IFERP

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 9, September 2023

Design and Development of the Multipurpose Agricultural Mobile Bot

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Abstract— ***The agriculture sector in India plays a crucial role in the country's economy, employing a significant portion of the population. However, it faces challenges like low productivity, labor shortages, and climate change. This review paper explores the potential of using robots in Indian agriculture to overcome these issues by improving efficiency, reducing labor costs, and promoting sustainability. The paper highlights various tasks where robots can be utilized, including crop monitoring, planting, harvesting, and pesticide spraying. It acknowledges the benefits of employing robots, such as increased productivity and reduced labor costs, but also identifies challenges like high costs, limited technology access, and the need for skilled operators. The paper suggests that policymakers should support and invest in the adoption of robotic technologies to revolutionize the agriculture sector in India, enhancing its resilience and sustainability.***

Index Terms— ***Robotics, Soil Testing, Economy, Climate change, crop monitoring, labor shortages, Agri bot, seed mapping***

I. INTRODUCTION

The design and development of a multipurpose agriculture robot is a fascinating project that aims to improve the efficiency and productivity of agriculture. This project involves creating a machine that can perform a variety of tasks on the farm, from planting and watering to harvesting and weeding.

The development of a multipurpose agriculture robot requires a combination of engineering, and agriculture expertise. The robot must be able to navigate uneven terrain, detect and avoid obstacles, and accurately perform tasks with precision.

To design and develop a successful multipurpose agriculture robot, it is important to consider factors such as the size and shape of the robot, the types of sensors and actuators needed, the locomotion system required to move the robot, and the control systems necessary to manage its movements and tasks. The Ladybird, a studies product managed by means of the University of Sydney, is a sun powered Robot specialized in monitoring the fields and imparting records. It's far equipped with many Distinctive sensors so that it could construct a very distinct 3-d-map of the farm. For the reason that it is a research Platform, it also has other sensors that the developers think could be useful in destiny precision

Agriculture [1].

Overall, this project has the potential to revolutionize the agriculture industry by improving crop yields, reducing labor costs, and stepping towards sustainability.

The idea of robotic agriculture (agricultural environment serviced by smart machines) is not a new one. Many engineers have developed driverless tractors in the past, but they have not been successful as they did not have the ability to embrace the complexity of the real world. Most of them assumed an industrial style of farming, where everything was known beforehand and the machines could work entirely in predefined ways. The approach nowadays is to develop smarter machines that are intelligent enough to work in an unmodified or semi natural environment. These machines must exhibit sensible behavior in recognized contexts. In this way they should have enough intelligence embedded within themselves to behave sensibly for long periods of time, unattended, in a semi-natural environment. A trend that can assist in the development of more complex machines that meet the needs of the new practice in agricultural area is the Prototyping.

Every farm will then have a swarm of self-driving robots that can work day and night without causing damage to the soil. Before this becomes a reality, there is a wide variety of problems related to safe and robust autonomous operation that need to be solved. For this purpose, mobile research robots are required.

With the system presented in this paper, it is possible to create an array of different all-weather robots using the same basic modules and only basic hand tools. A robot that is configured for working outdoors, driving in wide tractor tracks, can easily be reconfigured to be used in narrow rows inside a greenhouse.

The purpose of this study is to present a mechanical structure to form an Agricultural Mobile Robot, developed with Prototyping, including a CAD model and a finite elements analysis at the normal operating conditions and the worst-case conditions. The Agricultural Mobile Robot can be developed to test different mechanism systems and tools in the field, and should be able to work under field conditions.

In this study, the principal parts that compose the set of the Agricultural Mobile Robot and its functions were described.

II. METHODOLOGY

1. Design of agriculture bot

The design of the bot includes: 1) Frame 2) plough System and 3) Seeding system.

A. Frame Design

Solidwork and fusion360 is used to design the frame and all as shown in Figs(10) with suitable ground clearance for free movement on different terrains. Isometric view of robot chassis is shown Fig(12) respectively. The choices of the materials used in the prototype are based on cost and physical properties. The frame is made with 30X30 square 2mm thick aluminium square pipe, which holds the driver circuits, controller and a battery are mounted on the platform. A motor base plate made up with MS (mild steel) plate of thickness with 10mm. The movement of the entire assembly is enabled by four wheels of 400mm diameter each.

B. Plough System:

Plough tools are typically made of high-strength steel and have a blade-like shape. The design and shape of the tool can vary depending on the type of soil, depth of ploughing, and specific agricultural requirements. The front edge of the plough tool is sharpened to ensure effective cutting and penetration into the soil. It is important for the cutting edge to be sharp to minimize soil disturbance and provide clean furrows. Plough tools are subjected to significant wear and tear due to the abrasive nature of the soil. Therefore, they are often hardened or treated with wear-resistant materials, such as carbide coatings, to prolong their lifespan and maintain cutting performance.

Plough tools are typically detachable and replaceable, allowing for easy maintenance and customization. They are attached to the plough frame using bolts or other fastening mechanisms, enabling quick replacement when necessary.

- *Types of Plough Tools:* There are various types of plough tools designed for specific soil conditions and ploughing purposes.

For example, a moldboard plough uses a curved, concave-shaped ploughshare, while a chisel plough may have a straight, pointed tool. Each type of plough tool has its own advantages and is chosen based on factors like soil type, depth requirements, and the desired level of soil inversion.

C. seeding wheel system:

The seeding wheel with a diameter of 200mm and four holes for seed dropping provides flexibility in seed placement based on the type of seed and the desired distance between seeds. This adjustable seed dropping diameter allows for customization to accommodate different seed sizes and planting requirements. The 200mm diameter of the seeding wheel influences the distance between seeds. As the wheel rotates, the seeds drop through the holes into the soil. The circumference of the wheel determines the spacing between seeds, and a larger diameter generally allows for greater spacing flexibility. The size of the holes in the seeding wheel determines the Diameter of the area through which the seeds are released. This diameter can be adjusted based on the type of seed being planted. Different seeds have varying sizes, and customizing the seed dropping diameter allows for precise seed placement.

The distance between seeds is crucial for optimal crop growth. By adjusting the seed dropping diameter, you can control the spacing between seeds, ensuring proper distribution and avoiding overcrowding. Proper spacing allows each seedling to receive sufficient nutrients, sunlight, and water, promoting healthy growth and reducing competition among plants.

Different crops and seeds have specific requirements for seed spacing. Some crops may require seeds to be placed closer together, while others may need greater spacing. By adjusting the seed dropping diameter, you can tailor the seed placement to match the recommended distance for the specific seed type. It's important to note that the actual seed dropping diameter and the number of holes in the seeding wheel may vary depending on the specific design and model of the agriculture robot. It's always beneficial to consult the manufacturer's guidelines or technical specifications for accurate information on the seeding wheel's capabilities and adjustments.

By incorporating a seeding wheel with adjustable seed dropping diameter and the ability to accommodate different seed types and spacing requirements, this agriculture bot can provide precise and customizable seed placement, contributing to optimal crop establishment and growth.

2. Electrical components and is working

A. Motor Driver Controller

The DC motor driver Controller is an essential component used to control and regulate the operation of a DC motor. In this case, the note will focus on the DC 48V, 500W, 12A and 20000 RPM Brushless Spindle BLDC Motor Driver Controller.

Function and Operation of the DC motor driver controller is specifically designed for brushless DC (BLDC) motors, which offer advantages such as high efficiency, smooth operation, and reduced maintenance. The controller manages the motor's speed, direction, and torque output based on user input or external signals. Voltage and Power Rating of the DC motor driver controller operates at a DC voltage of 48V, aligning with the electrical system of the motor and the power source. The power rating of 500W indicates the maximum power the controller can deliver to the motor, determining the motor's overall performance capabilities. Current Handling of the motor controller is capable of handling a maximum current of 12A, ensuring that it can provide the necessary current to the motor for proper operation. Current control is crucial for preventing overheating and ensuring the motor operates within safe operating limits.

An electric powered motor converts mechanical energy into mechanical energy, and are very versatile. Electric motors may be located with ratings less than 0.5W [02], even as others exceed 100 Megawatts [03]. They may be observed in the whole lot from small toys and watches, to automobiles, trains and factories. The 2 essential types of electric automobiles are powered by means of direct present day or alternate current. Electric powered DC vehicles capacity to run on batteries makes them very appropriate for cell programs. Within the Following clarification, most effective DC motors might be taken into consideration. A DC motor includes two Components, a rotor (the rotating component) and a stator (the stationary element).

Speed Control of the controller allows precise control over the motor's rotational speed. With a maximum speed of 20000 RPM (revolutions per minute), the controller can adjust the motor's speed within this range based on user input or control signals. This feature enables fine-tuning of the motor's speed for different applications. Brushless Spindle BLDC motor compatibility of the motor controller is specifically designed for brushless spindle BLDC motors. These motors are commonly used in applications that require high-speed rotation, such as spindle motors in machining tools, small fans, or other precision equipment. The controller's design and features are optimized for the characteristics and requirements of these types of motors.

Control Modes and Features of the motor controller may offer various control modes and additional features to enhance motor performance. These can include speed control, direction control, braking functions, and protection mechanisms against overcurrent, overvoltage, and over temperature conditions. The specific control modes and features depend on the manufacturer and model of the controller.

Integration and Interface the DC motor driver controller is typically designed for easy integration with the motor and the overall control system. It may feature input and output interfaces for connecting to external devices, such as speed control potentiometers, external switches, or microcontrollers. These interfaces facilitate seamless integration and allow for convenient control of the motor. When selecting a DC motor driver controller for a specific application, it's important to consider the motor's specifications, the desired control features, and the compatibility with the overall system. Proper matching of the motor and controller ensures optimal performance and reliable operation of the motorized system. Always refer to the manufacturer's documentation and guidelines for accurate information regarding the specific DC Motor Driver Controller model being used.

Figure 01: motor driver controller

B. (BLDC) Motor System

A motor system is a complex arrangement of components that work together to convert electrical energy into mechanical motion. Motors are used in a wide range of applications. The core component of the 1418ZXF motor is a brushless DC (BLDC) geared motor specially engineered for e-bikes, offering a power output of 500W and a rated speed of 450 RPM. It operates on a 48V electrical system, which is a common voltage used in e-bike applications.

Key features and characteristics of the 1418ZXF motor is a power rating of 500W, this motor provides ample power for acceleration and maintaining higher speeds. The rated speed of 450 RPM indicates the rotational speed of the motor under normal operating conditions. The 1418ZXF motor operates on a 48V electrical system, which is commonly used in e-bikes. This voltage range ensures compatibility with e-bike battery packs designed for 48V operation.

The motor is described as a premium quality product, suggesting that it meets high manufacturing and performance standards. Premium quality motors often feature robust construction, reliable components, and optimized design for superior performance and durability.

Being a brushless motor, it eliminates the need for brushes and a commutator, resulting in reduced maintenance requirements and increased motor lifespan. The absence of brushes also enhances efficiency and minimizes electromagnetic interference.

Motors require a suitable 48V DC power supply to provide the electrical energy needed for operation. In motor systems, a motor controller manages and regulates the electrical input to the motor, controlling factors such as speed, torque, and direction, ensuring precise and efficient motor performance.

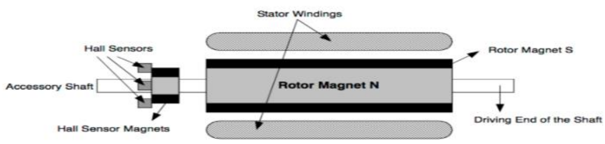


Figure 02: Cross section of a three-phase BLDC motor
Image: Microchip [07]

Maximum 3-segment automobiles have 3 stator windings linked in famous person fashion, and each of them are allotted over the stator periphery to form an even quantity of poles. The stator windings ought to be energized in the right series for the motor to rotate, and therefore, the stator position has to be recognised at all time. By embedding Hall Effect sensors into the stator, the Function may be mapped. Every time a magnetic pole passer near a hall sensor, they provide a high (N) or low (S) signal, indicating which pole is passing. The collection of commutation is decided by using 3 hall sensors with a segment shift of 60degree or 120degree to each other. To get this alignment accurate may be hard, and some vehicles have committed hall impact magnets on the rotor to simplify this process.

For additional information about the BLDC motor, see references: [07], [08].

Sensors are often integrated into motor systems to provide feedback on parameters such as speed, position, temperature, and current. These sensors allow the motor controller to monitor and regulate the motor's operation, optimizing performance, and providing protection against faults or abnormal conditions.

The motor system interacts with a mechanical load, which can be anything the motor is intended to move or power, such as a conveyor belt, pump, fan, or robotic arm. The load determines the mechanical requirements, including torque, speed, and power output, placed on the motor system.

Figure 03: BLDC Motor

C. Battery System

The 48V rating refers to the nominal voltage of the Lithium-Ion battery, indicating the electrical potential difference across its terminals. The 3 kWh capacities signify the energy storage capability, measuring the amount of energy the battery can store and deliver over time. Together, these specifications make the battery suitable for powering in bot.

Li-ion batteries offer advantages such as high energy density, lightweight construction, and longer cycle life. These characteristics make them ideal for compact and portable electric vehicles like this bot. Energy Storage with a 3 kWh capacity, the battery can store a significant amount of electrical energy. This capacity determines the range an bot can travel on a single charge. A higher-capacity battery, such as one with a 3 kWh rating, typically provides a longer range, allowing for extended trips or multiple commutes between charges. Voltage Compatibility the 48V rating of the battery aligns with the electrical system of bot designed to operate at this voltage. The compatibility ensures efficient power delivery and compatibility with the motor controller, electrical components, and charging infrastructure.

Lithium-ion batteries used in bot often incorporate built-in safety features, including protection circuits and thermal management systems to ensure safe and reliable operation. It's important to follow manufacturer guidelines for battery usage, charging, and maintenance to maximize safety and longevity. The 48V and 3 kWh 2 DC battery plays a vital role in powering in this bot, providing the necessary energy for propulsion and electrical system operation. The combination of a 48V electrical system and a 3 kWh capacity offers a balance between performance, range, and practicality, making it suitable for various bot applications.

Figure 04: Battery

III. SELECTION OF MATERIAL AND CALCULATION

A. Selection of Material

The selection of materials plays a crucial role in manufacturing and design. Choosing the right materials for a specific application involves considering several factors, including the desired properties, functionality, cost, availability, and environmental impact. here are some key points to note when it comes to the selection of materials desired properties, material compatibility, strength and stiffness, cost and availability, manufacturing and processing, environmental impact.

Property	HSS	DCI
Young's modulus/GPa	233	173
Poisson's ratio	0.3	0.3
Density/kg m^{-3}	7600	7300
Thermal expansion coefficient/K^{-1}	12.6×10^{-6}	13.0×10^{-6}
Thermal conductivity/W $(m\ K)^{-1}$	20.2	23.4
Specific heat/J $(kg\ K)^{-1}$	461	460
Tensile strength/MPa	1280	415

Figure 05: Mechanical and thermal properties of the HSS work roll at room temperature [9].

Materials are substances or compounds that are used to create various objects, structures, and products. They are the fundamental building blocks of everything around us and play a crucial role in shaping our modern structure. The study of materials is a multidisciplinary field that encompasses aspects of physics, chemistry, engineering, and materials science. Materials can be classified into several categories based on their properties and characteristics. Some common classifications include metals, composites, and semiconductors. Each material category possesses unique properties that make them suitable for specific applications.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 9, September 2023

Blank material	DC04
Yield strength	188,9 N/mm2
Tensile strength	298,4 N/mm2
Elastic module	210000 N/mm2
Strength coefficient	384,98 N/mm2
Hardening exponent	0,21
Coefficient of anisotropy	1,78

Figure 06: Material properties of sheet metal [6].

We used metals such as iron, aluminum Polymers and steel are known for their strength, conductivity, and malleability. They offer improved strength, durability, and specific charactasueristics tailored for specific applications.

The development and advancement of materials have significantly contributed to technological progress and innovation across various applications to meet evolving needs and address challenges related to sustainability, energy efficiency, and environmental impact.

Aluminium grade	$f_{0.2}$ [MPa]	f_u [MPa]	E [GPa]	$f_{0.2}/f_u$	n
5052-H36	211.6	257.8	64.2	0.82	-
6061-T6	234.0	248.0	66.0	0.94	12
6063-T5	179.0	220.0	69.0	0.81	10
6082-T4	120.1	221.0	66.9	0.54	26
6082-T6	312.2	324.2	66.7	0.96	74
7108-T7	314.0	333.4	66.9	0.94	65

Figure 07: mechanical property of aluminum alloys [5].

B. calculation:

Bending Moment: The bending moment represents the internal forces experienced by a structural element when subjected to external loads. By calculating the bending moment, we can determine the maximum stresses induced in the aluminium square hollow bar.

The bending moment (M) can be calculated using the formula:

σ = (M * d)/I

- Where: M is the Maximum bending moment (let's assume maximum bending …
- moment for aluminium is 100Nm
- d is the distance from the neutral axis to the point of interest
- I the moment of inertia.

Moment of Inertia: The moment of inertia characterizes an object's resistance to changes in its rotational motion. For a square hollow bar, the moment of inertia depends on the dimensions of the cross-section.

The moment of inertia (I) can be calculated using the formula:

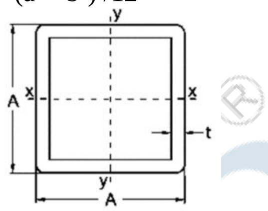
I = (a^4 - b^4) / 12

Where:

- I is the moment of inertia,
- a is the outer side length of the square hollow bar
- b is the inner side length of the square hollow bar.

The moment of inertia (I) can be calculated using the formula:

$I = (a^4 - b^4) /12$



- *For 30MM*

$$I=\frac{0.03\text{^}4X0.026\text{^}4}{12}$$
$$= 3.084X\mathbf{10^{-14}M^4}$$

- *For 33MM*

$$I=\frac{0.033\text{^}4X0.029\text{^}4}{12}$$
$$= 6.9898X\mathbf{10^{-14}M^4}$$

The bending moment (M) can be calculated using the formula: σ = (M * d)/I

- *For 30MM*

$$\sigma = \frac{100X0.015}{3.084X10^{-14}}$$

$$=48.638X\mathbf{10^{12}N/M^2}$$

- *For 33MM*

$$\sigma = \frac{100X0.0165}{6.9898X10^{-14}}$$

$$=23.6058X\mathbf{10^{12}N/M^2}$$

[Note: 33MM have good bending strength so we selected this one]

Calculation to be carries to find torque and selection of motor:

$\boldsymbol{\tau = W * r}$

Where:
τ = Torque (in Newton-meters, Nm)
W = Weight of the load (in Newton's, N)
r = Radius of the wheel (in meters, m)

Data:

- Load to be carry: 400kg (3924N)
- r: 200mm= (0.2m)
- no of motor used= 04NOS

Solution:
W=3924/4
=981N

τ = W * r

τ = 981X0.2
τ =192.2Nm

[Note: *Required torque is 192.2Nm
*Selected motor torque is 1000.62Kg-m. (5 time extra torque)]

IV. TESTING AND RESULTS

Testing involves conducting experiments or field trials to evaluate the performance of the plough tool under various conditions. This could include testing different soil types, moisture levels, and operating speeds to assess the tool's effectiveness in cutting, soil penetration, and turning.

During testing, relevant parameters are measured and data is collected. This may include the force required for soil penetration, depth of cut, soil disturbance, and energy consumption. Accurate and consistent measurement techniques are employed to ensure reliable data collection.

Once data is collected, it is processed and analyzed using appropriate calculation methods. This may involve statistical analysis, regression analysis, or other mathematical techniques to extract meaningful insights and quantify the performance of the plough tool.

The calculated results are then compared to predefined benchmarks or performance criteria. This allows for an evaluation of the plough tool's efficiency, effectiveness, and suitability for specific agricultural tasks. The comparison may involve analyzing data from different plough tools or variations in the design of the same tool. Based on the results and evaluation, modifications or adjustments can be made to the plough tool design or operating parameters to optimize its performance. This iterative process helps refine the tool and enhance its capabilities for better soil cultivation.

The testing, calculation, and results are documented in report, which includes details of the testing methodology, measurement techniques, data collected, calculations performed, and the final analysis. This report serves as a valuable reference for future studies, equipment manufacturers, and agricultural practitioners.

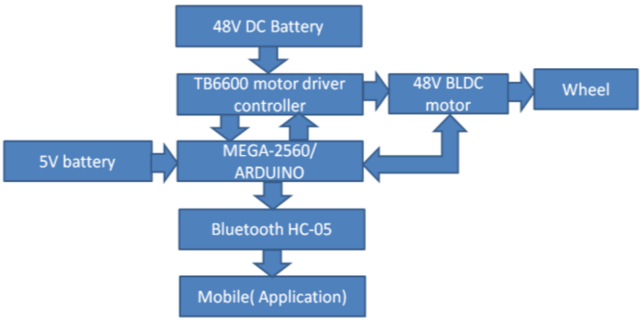


Figure 09: working Flow chart

Simulation: Simulation is an essential aspect of the project model as it allows for the testing and evaluation of various scenarios in a controlled virtual environment.

By simulating the project, we can gain valuable insights into its performance, identify potential risks, and optimize the project's design and implementation. During the simulation, multiple variables and parameters can be adjusted and tested to understand their impact on the project's outcomes. This helps in making informed decisions and mitigating potential issues before the actual implementation phase. Simulation also enables us to assess the project's feasibility, estimate resource requirements, and predict the project's timeline and cost. By running simulations with different assumptions and conditions, we can identify bottlenecks, optimize processes, and enhance overall project efficiency.

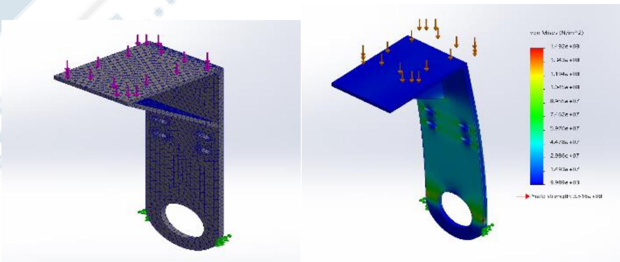
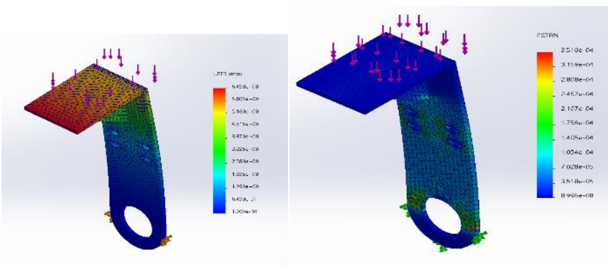


Figure 08(a): Motor support mesh (b): Motor support stress analysis



(c): Motor support displacement (d): Motor support strain

The simulation conducted on the motor support rest using SolidWorks software provided valuable insights into its structural behavior. The analysis revealed that the von Mises stress values ranged from 1.492e+08 N/m to 9.989e+03 N/m^2, well below the yield strength of the material at 3.516e+08 N/m^2. This indicates that the motor support rest is operating within acceptable stress limits and should be able to withstand applied loads without significant deformation or failure. Additionally, the strain values ranged from 3.510e-04 to 8.996e-08, indicating the extent of deformation experienced by the component. The displacement values ranged from 1.000e-30 mm to 6.450e+00 mm, representing the magnitude of movement or deformation in the motor support rest. Overall, based on the simulation results, the motor support rest appears to be structurally sound and capable of adequately supporting the motor. However, it is crucial to consider other factors, consult experts, and adhere to design specifications and safety factors to ensure a comprehensive assessment of the component's performance

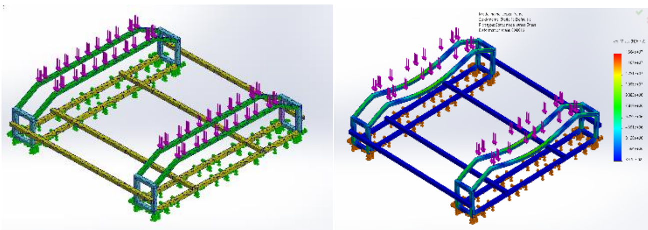
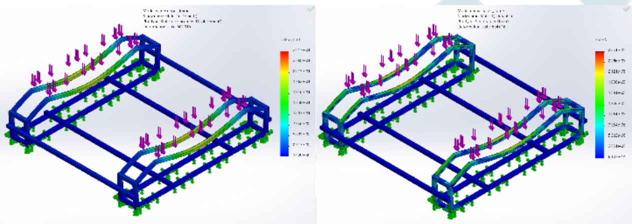


Fig 10(a): Frame mesh (b): Frame stress analysis



(c): Frame displacement (d): Frame strain analysis

The analysis conducted on the frame of the model using SolidWorks software provided insights into its structural behavior. The von Mises stress values ranged from 1.546e+07 N/m^2 to 3.470e-02 N/m^2, and the strain values ranged from 2.651e-05 to 6.107e-14. These results indicate a wide range of stress and strain distribution throughout the frame. Additionally, the displacement values ranged from 2.517e-01 mm to 1.000e-30 mm, suggesting varying degrees of movement within the structure. However, a comprehensive assessment of the frame's safety requires comparing these values with the material's limits, design requirements, and safety factors. Consultation with a mechanical engineer or a qualified professional is recommended to ensure a thorough evaluation of the frame's structural integrity and to make informed decisions regarding any necessary design modifications.

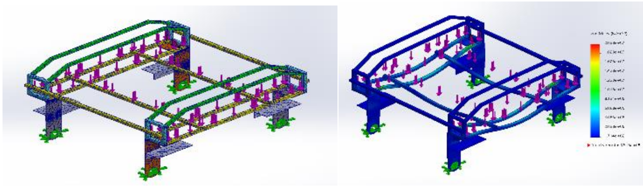
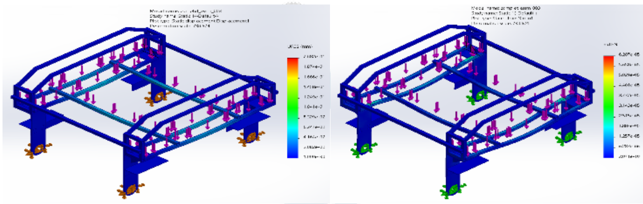


Fig 11(a): Frame & Motor support mesh (b) Frame & Motor support stress



(c) Displacement analysis (d) Frame & Motor support strain

The analysis conducted on the assembly of the frame and motor support revealed valuable information about its structural behavior. The von Mises stress values ranged from a minimum of 1.714e+02 N/m^2 to a maximum of 2.033e+07 N/m^2, indicating varying stress concentrations within the assembly. The strain values ranged from a minimum of 2.071e-10 to a maximum of 6.207e-05, representing different levels of deformation or elongation. Additionally, the displacement values ranged from a minimum of 1.000e-30 mm (effectively zero) to a maximum of 2.082e-01 mm, indicating negligible or measurable movement in the assembly, respectively. While the stress and strain values should be evaluated against design limits and material properties, the displacement values suggest that certain locations within the assembly experienced minor movement. To ensure the structural integrity and safety of the assembly, it is recommended to consult with a qualified professional who can comprehensively review the analysis results, consider additional factors, and make informed decisions regarding design modifications or necessary adjustments to meet the required specifications and safety standards.

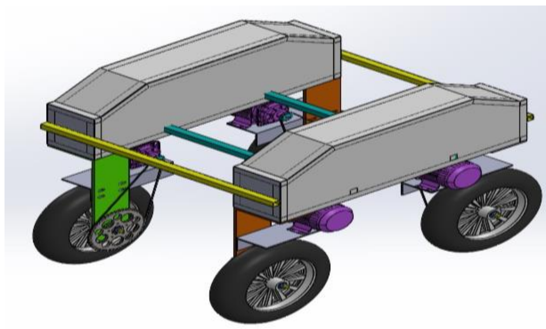


Figure 12: agricultural robot Isometric view

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 10, Issue 9, September 2023

Sl/no	Specifications	
01	**Height**	1200mm
02	Length	1500mm
03	Width	1400mm
05	Wight	102KG
06	Load carry capacity	450kg(4415N)
07	Power sour ce	48V dc battery(2nos)
08	No of Motors used	4Nos
09	Wheel diameter	400mm

Costing

Sl/No	Name/item	Single price	Qty	Total
01	Motor	4758	04	19,032.
02	Controller	8873	04	35,492.
03	Battery	20000	02	40,000.
04	Electronics	--	--	10,000.
05	Materials	--	--	70,000.
06	Manufacturing	--	--	1,35,000.
07	Others	--	--	50,000.
	TOTAL COST(Two testing model included)			3,59,524.000

B. Results:

A multipurpose agriculture robot successfully completed two lab prototypes and a final field test. The robot demonstrated accurate performance in seeding, plough, spring pesticide, and autonomous performance. The field test evaluated its adaptability to real-world conditions. The project adhered to safety protocols and ethical considerations. Overall, the project's milestones mark significant progress in developing an efficient agricultural robot, with the potential to revolutionize farming practices and enhance productivity in the agriculture industry.

V. CONCLUSION

An attempt has been made to develop a Bluetooth operated agricultural robot which performs ploughing, seeding, and spraying pesticide. The proposed system is battery operated and controlled by Bluetooth device. Using this robot, farmer can carry out other secondary activity along with operating the robot. By carrying out multiple activities at the same time, farmer can increase his income.

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