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DESIGN AND STRUCTURAL ANALYSIS OF AGRIBOT

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ABSTRACT:

Many advances in technology have made the agriculture business a much less labor intensive industry to be a part of. If we think back even only 50 years, farmers were just beginning to incorporate technologies into their farming techniques. It has been said that individuals that are involved in the farming industry are some of the least susceptible to change. They are very set in the ways of those came before them. When we take a look at the farming industry now, we can see that this is rapidly changing. Farmers are looking for new ways to implement technology to cut costs and reduce labor hours. One of the ways that farmers are beginning to explore new technologies in farming come from the Agribot. This is something new to the agriculture industry, but is quickly gaining popularity from agriculture research companies around the country. These Agribot are described by Farm Industry News as an Agribot that drives it's solving with a computer in control. Although still in the research phase of development, Agribot are rapidly becoming more of a reality than an idea. The Agribot is controlled by a wireless communication system. This can be moved forward and reverse direction using DC motors. Also this robot can take sharp turnings towards left and right directions. Most of the cases the things done during farming are plough, watering and seeding. For performing all these operations lot of manpower is needed. So, by using Agribot all these things can be done with ease. Without much manual effort, by simply pressing switch using wireless communication corresponding action can be performed. This project is about frame and load calculation and dimensioning, of the elements. For the determination of forces on the elements, models and drawings are to be made in CAD software like Catia and analysis by Ansys software. The quality mesh is prepared for converged solution and the solver set as analysis package with high optimizing results. The resultant calculation process can be used for designing the geometry and determination of the properties.

I.INTRODUCTION

Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching in telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated.

An agricultural robot or agribot is a robot deployed for agricultural purposes. The main area of application of robots in agriculture is at the harvesting stage. Fruit picking robots, driverless tractor / sprayer, and sheep shearing robots are designed to replace human labor. The agricultural industry is behind other complementary industries in using robots because the sort of jobs involved in agriculture are not straightforward, and many repetitive tasks are not exactly the same every time. In most cases, a lot of factors have to be considered (e.g., the size and color of the fruit to be picked) before the commencement of a task. Robots can be used for other horticultural tasks such as pruning, weeding, spraying and monitoring. Robots can also be used in livestock applications (livestock robotics) such as milking, washing and castrating.

The biggest benefit of automation is that it saves labor; however, it is also used to save energy and materials and to improve quality, accuracy and precision. The term automation, inspired by the earlier word automatic (coming from automaton), was not widely used before 1947, when General Motors established the automation department. It was during this time that industry was rapidly adopting feedback controllers, which were introduced in the 1930s. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, and electronic and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques.

Agribot are an alternative to the tractors found on fields today. Cultivation tasks like seeding, spraying, fertilizing and harvesting may be performed by fleets of Agribot in the future.

Independent of the actual design a serious agricultural robot will be a complex and expensive vehicle – the challenge is therefore to prove that it is competitive to traditional technology and may even bring a decisive lead. One critical factor here is the optimal utilization of the robot over the day and over the year. To reach a full utilization we need to support multiple applications as the tractor does with different tractor/implement combinations. Following that scheme the agricultural robot needs to be a vehicle with some basic capabilities and the possibility to support multiple applications. Among the basic capabilities we surely require a navigation system for safe and autonomous navigation.

II - LITERATURE REVIEW

The aim of this chapter is to present the status of the current trends and implementation of agricultural and horticultural robots and autonomous systems and outline the potential for future applications. Different applications of autonomous vehicles in agriculture have been examined and compared with conventional systems, where three main groups of field operations have been identified to be the first potential practical applications: crop establishment, plant care and selective harvesting.

Moreover we will give examples of the economic potential of applying autonomous robotic vehicles compared to conventional systems in two different applications: robotic weeding in high value crops, particularly sugar beet, and crop scouting in cereals. The comparison was based on a systems analysis and an individual economic feasibility study for each of the applications. Focus will be put on potential labor cost savings, farm structure implications and sizes for operation, daily working hours, potential environmental impact, energy costs and safety issues.

2.1 Types of automation

Two common types of automation are feedback control, which is usually continuous and involves taking measurements using a sensor and making calculated adjustments to keep the measured variable

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within a set range, and sequence control, in which a programmed sequence of discrete operations is performed, often based on system logic. Cruise control is an example of the former while an elevator or an automated teller machine (ATM) is an example of the latter.

The theoretical basis of feedback control is control theory, which also covers servomechanisms, which are often part of an automated system. Feedback control is called "closed loop" while non-feedback control is called "open loop."

2.1.1 Feedback control

Feedback control is accomplished with a controller. To function properly, a controller must provide correction in a manner that maintains stability. Maintaining stability is a principal objective of control theory.

As an example of feedback control, consider a steam coil air heater in which a temperature sensor measures the temperature of the heated air, which is the measured variable. This signal is constantly "fed back" to the controller, which compares it to the desired setting (set point). The controller calculates the difference (error), then calculates a correction and sends the correction signal to adjust the air pressure to a diaphragm that moves a positioned on the steam valve, opening or closing it by the calculated amount. All the elements constituting the measurement and control of a single variable are called a control loop.

III - DESCRIPTION OF THE PROJECT

3.1 Robots Designed for Agricultural

Engineers and researchers works to increase the level of autonomous machinery in agriculture and the best solution is to design and build robots capable to work continuously without human guidance.

Robots deployed for agricultural purposes can deliver high accuracy and low costs while the farmers can have in real-time a situation of tasks already completed.

Robots could be designed to include many agricultural techniques using a limited set of tools and replacing the human laborers. A fully Agribot should have the ability to understand the environment, work for an unlimited time without any operator intervention, capable for environment adaptation when changes occur, and to ensure the security for humans.

The number of commercial agricultural robots is still limited for a moment, but there is the assumption that in the near future their number will increase significantly.

Fig: 3.1: Autonomous Robot Tractor

The aim is to build a robot able for a wide range of maneuvers and working the ground with high accuracy. They pass the problems with uneven and inconsistent terrain that can change the direction of the tractor.

The autonomous system component includes a system to act the acceleration and steer, processing unit, and sensors to locate the position including GPS system. Sensors and a powerful computer is not enough to keep the tractor on the right path. The development team creates an application where the user calibrates the robot according to each terrain type.

Advantages

1. Is designed to replace on labor.
2. An autonomous lawn mower requires a minimal intervention from the user.
3. An autonomous lawn mower does not require guidance from the user.
4. It is very easy to program a robotic lawn mower.

An agricultural robot is intelligent machinery designed for agricultural purposes and requires delicacy especially for robots used in harvesting. Imagine a tractor that can turn around, may go between the plant rows, or a machine that can recognize the potatoes that are not based on standards that allowing the commercialization.

IV - WORKING OF AGRIBOT

4.1 MATERIAL AND METHODS

The Agricultural Mobile Robot is designed to sensing agronomic parameters of most important Brazilian culture (maize, sugar cane, soybeans, and orange) during almost the entire cycle of growth and post harvest in large areas. It does not require actions that demand high power, as in agricultural operations, but only moving efficiently in this environment. According to MADSEN & JAKOBSEN, 2001 the considerations made about the principles of the vehicle and the choices of concept for the mobile robot were: traction, steering, dimensions, frame, motors and power supply. The mechanical structure was designed by the studying of working conditions required in field and desired characteristics of the project, using the steps of processes described.

Power supply

Batteries have been chosen for the vehicle, because they are easy to install and should be able to deliver power for the necessary time to do the analyses on the field. Traction battery is the term relates to all batteries used to power supply electric vehicles. They are designed to be fully discharged and recharged daily, can withstand thousands of discharge cycles. For this works eight batteries of 12 V and 70 Ah for traction, four batteries of 12V and 10 Ah for the steering system and one battery of 12V and 50 Ah for the computing system are used. As a consequence this technology allows the characterization of parameters for an individual plant during the complete growth stages. Moreover, groups of plants might be analyzed with respect to their position in the field or other boundary conditions (such as soil properties).

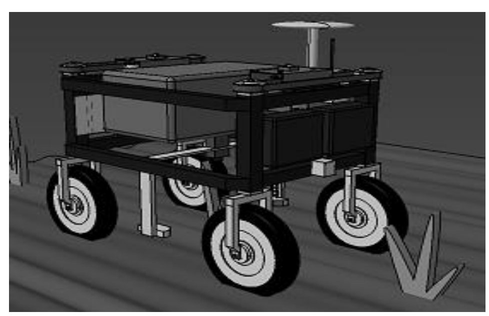

Fig. 4.1: Concept of an autonomous field robot for agricultural field trials.

The real-time combination of sensor information and GPS is the first step towards robots for agricultural field trials. In the second step the technologies for

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autonomous field robots described above have to be integrated. Since the complex outdoor navigation as well as the characterization of plants strongly depends on robust sensors and algorithms, the characterization itself is the natural first application for an agricultural field robot.

While the realization of commercially available autonomous field robots with actuators will still take some time, the concept of an autonomous field robot for field trials – as sketched in Figure 10 – might be realized within very few years.

The existence of a robust autonomous robot for field trial will offer a broad range of further applications. The already mentioned combinations with actuators – such as fertilization or weed control – are one perspective. Moreover, the existence of small robots has advantages with respect to safety and results in reduced soil compression as compared to present agricultural machines.

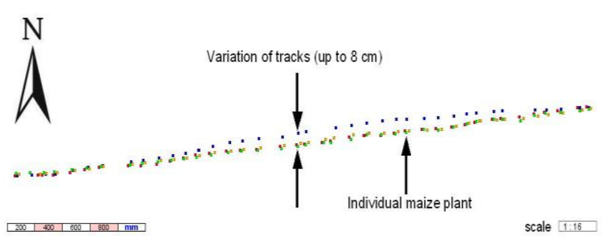

Fig. 4.2: Positions of single maize plants measured in 4 different runs

This demonstration of low-cost robots (total hardware prices are below 2000 € per robot) already illustrates future applications in agricultural engineering.

V - DESIGN METHODLOGY OF AGRIBOT

5.1 Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. CATIA competes in the high-end CAD/CAM/CAE market with Cero Elements/Pro and NX (Unigraphics).

CATIA can be applied to a wide variety of industries, from aerospace and defense, automotive, and industrial equipment, to high tech, shipbuilding, consumer goods, plant design, consumer packaged goods, life sciences, architecture and construction, process power and petroleum, and services. CATIA V4, CATIA V5, Pro/ENGINEER, NX (formerly Unigraphics), and Solid Works are the dominant systems.

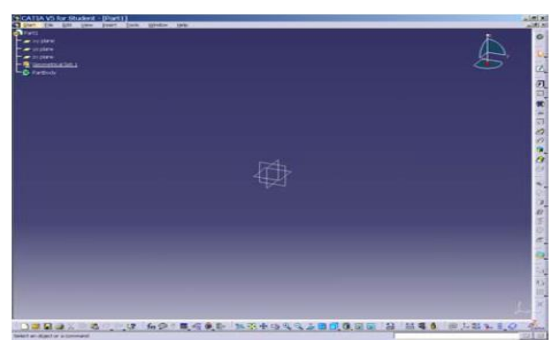

Fig: 5.1: Home Page of CatiaV5

Modeling of Agribot in CATIA V5

This **AGRIBOT** is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design.

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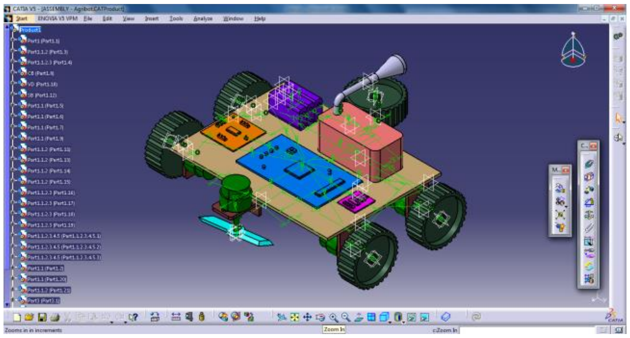

Fig: 5.2: Model design of AB in CATIA-V5

VI - ANALYSIS OF AGRIBOT

6.1 Procedure for FE Analysis Using ANSYS:

The analysis of the components is done using ANSYS. For compete assembly is not required, motor and attached system is to carried out by applying moments at the rotation location along which axis we need to mention.

6.2 Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

  File Menu > Import> STEP > Click ok for the popped up dialog box > Click

  Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

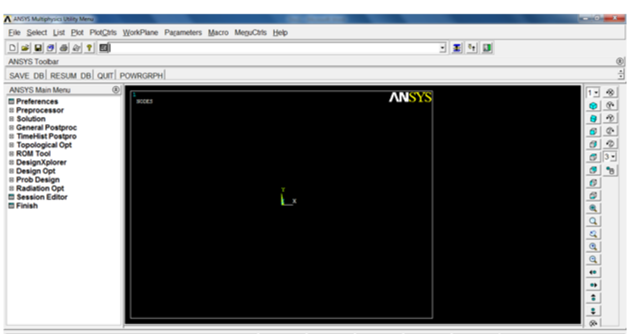

Fig.6.1: Import panel in Ansys.

6.2.1 Meshing:

Mesh generation is the practice of generating a polygonal or polyhedral mesh that approximates a geometric domain. The term "grid generation" is often used interchangeably. Typical uses are for rendering to a computer screen as finite element analysis or computational fluid dynamics. The input model form can vary greatly but common sources are CAD, NURBS, B-rep and STL (file format). The field is highly interdisciplinary, with contributions found in mathematics, computer science, and engineering.

Meshing is an integral part of the computer-aided engineering (CAE) simulation process. The mesh influences the accuracy, convergence and speed of the solution. Furthermore, the time it takes to create a mesh model is often a significant portion of the time it takes to get results from a CAE solution. Therefore, the better and more automated the meshing tools, the better the solution. From easy, automatic meshing to a highly crafted mesh, ANSYS provides the ultimate solution. Powerful automation capabilities ease the initial meshing of a new geometry by keying off physics preferences and using smart defaults so that a mesh can be obtained upon first try. Additionally, users are able to update immediately to a parameter change, making the handoff from CAD to CAE seamless and aiding in up-front design. Once the best design is found, meshing technologies from, ANSYS provide the flexibility to produce meshes that range in complexity from pure hex meshes to highly detailed Hybrid meshes.

VII - DISCUSSION ON ANALYSYS RESULT

7.1 Results of Displacement analysis:

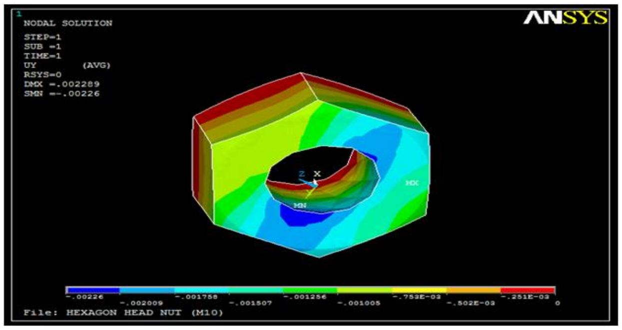

Fig: 7.1: Displacement of Hex Nut

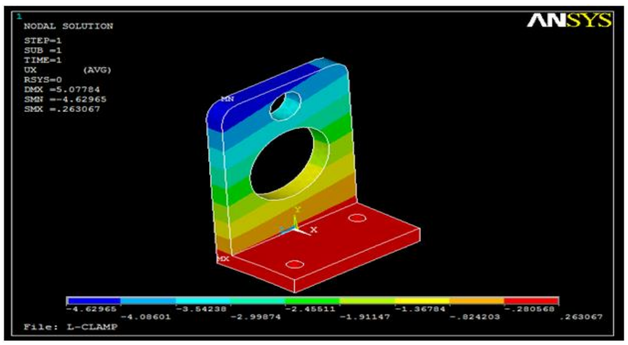

Fig: 7.2: Displacement of L-Clamp

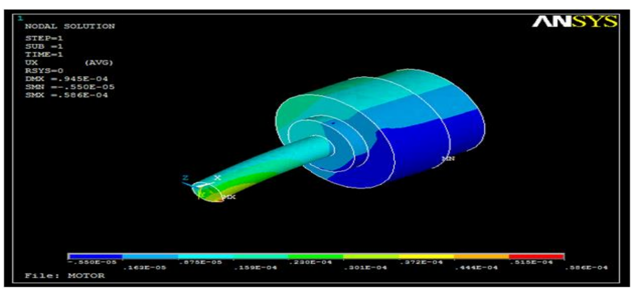

Fig: 7.3: Displacement of Motor

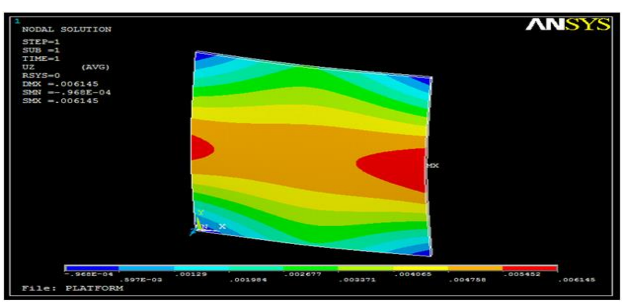

Fig: 7.4: Displacement of Platform

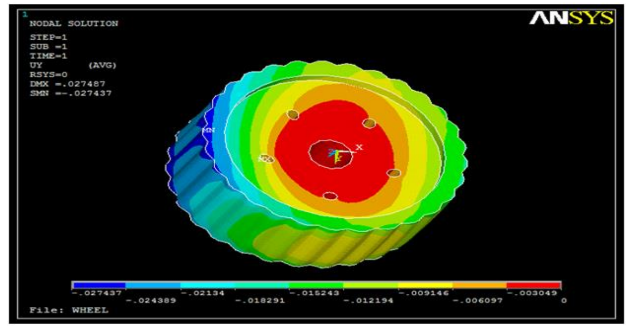

Fig: 7.5: Displacement of Wheel

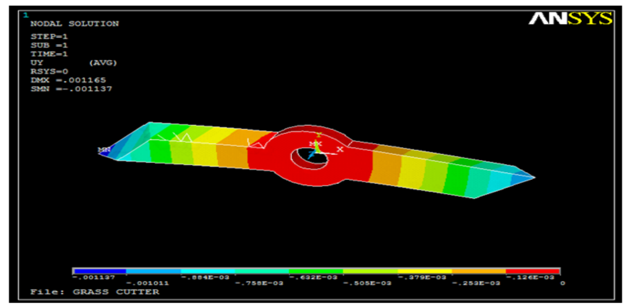

Fig: 7.6: Displacement of Grass Cutter

7.2 Results of Stress analysis:

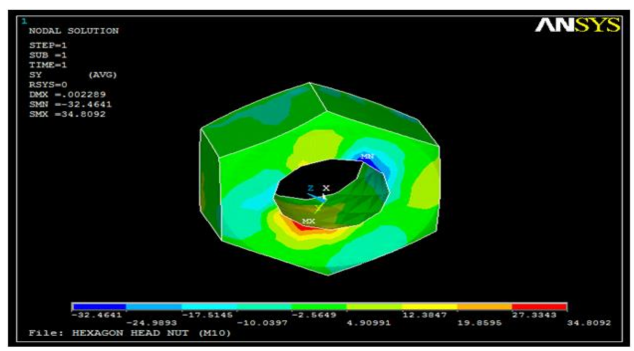

Fig: 7.7: Stress Analysis of Hex Nut

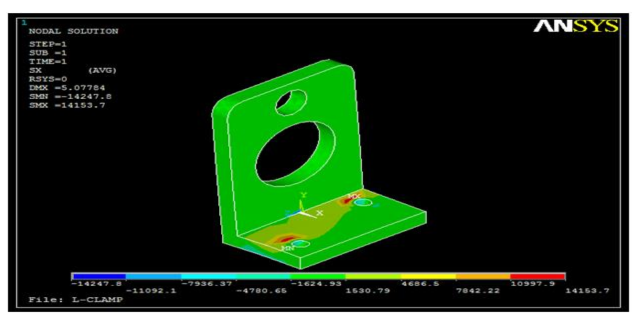

Fig: 7.8: Stress Analysis of L-Clamp

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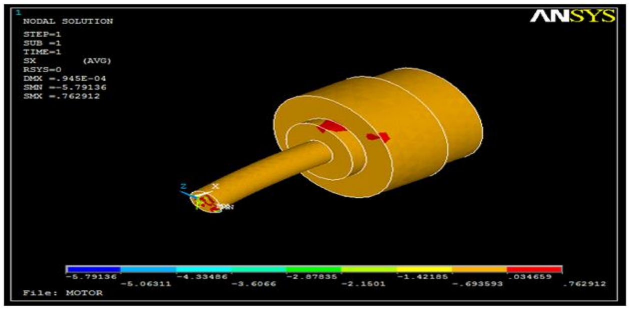

Fig: 7.9: Stress Analysis of Motor

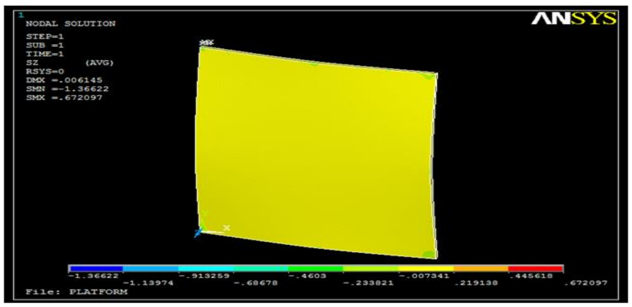

Fig: 7.10: Stress Analysis of Platform

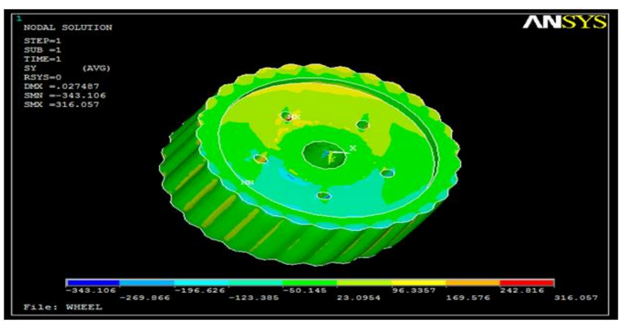

Fig: 7.11: Stress Analysis of Wheel

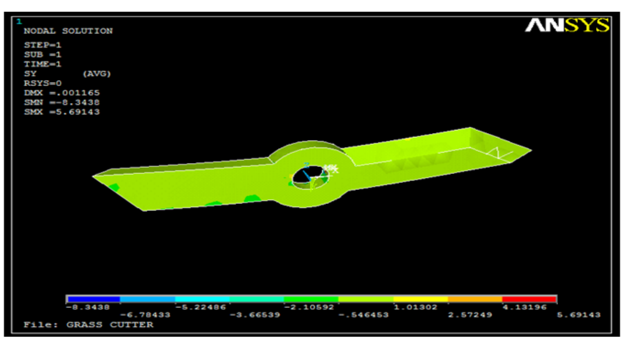

Fig: 7.12: Stress Analysis of Grass Cutter

6.3 Results of Strain analysis:

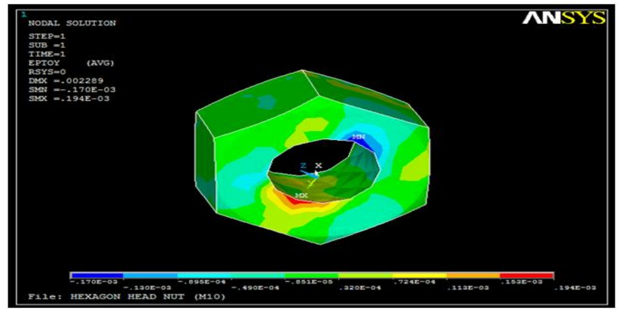

Fig: 7.13: Strain Analysis of Hex Nut

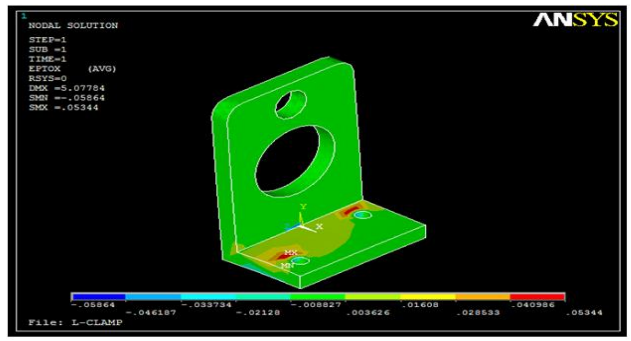

Fig: 7.14: Strain Analysis of L-Clamp

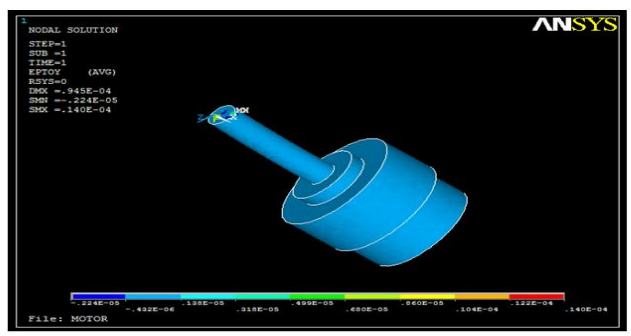

Fig: 7.15: Strain Analysis of Motor

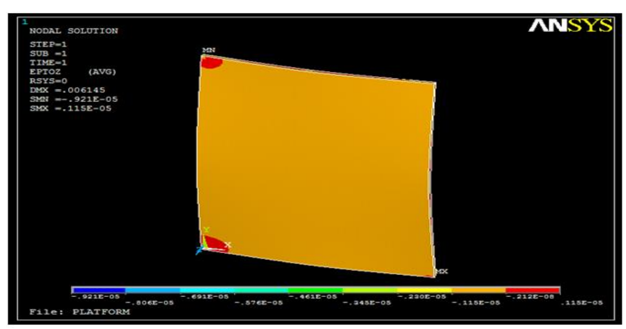

Fig: 7.16: Strain Analysis of Platform

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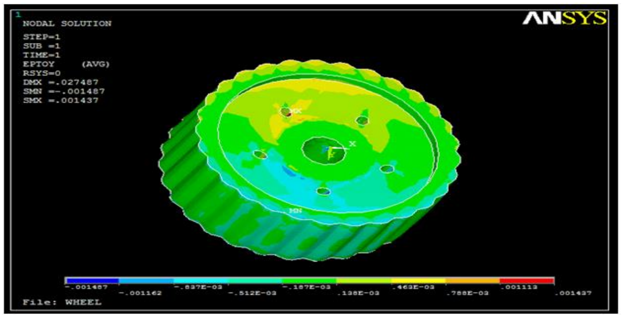

Fig: 7.17: Strain Analysis of Wheel

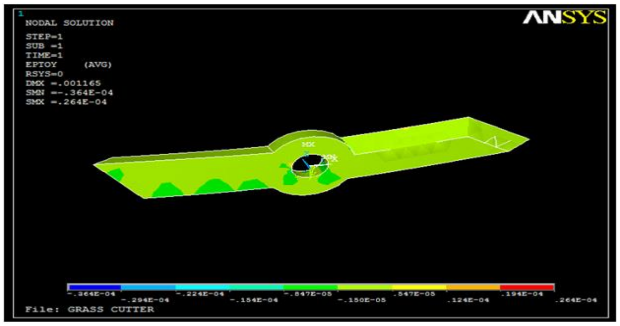

Fig: 7.18: Strain Analysis of Grass Cutter

VIII - CONCLUSION

This paper has set out a vision of how aspects of crop production could be automated in the future. Although existing manned operations can be efficient over large areas there is a potential for reducing the scale of treatments with autonomous machines that may result in even higher efficiencies. As shown above figures, we are considering the Analysis results of wheel and grass cutter as they are the major working components in the project, so the displacement of the design is meshed and solved using Ansys and displacement, which is very less. This is showing us that clearly each component in robot assembly is having minor displacement.

Stress is at the fixing location (Minimum Stress which is acceptable), the value which is very less compared to yield value of Aluminum & Mild steel; this is below the yield point. The maximum strain, this solution solving with the help of Ansys software so that the maximum stress is less .so we can conclude our design parameters are approximately correct. The development process may be incremental but the overall concept requires a shift in the way we think about mechanization for crop production that is based more on plant needs and novel ways of meeting them rather than modifying existing techniques.

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