pawar, Sneha A. Patil, Prof. D.O. Shirsath [7] had represented Compared to spraying pesticides manually when the environment is more closed, and has a high temperature, humidity and so on for operating the spray work in the greenhouse in which we use Bluetooth communication to interface controller and android. Controller can be interfaced to the Bluetooth module though UART protocol. According to commands received from android the robot motion can be controlled. The consistent output of a robotic system along with quality and repeatability are unmatched Although the productivity of the prototype is not quite efficient, the robot still meets the requirements of pesticide spraying in the greenhouse without human operators.

A.M. Kassim, M. F. N. M. Termezai, A. K. R. A. Jaya, A. H. Azahar [8] had represented, the fertigation farm in Malaysia has advantages in the fertilization and irrigation management system, it still lacking with the pest management system. Since almost the insect and pests are living under the crop's leaves, it is difficult and hard labor work to spray under the leaves of the crop. Almost agricultural plants are damaged, weakened, or killed by insect pests especially. These results in reduced yields, lowered quality, and damaged plants or plant products that cannot be sold. Even after harvest, insects continue their damage in stored or processed products. Therefore, the aim of this study is to design and develop an autonomous pesticide sprayer for the chili fertigation system. Then, this study intends to implement a flexible sprayer arm to spray the pesticide under the crop's leaves, respectively. This study involves the development of unmanned pesticide sprayer that can be mobilized autonomously. It is because the pesticide is a hazardous component that can be affected human health in the future if it exposed during manual spraying method especially in a closed area such as in the greenhouse. The flexible sprayer boom also can be flexibly controlled in the greenhouse and outdoor environment such as open space farms. It is expected to have a successful pesticide management system in the fertigation-based farm by using the autonomous pesticide sprayer robot. Besides, the proposed autonomous pesticide sprayer also can be used for various types of crops such as rockmelon, tomato, papaya. Pineapples, vegetables etc.

Ravi Gorapudi, Bhargava Rama Sai Pavan Rudrapaka, Aadi Seshu Valluri [9] had represented India is an agriculturally based country. Spraying of pests is an important task for every Farmer. In ancient days Farmers have used hand operated or fuel operated spray pump for this task as a result carbon dioxide emitted as pollutant during the operation of such pumps has a unpleasant effect in the environment. Also, there is a chance of directly getting in touch with of pesticides with human body which will be harmful. Hence, these conservative sprayers are not much appreciated. This paper designed a pesticides spraying robot using raspberry pi. Fossil Fuels operated Sprayers are eliminated by DC pump which results in the reduction of vibrations and noise. This makes spraying system ecofriendly. To implement the idea a vehicle is made which is electronically operated by a remote (mobile app). Sprayer is fitted the robot so that it can spray pesticides uniformly covering a large area in less time. The main advantage in this paper is sprayer Height is Adjusted According to the Plant Height.

Ashutosh B. Adhav, Vivek D. Jagtap, Rushabh R. Sonawane, Ganesh K. Gaikwad [10] had represented the exposition of how robotics can be applied to various fields of agriculture. One of the most important professions in a developing country like India is agriculture. It is very important to improve the efficiency and productive capacity of agriculture by replacing laborers with intelligent solar-powered machines like robots using the latest technologies. The system proposes a new plan to put back humans in diverse agricultural operations like detection of the presence of pests, spraying of pesticides, spraying of fertilizers, etc. thereby providing safety to the farmers and accurate agriculture. The evolved system includes plotting a prototype that uses simple cost-effective equipment like microprocessors, solar panels, wireless, different motors and terminal equipment which helps the farmers in different crop field activities. The main feature of this system is Electrostatic spraying. This application is adopted in crop protection to prevent pest infestation, to improve product quality and to maximize yield. It involves a superposition of charges to pesticide spray droplets to attract substrate ions at hidden surfaces. The droplets wraparound effect lowers off-target deposition, increases on-target spray and invariably improves spray efficiency. Electrostatic spraying system works productively at best suitable parameters in union with charging voltages, spraying height arrangement, application pressures, flow rate, travel speed, electrode material, and nozzle orientation.

Kazi Khalid Abdul Karim, Mankari Hemant Tanaji [12] had represented the exposition of how robotics can be applied to various fields of agriculture. One of the most important occupations in a developing country like India is agriculture. It is very important to improve the efficiency and productivity of agriculture by replacing labourers with intelligent machines like robots using latest technologies. The project proposes a new strategy to replace humans in various agricultural operations like detection of presence of pests, spraying of pesticides, spraying of fertilizers, etc. there by providing safety to the farmers and precision agriculture. The developed system involves designing a prototype which uses simple cost-effective equipment's like microprocessors, wireless camera, various motors, and terminal equipment's which is an aid to the farmers in various crop field activities.

Parmar Milan, Dafada Jigna, Chauhan Kamlesh, Mehul Bataviya [13] had represented near about 70% people are dependent upon agriculture. So, the agriculture system in India should be advanced to reduce the efforts of farmers. Many farmers have suffered from a toxic chemical exposure after spraying pesticide on the crop. It is necessary to protect a plant. We must avoid a pest from plant. Human will injure during this work so we can take safety step. So, we proposed to make a robot for spraying pesticide on farm. Generally, more than one person requires during this work, but after made a demo model, only one person do all this work without any hard work & injury.

Jaggumantry Swapna Kumari, Kazi Khalid Abdul Karim, Mankari Hemant Tanaji [14] had represented the exposition of how robotics can be applied to various fields of agriculture. One of the most important occupations in a developing country like India is agriculture. It is very important to improve the efficiency and productivity of agriculture by replacing laborer with intelligent machines like robots using latest technologies. The project proposes a new strategy to replace humans in various agricultural operations like detection of presence of pests, spraying of pesticides, spraying of fertilizers, etc. there by providing safety to the farmers and precision agriculture. The developed system involves designing a prototype which uses simple cost-effective equipment's like microprocessors, wireless camera, various motors and terminal equipment's which is an aid to the farmers in various crop field activities.

Redmond Ramin Shamshiri, Cornelia Weltzien, Ibrahim A. Hameed [15] had represented the practice of modern technologies such as sensors, robotics, and data analysis for shifting from tedious operations to continuously automated processes. This paper reviews some of the latest achievements in agricultural robotics, specifically those that are used for autonomous weed control, field scouting, and harvesting. Object identification, task planning algorithms, digitalization and optimization of sensors are highlighted as some of the facing challenges in the context of digital farming. The concepts of multi-robots, human-robot collaboration, and environment reconstruction from aerial images and ground-based sensors for the creation of virtual farms were highlighted as some of the gateways of digital farming. It was shown that one of the trends and research focuses on agricultural field robotics is towards building a swarm of small-scale robots and drones that collaborate to optimize farming inputs and reveal denied or concealed information. For the case of robotic harvesting, an autonomous framework with several simple axis manipulators can be faster and more efficient than the currently adapted professional expensive manipulators. While robots are becoming the inseparable parts of the modern farms, our conclusion is that it is not realistic to expect an entirely automated farming system in the future.

Shubhangi B. Londhe, K. Sujata [16] had represented n industrialization, agriculture remains a dominant sector of the Indian economy both in terms of contribution to gross domestic product (GDP) as well as a source of employment to millions across the country. Agriculture plays a vital role in the Indian economy. Over 70 per cent of the rural households depend on agriculture as their principal means of livelihood. But an attack of pest in crops is one of the major problems to reduce the production growth in agriculture field. To deal with this kind of problem diagnosis of crop disease is very essential. This paper presents an engineering solution to tackle this kind of problem in which an automatic pesticide sprayer is involved to spray the pesticide to the localized area of the affected crops. This system is based on sprayer filled with pesticides. The Sprayer movement is controlled by DC motor at low velocity, up & down direction according to plant height. The design deals with three modules image capturing processing and automatic pesticide spraying. The proposed system can remotely operate through any electronic device like mobile, laptop etc.

Sonal Sharma and Rushikesh Borse [17] had represented explores the technology of wireless sensors for remote real time monitoring of vital farm parameters like humidity, environmental temperature, and moisture content of the soil. We also employ the technique of image processing for vision based automatic disease detection on plant leaves. Thus, this paper vigorously describes the design and construction of an autonomous mobile robot featuring plant disease detection, growth monitoring and spraying mechanism for pesticide, fertilizer, and water to apply in agriculture or plant nursery. To realize this work we provide a compact, portable and a well-founded platform that can survey the farmland automatically and can identify disease and can examine the growth of the plant and accordingly spray pesticide, fertilizer and water to the plant. This approach will help farmers make right decisions by providing real-time information about the plant and its environment using fundamental principles of Internet, Sensor's technology, and Image processing.

Mitul Raval, Aniket Dhandhukia and Supath Mohile [18] had represented a technological solution to the current human health hazards involved in spraying of potentially toxic chemicals in the confined space of an atmosphere. This is achieved by the design and construction of an autonomous mobile robot for use in pest control and disease prevention applications in commercial Farm. The effectiveness of this platform is shown by the ability to successfully navigate itself down rows of a Farm, spray the pesticides effectively while the farmer controls it from a far distance. And this pesticide spraying system efficiently covers the plants evenly with spray in the set dosages.

Amruta Sulakhe, M.N. Karanjkar [19] had represented Compared to spraying pesticides manually outdoors, the environment is more closed, and has a high temperature, humidity and so on for operating the spray work in the greenhouse. To protect laborer and reduce labor intensity, we develop a prototype of pesticide spraying robot specially used in the greenhouse. This paper emphatically describes the structural design, the robot control system design, and the results of navigation experiment. The experiment shows that this robot can track a signal wire well which is set on the ground for navigation, and it obtains a nice steering ability even for short turns with the speed less than 0.5 m/s. Although the productivity of the prototype is not quite efficient, the robot still meets the requirements of pesticide spraying in the greenhouse without human operators. Philip J.

Sammons, Tomonari Furukawa and Andrew Bulgin [20] had represented an engineering solution to the current human health hazards involved in spraying potentially toxic chemicals in the confined space of a hot and steamy glasshouse. This is achieved by the design and construction of an autonomous mobile robot for use in pest control and disease prevention applications in commercial greenhouses. The effectiveness of this platform is shown by the platforms ability to successfully navigate itself down rows of a greenhouse, while the pesticide spraying system efficiently covers the plants evenly with spray in the set dosages.

III. PESTICIDE SPRINKLER ROBOT DESIGN

After selection of different component to assemble all component as per need and by using CAD tool like Solidworks 2016 for making 3 D Model for better understanding all component for analysis purposes. The table the list of the components with some of the picture attached with the Render images of the CAD model.

Table 1 List of Component of Pesticide Sprinkler Robot:

Sr. No.	Name of Components	
1	Toy car circuit	
2	RF transmitter & receiver	
3	RF encoder	
4	Push button	
6	750K Ohm resistor	
7	Relay (Qty = 2)	
8	12 Volt battery (Qty = 3)	
9	11 inches Tyre (Qty = 4)	
10	Chain Drive Mechanism	
11	10-liter Water Tank	
12	Shaft	
13	Base Plate	
14	Micro Submersible Water Pump	
15	4-meter pipes	

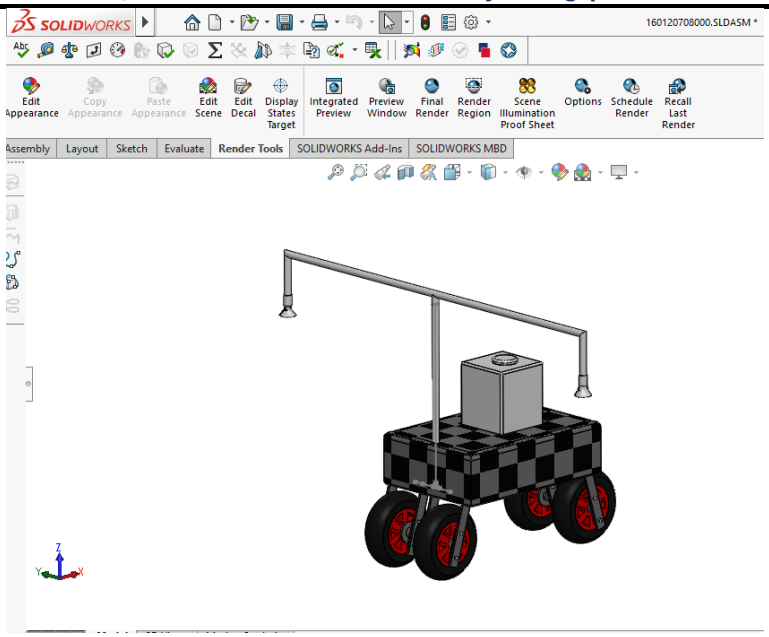

Fig.1 Render Image of Robot

Fig.2 Render Image of Robot

IV. FINITE ELEMENT ANALYSIS OF BASE PLATE

- Structural Analysis of Base Plate
- Basic Steps of FEA Analysis for Base Plate

From the perspective of FEA software, each application of FEA requires three steps:

1. Preprocessing of the FEA model, which involves defining the model and then splitting it into finite elements
2. Solving for desired results
3. Post-processing for results analysis

We will follow the above Four steps in every exercise. From the perspective of FEA methodology, we can list the following FEA steps:

- Building the mathematical model
- Building the finite element model by discretizing the mathematical model
- Solving the finite element model
- Analyzing the results

Table 2 Material Properties (Plain Carbon Steel- EN 8)

Mass Density	7800 kg/m3
Tensile Strength	400 MPa
Yield Strength	220 MPa
Shear Modulus	79 MPa
Modulus of Elasticity (E)	210 GPa
Poisson Ratio	0.28
Specific Heat Capacity	0.43
Thermal Conductivity	43 W/mk

Having prepared a meshable, but not yet meshed geometry, we now define material properties (these can also be imported from a CAD model), loads and restraints, and provide information on the type of analysis that we wish to perform.

Static study is the only type of study available in some SOLIDWORKS packages. Working with Static study we need to accept important limitations: material is assumed as linear, and loads are static.

Solid mesh which is programme generated.

Fine Meshing is apply

No. of Nodes: - 62284

No. of Elements: - 31083

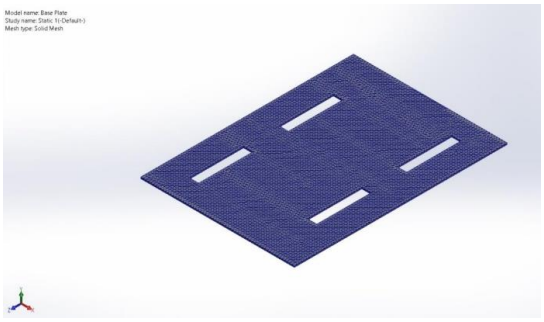

Fig.6 Meshing of Base Plate using static analysis

Define Boundary condition

Apply fixed support at end of hexagonal bar which is operation condition passing of through two different roller like upper and lower roller.

Before we proceed with the classification of finite elements, we need to introduce the concept of nodal degrees of freedom which are of paramount importance in FEA. The degrees of freedom (DOF) of a node in a finite element mesh define the ability of the node to perform translation and rotation. The number of degrees of freedom that a node possesses depends on the element type.

In SOLIDWORKS Simulation, nodes of solid elements have three degrees of freedom, while nodes of shell elements have six degrees of freedom. This is because in order to describe the transformation of a solid element from the original to the deformed shape, we only need to know three translational components of nodal displacement. In the case of shell and beam elements, we need to know the translational components of nodal displacements and the rotational displacement components.

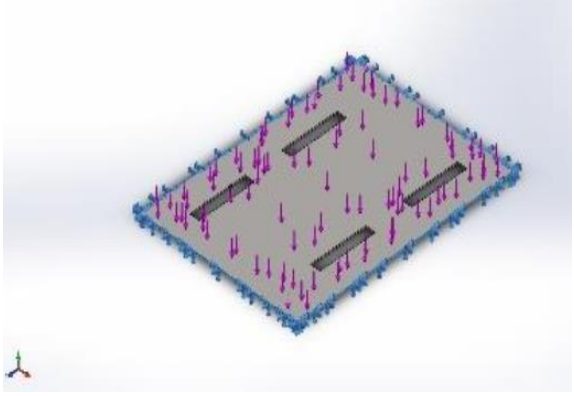

Fig. 7 Boundary condition of Base Plate using static analysis

Apply Force

As reference of self-weight of plate consider as push load and other sub assembly component weight consider as load so magnitude of force on end of chain link is 600 N.

Static loads

All structural loads and restraints are assumed not to change with time. Dynamic loading conditions cannot be analyzed with Static study. This limitation implies that loads are applied slowly enough to ignore inertial effects.

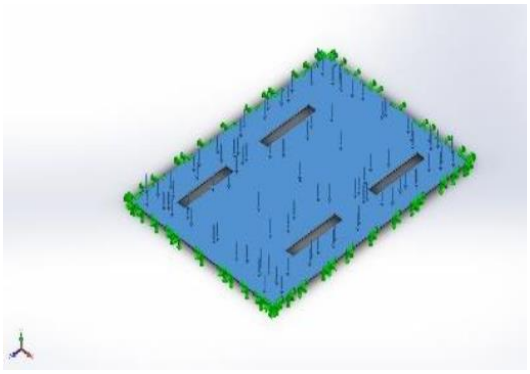

Fig. 8 Force applying on Base Plate

V. RESULTS AND METHODOLOGY

Equivalent Stress for static analysis:

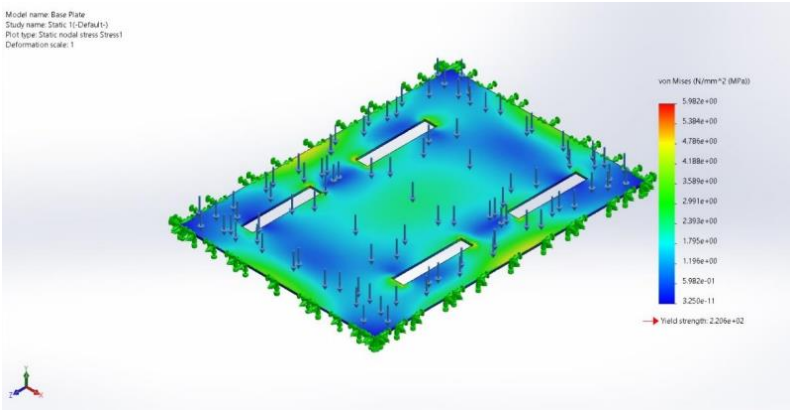

Fig. 9 Von mises Stress analysis of Base Plate

Total Deformation:

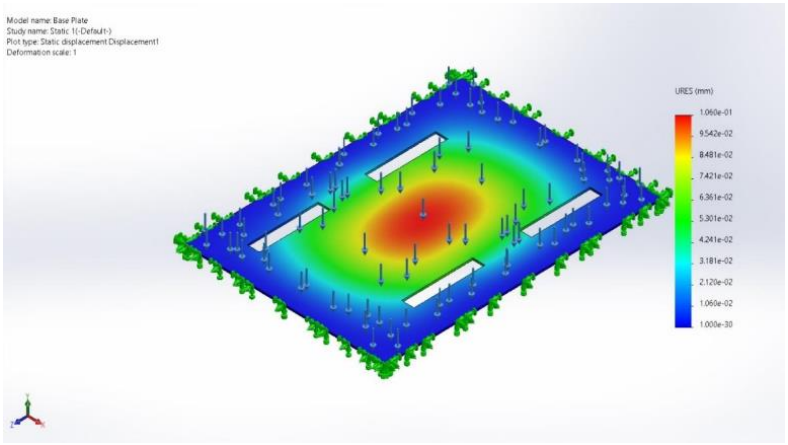

Fig. 10 Deformation of Base Plate

Strain:

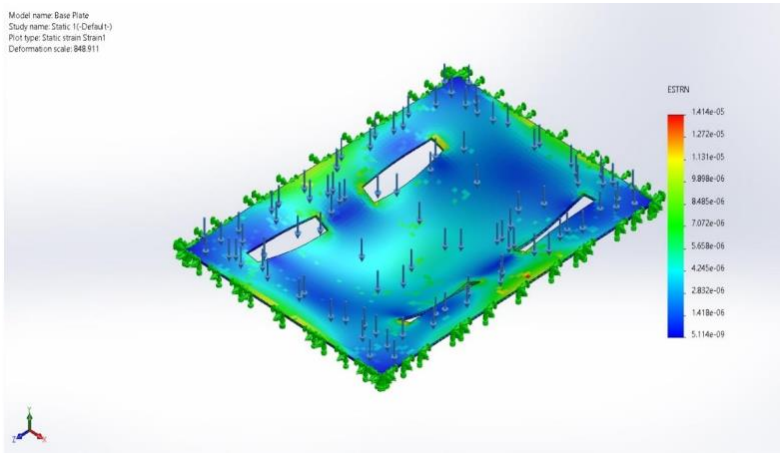

Fig. 10 Strain of Base Plate

Table 3 Result

Stress in MPa	Deformation in mm	Strain
5.982	0.1060	0.000001414

V. CONCLUSION

By taking different literature review of research paper which gives idea about development of different application of robot. For that to set standard procedure for selection different components like car toy circuit, electronics components, shaft, base plate, chain drive mechanism, pump set etc.

By using standard manufacturing process to developed robot as per input data and make prototype model. Also done reverse engineering every major component parameter and done assembly by using Solidworks 2016 which more user-friendly software to justified 3 D modelling and simulation mode in which done base plate static analysis.

In static analysis gives result of von mises stress, deformation and strain values are 5.982 MPa, 0.1060mm and 0.000001414 respectively.

By this all Research, CAD modeling & Analysis We have develop the Pesticide robot as you can see In the Fig.11 & Fig. 12.

Fig. 11 Assembly of Pesticide Robot

Fig. 11 Assembly of Pesticide Robot with Tank

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