THE DEVELOPMENT OF A FULLY AUTOMATED KITCHEN ROBOT AT DREAMBOT

An Internship report submitted in partial fulfilment of requirements for the award of degree of

Bachelor of Technology in

Mechanical Engineering (Robotics)

by

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CERTIFICATE

This is to certify that the Internship -II report titled

“ The Development of a Fully Automated Kitchen Robot at DreamBot’’

Is a bonafide record of the Internship work submitted by

CHINTA NSR SHANMUKHA TEJA
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In their VII Semester in partial fulfilment of the requirements for the Award of Degree

Bachelor of Technology in MECHANICAL ENGINEERING(ROBOTICS)
of the
Gayatri Vidya Parishad College of Engineering (Autonomous)
Affiliated to JNTU Kakinada, during the year
2024-2025

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dreambot

CERTIFICATE

OF INTERNSHIP

THIS CERTIFICATE IS PROUDLY PRESENTED TO

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Who has completed two months of internship at Dreambot Pvt Ltd
AHUB, AU, Visakhapatnam,Andhra Pradesh - 530003
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ABSTRACT

The internship was conducted at DreamBot, focusing on the development of a fully automated kitchen robot. This internship spanned two months and involved extensive hands-on experience in the design, simulation, and optimization of robotic systems.

During the internship, the primary project revolved around enhancing the functionalities and efficiency of a kitchen robot. This included the development of multitasking capabilities such as chopping vegetables, cooking meals, and washing utensils autonomously. Advanced AI techniques were employed to enable the robot to operate without human supervision, manage ingredient measurements, and schedule cleaning routines intelligently.

The project also entailed significant design innovations, including the incorporation of robust frames with dispensers for ingredients and spices, ergonomic enhancements, and improved cleaning systems. Various software tools such as RoboAnalyzer, CATIA V5, and ANSYS were utilized to simulate, analyze, and optimize the robot's design and performance. Specific tasks included kinematic and dynamic analysis, forward and inverse kinematics, workspace analysis, and structural integrity studies.

Key achievements of the internship include the successful reduction of the robot's frame thickness while maintaining structural integrity, the redesign of the XY carriage to improve efficiency and performance, and the comprehensive analysis of the PUMA robot using RoboAnalyzer for better design optimization.

Overall, this internship provided a valuable learning experience in the field of robotic process automation, enabling the development of a sophisticated kitchen robot that can significantly simplify and automate various kitchen tasks, making it a versatile solution for residential and commercial applications

Contents	INDEX	PageNo.

Contents	INDEX	PageNo.

CHAPTER-6

CHAPTER – 1
ROBO ANALYZER

1.1 Introduction

RoboAnalyzer is a sophisticated robotic simulation software designed to help users understand the kinematics and dynamics of robotic systems through intuitive and interactive simulations. It is particularly valuable in educational contexts, aiding students and researchers in visualizing and analyzing complex robotic mechanisms.

1.2 Key Features

1. 3D Visualization:-

RoboAnalyzer provides detailed 3D visualizations, allowing users to observe robotic configurations and movements in a three-dimensional space.

2. Kinematics Analysis:-

The software supports forward and inverse kinematics, enabling calculations of the robot's end-effector position and joint parameters.

3. Dynamic Analysis:-

Users can perform dynamic analyses to study the forces and torques in robotic movements.

4. User-Friendly Interface:-

The interface is designed for ease of use, making it accessible to users without extensive prior experience. Users can easily input parameters, modify robot designs, and run simulations without extensive prior experience.

5. Educational Modules:-

Educational modules offer tutorials and examples, facilitating step-by-step learning for students.

6. Support for Various Robots:-

RoboAnalyzer supports serial, parallel, and mobile robots, making it versatile for different applications.

7. MATLAB Integration:-

The software integrates with MATLAB, allowing for advanced analyses and custom scripting.

1.3 Applications

1. Academic Research:-

Used for simulating and analyzing robotic systems, aiding in the development of new designs and testing hypotheses.

2. Education:-

Enhances learning by making complex concepts more engaging and understandable through interactive simulations.

3. Industrial Design:-

Helps engineers design and optimize robotic systems, identifying potential issues in a virtual environment before physical prototypes are created.

FIG.1.1 Robo Analyzer

1.4 Implications

RoboAnalyzer stands out as an indispensable tool for robotics education, research, and industrial design. Its extensive features and user-friendly interface provide significant value to students, researchers, and engineers, enabling them to visualize, analyze, and optimize robotic systems with remarkable efficiency.

CHAPTER – 2
CATIA V5 SOFTWARE

2.1 Introduction

CATIA V5 (Computer-Aided Three-Dimensional Interactive Application) is a comprehensive CAD software suite developed by Dassault Systemes, widely used for product design, engineering, and manufacturing.

2.2 Key Features

1. Advanced 3D Modeling:-

Provides powerful tools for creating precise 3D models, suitable for complex geometries and assemblies.

2. Integrated Product Lifecycle Management (PLM) :-

Supports efficient management of the entire product lifecycle, from conception to production.

3. Surface Design and Styling:-

Offers advanced capabilities for creating high-quality surfaces, crucial for industries focused on design aesthetics.

4. Simulation and Analysis:-

Includes robust tools for testing designs under real-world conditions, optimizing them before production.

5. Parametric Design:-

Allows for models based on parameters, enabling easy modifications and updates.

6. Collaboration Tools :-

Facilitates collaborative design with multiple users working on the same project simultaneously. This fosters teamwork and streamlines the design process.

2.3 Applications

1. Automotive Industry:-

Used for designing vehicle components and assemblies, aiding in innovative automotive designs.

2. Aerospace Industry:-

Essential for designing aircraft structures and components, meeting stringent aerospace requirements.

3. Industrial Machinery:-

Utilized for creating detailed designs and ensuring product functionality and durability.

4. Consumer Goods:-

Helps in designing functional and aesthetically pleasing consumer products.

FIG.2.1 CATIA V5

2.4 Summary

CATIA V5 is a versatile CAD software suite that supports advanced 3D modeling, PLM integration, surface design, and simulation. It is essential for industries like automotive, aerospace, industrial machinery, and consumer goods, helping engineers and designers create innovative, efficient, and high-quality products

CHAPTER – 3
ANSYS SOFTWARE

3.1 Introduction

ANSYS Static Structural is a specialized tool for performing static structural analysis, widely used in engineering to ensure the safety and reliability of structures under various static loads.

3.2 Key Features

1. Linear and Nonlinear Analysis:-

Supports analysis of structures under different loading conditions and material behaviors.

2. Comprehensive Material Models:-

Includes models for metals, plastics, composites, and hyperelastic materials.

3. Load and Boundary Conditions:-

Allows application of forces, pressures, and supports to simulate real-world scenarios.

4. Advanced Meshing Capabilities:-

Provides high-quality meshing tools for accurate results and efficient computation.

5. Result Visualization:-

The software provides powerful visualization tools to interpret analysis results, including stress, strain, and deformation distributions, making it easier to identify potential issues.

6. Integration with ANSYS Tools:-

Seamlessly integrates with other ANSYS products for multiphysics simulations.

3.3 Applications

1. Aerospace:-

Used for analyzing aircraft components to ensure structural integrity and performance under various static loads.

2. Automotive:-

Helps in the design and analysis of vehicle parts, ensuring they can withstand operational stresses and impacts.

3. Civil Engineering:-

Employed in the analysis of buildings, bridges, and other structures to ensure they meet safety and performance standards.

4. Industrial Machinery:-

Utilized for evaluating the strength and durability of machinery components under static loads.

FIG.3.1 ANSYS Software

3.4 Overview

ANSYS Static Structural is a powerful tool for static structural analysis, offering robust features for linear and nonlinear analysis, comprehensive material models, and advanced meshing capabilities. Its applications span across aerospace, automotive, civil engineering, and industrial machinery, making it an essential tool for ensuring the safety, reliability, and performance of structural designs.

CHAPTER–4
PROJECT- K
(Kitchen Robot)

4.1 Introduction

DreamBot is revolutionizing home kitchens with its advanced kitchen robot, designed to handle multiple tasks, making cooking more efficient and hassle-free.

4.2 Key Features

1. Multitasking Capabilities:-

The robot chops vegetables, cooks meals, and washes utensils, streamlining the entire kitchen process.

2. Advanced AI:-

Incorporating sophisticated AI, the robot operates without human supervision, managing cooking, ingredient measurements, and cleaning schedules intelligently.

3. Automated Cooking and Chopping:-

Automates preparation, ensuring precision and consistency in meals, reducing human error and saving time.

4. Utensil Washing:-

Efficiently washes utensils after cooking, completing the kitchen cycle.

5. Intelligent Movement:-

Navigates the kitchen autonomously, performing tasks seamlessly.

4.3 Design Innovations

1. Robust Frame with Dispensers:-

Features dispensers for ingredients and spices, ensuring all components are readily available during cooking.

2. Design Modifications:-

Includes ergonomic enhancements, improved dispensers, and robust cleaning systems for better functionality.

4.4 Applications

1. Residential Kitchens:-

Simplifies meal preparation and kitchen cleaning for busy households.

2. Commercial Use:-

Suitable for small restaurants and catering services, ensuring consistent quality and reducing labor costs.

3. Assistance for Elderly and Disabled:-

Offers significant help, providing greater independence in daily cooking activities.

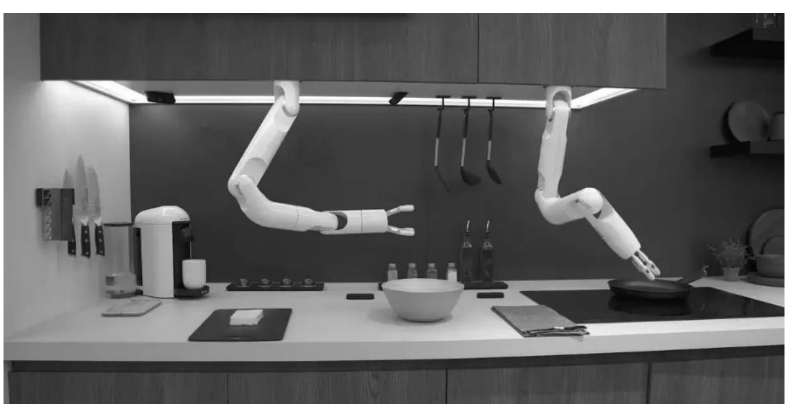


FIG.4.1 Kitchen Robot

CHAPTER–5
PUMA Robot Analysis with RoboAnalyzer

5.1 Introduction

We used RoboAnalyzer software to study the Denavit-Hartenberg (DH) parameters, forward and inverse kinematics, and the workspace of a PUMA robot. This analysis helped us optimize the robot's design and functionality.

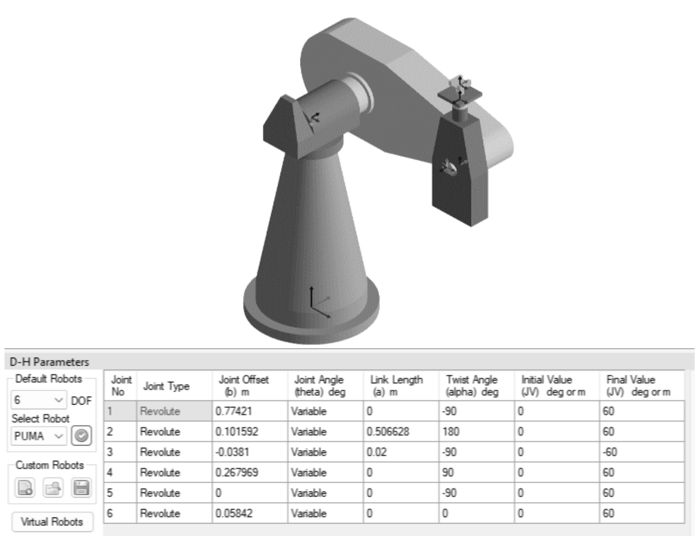
5.2 Understanding DH Parameters

RoboAnalyzer helped us define and visualize the DH parameters for the PUMA robot:

1. **Link Lengths and Angles:-**
   Precisely defined the link lengths and joint angles.

2. Coordinate Frames:-

Set up coordinate frames for each link, providing an accurate geometric model.



Joint No	Joint Type	Joint Offset (b) m	Joint Angle (theta) deg	Link Length (a) m	Twist Angle (alpha) deg	Initial Value (JV) deg or m	Final Value (JV) deg or m
1	Revolute	0.77421	Variable	0	-90	0	60
2	Revolute	0.101592	Variable	0.506628	180	0	60
3	Revolute	-0.0381	Variable	0.02	-90	0	-60
4	Revolute	0.267969	Variable	0	90	0	60
5	Revolute	0	Variable	0	-90	0	60
6	Revolute	0.05842	Variable	0	0	0	60

FIG.5.1 D-H Parameters for the PUMA robot

5.3 Forward Kinematics

Forward kinematics involves calculating the end-effector's position and orientation from joint parameters:

1. Position Calculation:-

Computed the end-effector's exact position in 3D space.

2. Orientation Analysis:-

Determined the end-effector's orientation to ensure accurate target reach.

5.4 Inverse Kinematics

Inverse kinematics involves finding joint parameters for a specific end-effector position and orientation:

1. Target Positioning:-

Calculated necessary joint angles to achieve the desired position and orientation.

2. Path Planning:-

Planned smooth and efficient movements to reach target positions.

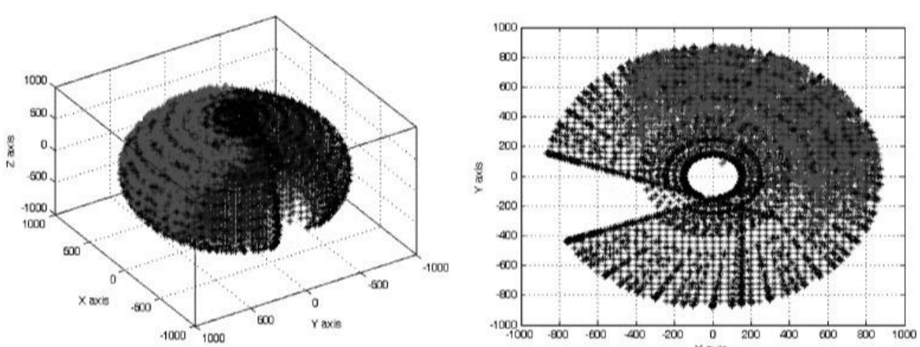


FIG.5.2 Workspace of the PUMA robot

5.5 Workspace Analysis

Studying the robot's workspace to understand its reach and operational limits:

1. Reachable Area:-
Visualized the robot's maximum reach and accessible areas.

2. Operational Limits:-
Identified the operational limits for optimal performance.

5.6 Robot Design Study

Examined and refined the robot's design using RoboAnalyzer:

1. Structural Integrity:-
Simulated and analyzed the robot under various loads.

2. Performance Optimization:-
Adjusted the design to enhance reliability and efficiency.

CHAPTER–6

Optimizing Structural Integrity: A Study on Thickness Variation in Robot Frame Design

6.1 Design Exploration

This report details the design exploration process for a custom frame utilizing hollow rectangular bars. The primary objective was to optimize material usage and cost while ensuring the frame's ability to withstand specific loads.

6.2 Design Iteration 1: 6mm Thickness

1. The initial design employed hollow rectangular bars with a uniform thickness of 6mm throughout the entire frame.
2. This design prioritized strength and structural integrity, offering a high load-bearing capacity.
3. However, the use of a constant 6mm thickness might lead to:
   1. Increased material cost.
   2. Unnecessary weight, potentially impacting performance or requiring a more robust foundation.

6.3 Design Iterations 2-4: Exploring Thickness

To achieve a balance between strength and material efficiency, three additional design iterations were explored:

1. **Iteration 1:** Hollow bars with a thickness of 4mm were implemented.
2. **Iteration 2:** Hollow bars with a thickness of 3mm were assessed.
3. **Iteration 3:** Hollow bars with a thickness of 2mm were evaluated.

I have first reduced the vertical bars supporting the robot by using Catia v5 software I have managed to redesign the bars with thickness of 2mm, 3mm, 4mm then I have also redesigned the vertical bars supporting the dispenser and the above bars.

Then I designed the vertical bars, I designed the upper bars as well which were attached to the dispenser.After designing bars, I have designed the clamps to the required sizes, then I have also re designed the angles and the supports also after all designing processes are completed then assembly operation is done for the frame r all three thicknesses.

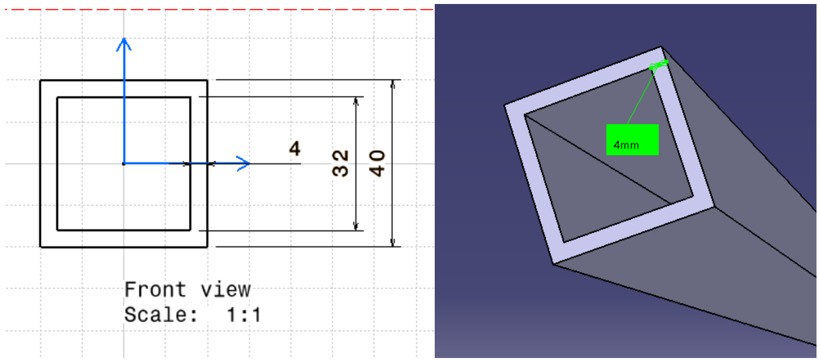


FIG.6.1 4mm Thickness

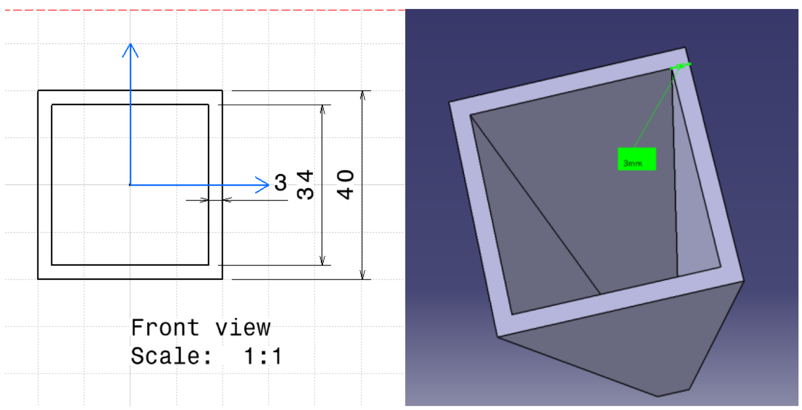


FIG.6.2 4mm Thickness

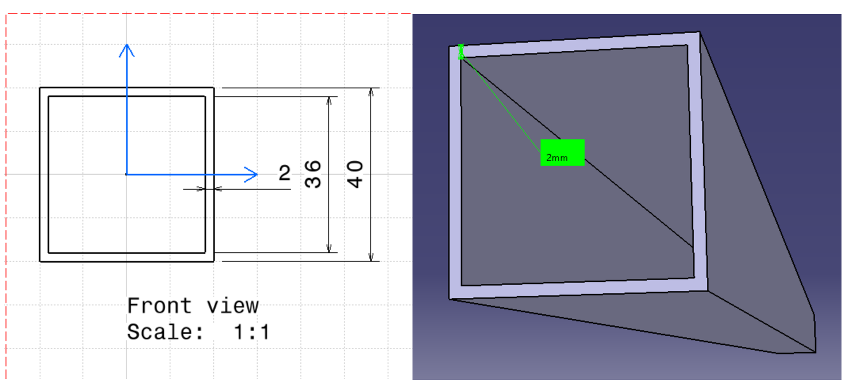


FIG.6.3 4mm Thickness

6.4 Strength Analysis

Following the design exploration, a strength analysis was conducted for each iteration (6mm, 4mm, 3mm, and 2mm thicknesses).

6.5 Analysis Method

By using structural analysis in ANSYS software I have managed to obtain total deformation, maximum principal stress, maximum principal strain, normal stress for all three thicknesses

6.6 Analysis Results

1. The analysis evaluated the stress distribution within the frame for each hollow bar thickness under the specified loads.

2. Critical locations experiencing the highest stress were identified.

3. The calculated stresses were compared to the material's yield strength to determine the frame's load-bearing capacity for each thickness.

4. The total deformation, maximum principal stress, maximum principal strain, normal stress for the three thicknesses were identified

6.7 Key Findings

The analysis revealed that all four design iterations (6mm, 4mm, 3mm, and 2mm) successfully withstood the applied loads without exceeding the material's yield strength.

6.8 Selection of Optimal Design

Based on the analysis results, the most suitable design iteration (thickness selection) can be chosen. This decision will likely involve a trade-off between:

1. **Material usage and cost:** Thinner bars (4mm, 3mm, or 2mm) will lead to material savings.
2. **Weight reduction:** Thinner bars contribute to a lighter frame, potentially improving performance or reducing foundation requirements.

3. **Safety factor:** A thicker bar (closer to 6mm) might offer a higher safety factor for critical applications.

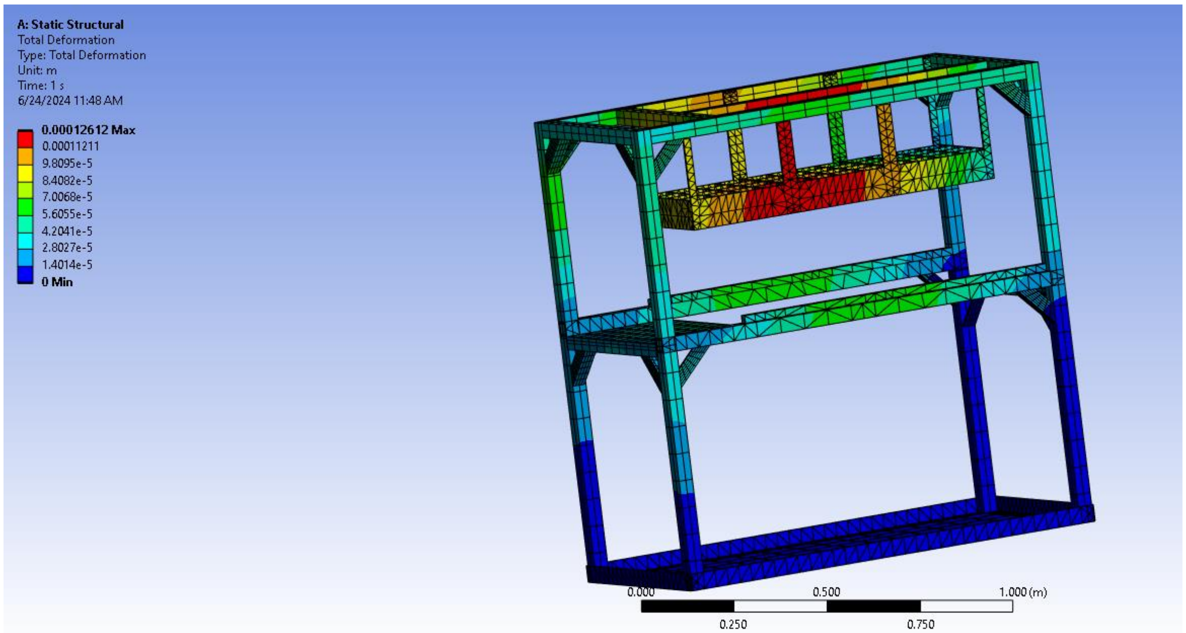


FIG.6.4 Frame ANSYS Analysis

Results	
Minimum	0. m
Maximum	1.9212e-004 m
Average	8.1e-005 m
Minimum Occurs On	Base Angel|PartBody
Maximum Occurs On	frame|PartBody[2]

FIG.6.5 Total Deformation Of Frame

S.NO	Material Type	Thickness	Total Deformation	Maximum Principal Stress
1	**Aluminium alloy**	6MM	0.38472mm	2.0965e7 pa
2	**Structural steel**	6MM	0.13637mm	2.0911e7 pa
3	**Aluminium alloy**	4MM	0.45414mm	2.3152epa
4	**Structural steel**	4MM	0.16098mm	2.3153epa
5	**Aluminium alloy**	3MM	0.52752mm	2.5867epa
6	**Structural steel**	3MM	0.18701mm	25874epa
7	**Aluminium alloy**	2MM	1.1996mm	3.7034epa
8	**Structural steel**	2MM	0.42323mm	3.6984e pa

TABLE.6.1 Frame Analysis Results

6.9 Material and Cost Optimization

By exploring design iterations with varying hollow bar thicknesses (6mm, 4mm, 3mm, and 2mm), this process achieved significant material and cost optimization while maintaining the frame's structural integrity.

CHAPTER–7
Design Modifications of XY Carriage of the Robot

7.1 Introduction

In our project, we focused on reducing the height of the XY carriage of the robot to improve its efficiency and performance. The initial height of the XY carriage was 260 mm, which we successfully reduced to 197 mm through several design modifications.

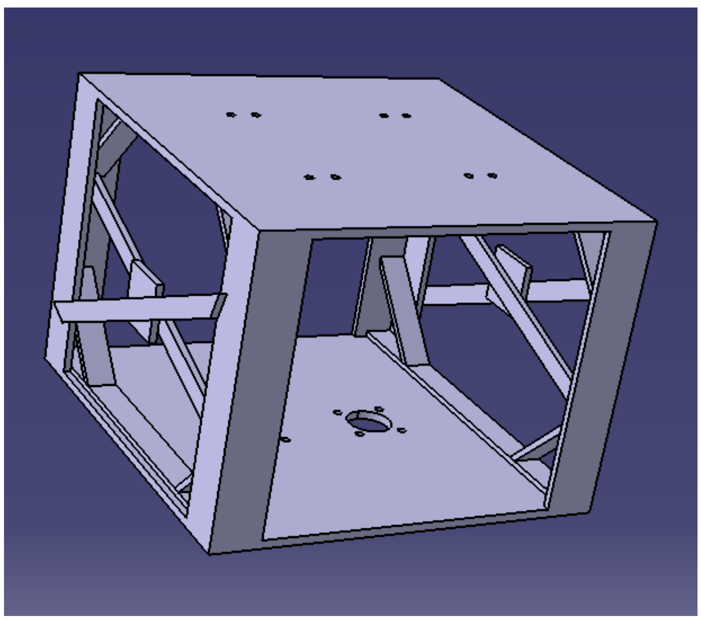


FIG.7.1 Frame XY carrage

7.2 Height Reduction Process

To achieve the reduction in height, we implemented the following changes:

1. Removal of 40 mm Bars:-

We removed the 40 mm bars that were initially part of the carriage structure. This significant change contributed to the overall height reduction.

2. Decreasing the Gap Between Motor and Rails:-

We reduced the gap between the motor and the rails by 20 mm. This adjustment not only lowered the height but also improved the compactness of the design.

3. Reducing the Thickness of Clamps:-

The thickness of the clamps was decreased by 2 mm. This reduction streamlined the structure without compromising the stability and strength of the carriage.

4. Adjusting Bearings:-

We decreased the thickness of the bearings by 3 mm. This modification helped in achieving the desired height while maintaining the functional integrity of the bearings.

7.3 Design Modifications

1. Overall Structural Redesign:-

The entire XY carriage was redesigned to accommodate the height reduction. This redesign ensured that all components fit perfectly within the new dimensions while maintaining functionality.

2. Optimization of Space:-

By removing unnecessary elements and optimizing the space between components, we achieved a more efficient design. The new configuration allows for smoother and more precise movements of the XY carriage.

3. Material Efficiency:-

The reduction in thickness of various parts led to a more material-efficient design. This not only reduced the weight but also contributed to cost savings in manufacturing.

7.4 Benefits of the Redesign

1. Improved Performance:-

The reduced height of the XY carriage resulted in a lower center of gravity, enhancing the stability and performance of the robot.

2. Compact Design:-

The overall size of the robot is now more compact, making it suitable for a wider range of applications, especially in environments where space is limited.

3. Enhanced Precision:-

The modifications allowed for better alignment and positioning of components, leading to increased precision in the robot's movements.

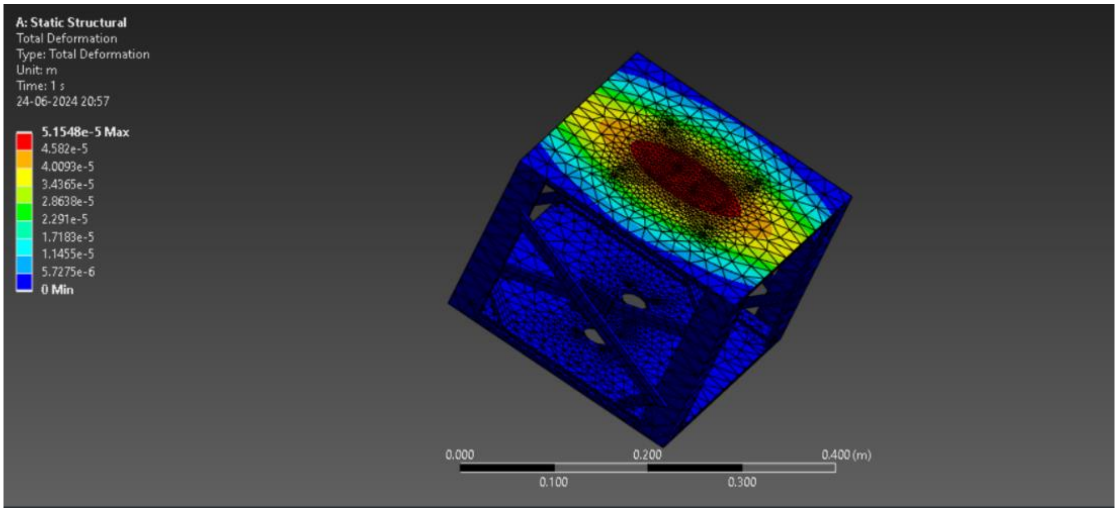


FIG.7.2 Carriage Total Deformation

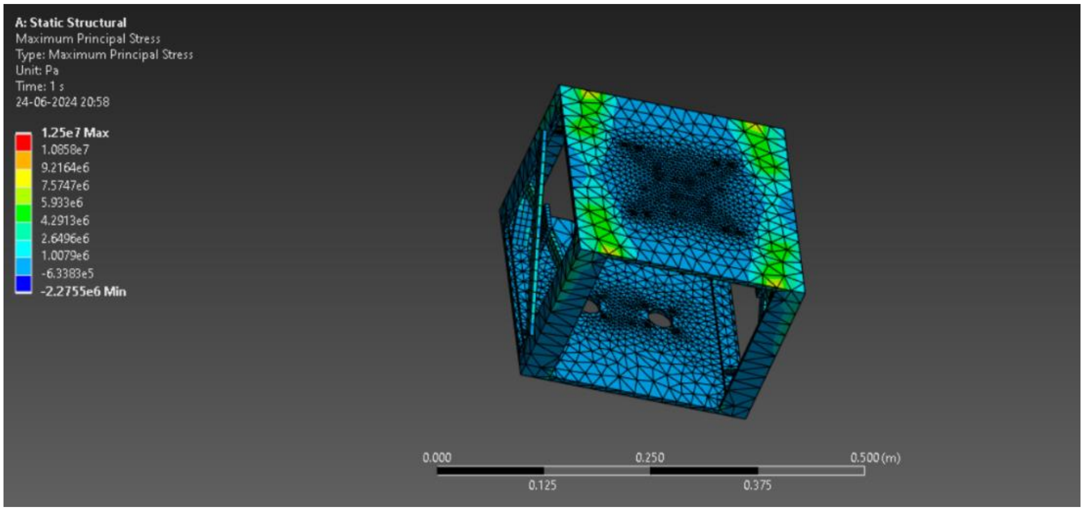


FIG.7.3 Carriage Maximum Principal Stress

7.5 Project Outcome

The redesign of the XY carriage from 260 mm to 197 mm involved significant changes, including the removal of 40 mm bars, reducing the gap between the motor and rails, decreasing the thickness of clamps and bearings. These modifications resulted in a more compact, efficient, and high-performing XY carriage. This project demonstrates the importance of thoughtful design adjustments in improving the overall functionality and adaptability of robotic systems.

CHAPTER–8
Efficient Frame Redesign To Improved Robot Performance

8.1 Introduction

In our project, I focused on redesigning the carriage that supports the robot. The redesign process involved creating a new carriage model in CATIA V5, adjusting the dimensions of the structural bars, and conducting an ANSYS structural analysis to ensure the frame's integrity and performance.

8.2 Carriage Design in CATIA V5

The first step in the redesign process was to create the new carriage model using CATIA V5's Part Design module. This software allowed for precise modeling and adjustments to meet the specific requirements of the project.

1.Initial Design:-

The carriage was initially with bars measuring 40mm in height and 40mm in width. This standard design provided a solid foundation for the structure.

2. Redesigning the Bars:-

To optimize the carriage, the dimensions of the bars were modified. The new design features bars with the following specifications:

1. Height and Width:- Reduced to 25mm

2. Interior Space:- 19mm

3.Thickness:- 3mm

These changes were aimed at reducing weight while maintaining structural integrity.

8.3 ANSYS Structural Analysis

After redesigning the carriage in CATIA V5, an ANSYS structural analysis was performed to evaluate the new frame's strength and durability.

1. Simulation Setup:-

The redesigned carriage model was imported into ANSYS for structural analysis. Boundary conditions and load scenarios were applied to simulate real-world stresses and forces the carriage would encounter during operation.

2. Results and Validation:-

The ANSYS analysis provided detailed insights into the stress distribution and deformation patterns within the redesigned frame. The results confirmed that the new design maintained sufficient strength and rigidity, despite the reduction in material dimensions.

8.4 Benefits of the Redesign

1. Weight Reduction:-

The new design with smaller bar dimensions resulted in a lighter carriage, which can improve the overall efficiency and speed of the robot.

2. Material Efficiency:-

Reducing the bar dimensions from 40mm to 25mm while maintaining structural integrity allows for more efficient use of materials, potentially lowering production costs.

3. Enhanced Performance:-

The lighter and more streamlined carriage design can contribute to better robot performance, including smoother movements and reduced energy consumption.

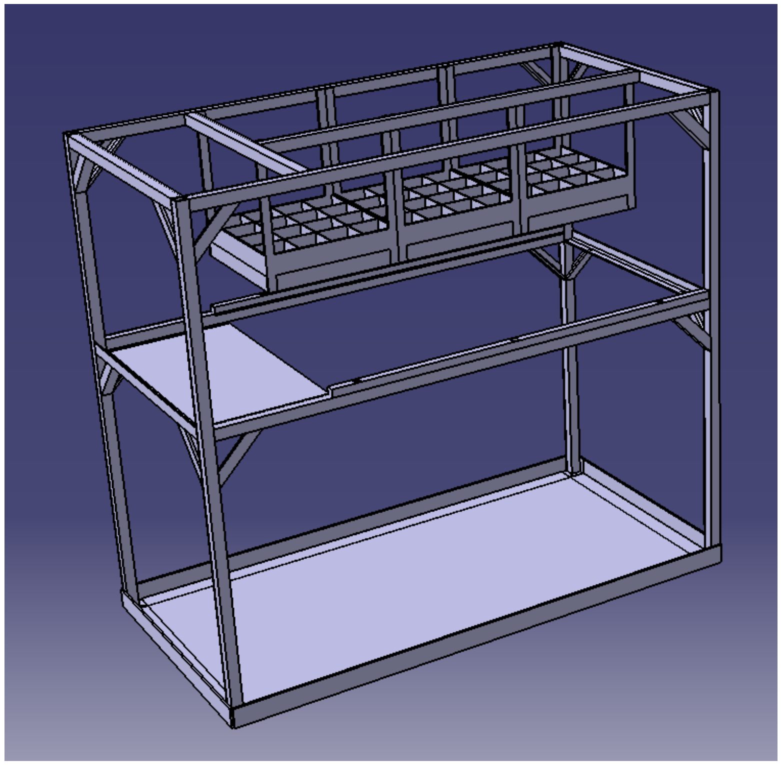


FIG.8.1 25mm Frame Design

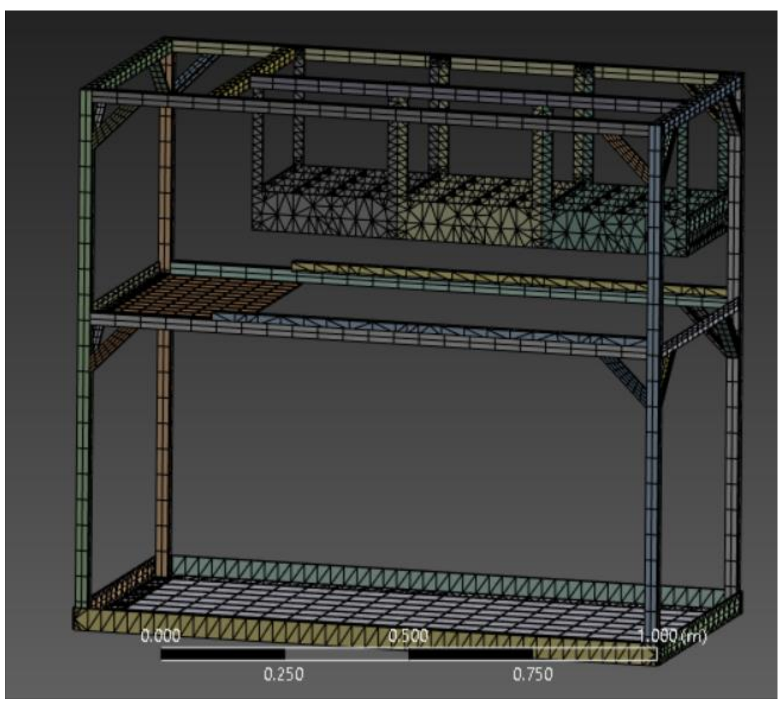


FIG.8.2 Ansys 25mm analysis

TABLE FOR FRAME OF 25mm THICKNESS (ST)

Steel (25mm)	Maximum	Minimum
Total deformation	0.473mm	0
Maximum principal strain	43.008e^4mm	-11.261e^6mm
Maximum principal stress	93.454e^7pa	-36.686e^7pa
Normal stress	26.813e^7pa	-68.831e^7pa
Factor of safety	NA	2.0563 (occurs on part body)

TABLE FOR FRAME OF 25mm THICKNESS (AL)

Aluminum(25mm)	Maximum	Minimum
Total deformation	1.1853mm	0
Maximum principal strain	11.807e^3mm	-34.385e^6mm
Maximum principal stress	94.704e^7pa	-44.598e^7pa
Normal stress	27.65e^7pa	-69.852e^7pa
Factor of safety	NA	2.3305(occurs on part body)

TABLE.8.1 Analysis Results

CHAPTER–9

Enhanced Kitchen Robot: Compact Design and Increased Safety

9.1 Introduction

In our project, we aimed to improve the design of the kitchen robot by reducing its total height and increasing its factor of safety. The modifications resulted in a more compact and safer robot structure.

9.2 Original Specifications

The original dimensions and specifications of the kitchen robot were as follows:

1. Total Height:- 1245.071 mm
2. Total Length:- 1220.28 mm
3. Total Width:- 610 mm
4. Height from Base to Middle:- 647.091 mm
5. Height from Middle to Top:- 564.071 mm
6. Thickness:- 6 mm

9.3 Modified Specifications

The modifications involved using a 25 mm thickness file to achieve a more compact design. The new specifications are:

1. Total Height:- 1108.651 mm
2. Total Length:- 1217.285 mm
3. Total Width:- 560 mm
4. Height from Base to Middle:- 627 mm
5. Height from Middle to Top:- 456.657 mm
6. Thickness:- 3 mm

These changes resulted in a significant reduction in the robot's overall dimensions.

9.4 Height Reduction

1. Total Height Reduction:-

The total height was reduced from 1245.071 mm to 1108.651 mm. This reduction of 136.42 mm was achieved by altering the structure's components.

2. Height from Base to Middle:-

The height from the base to the middle section was slightly reduced from 647.091 mm to 627 mm.

3. Height from Middle to Top:-

The height from the middle section to the top was significantly reduced from 564.071 mm to 456.657 mm, contributing to the overall height reduction.

4. Thickness Reduction:-

The thickness of the structural components was reduced from 6 mm to 3 mm.

9.5 Increased Factor of Safety

To enhance the robot's safety and reliability, the factor of safety was increased from 1 to 4. This improvement ensures that the robot can operate under higher stress conditions without risk of failure, making it more robust and dependable for various tasks.

9.6 Benefits of the Modifications

1. Compact Design:-

The reduction in height and dimensions makes the kitchen robot more compact, allowing it to fit better in various kitchen environments and operate more efficiently.

2. Improved Safety:-

By increasing the factor of safety to 4, the robot's durability and operational reliability have been significantly enhanced.

3. Material Efficiency:-

The reduction in thickness from 6 mm to 3 mm leads to a lighter structure, which can improve the robot's overall performance and reduce material costs.

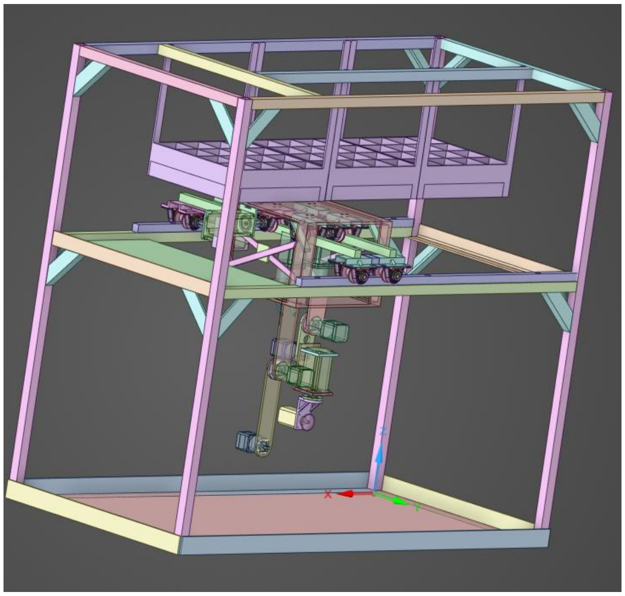


FIG.9.1 Final Design

9.5 Conclusion

1. Enhanced Functionalities and Efficiency:- The internship focused on improving the multitasking capabilities of the kitchen robot, enabling it to chop vegetables, cook meals, and wash utensils autonomously using advanced AI techniques .

2. Design Innovations:- Significant design changes were implemented, including the reduction of the XY carriage height, redesign of the carriage structure, and optimization of the robot's frame thickness. These modifications improved the robot's efficiency, performance, and structural integrity .

3. Use of Advanced Software Tools:- Tools like RoboAnalyzer, CATIA V5, and ANSYS were used extensively for design, simulation, and optimization, contributing to better analysis and performance of the robot .

4. Material and Cost Optimization:- Through various design iterations, material and cost optimization were achieved while maintaining the robot's structural integrity. This included reducing the thickness of structural components, which led to a lighter and more efficient design .

5. Valuable Learning Experience:- The internship provided hands-on experience in robotic process automation, offering insights into real-world applications of robotic systems in kitchen automation. The project demonstrated the importance of thoughtful design and optimization in developing sophisticated, efficient, and versatile robots .