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MODELLING OF MULTI TERRIAN SPY ROVER BY USING AUTODESK FUSION 360

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ABSTRACT

This project presents the modelling of a "Multi-Terrain Spy Rover" using Autodesk Fusion 360, focusing on the development of an accurate and parametric 3D representation of the system. The rover, designed with compact dimensions of 1.2 × 1.2 × 1.2 ft, was digitally modelled with detailed components such as the chassis, robotic arm, suspension structure, and outer body frame, ensuring proper dimensions, alignment, and structural consistency. Mechanical engineering principles were applied through structural design, load distribution considerations, and appropriate material representation within the CAD environment. Parametric modelling techniques enabled easy modification, flexibility, and efficient optimization of the design. All components were individually modelled and assembled to form a complete and well-integrated virtual system, enhancing visualization and design accuracy. The modelling process also facilitated better understanding of component interaction and system layout without physical fabrication. Overall, this project highlights the importance of CAD-based modelling in developing complex mechanical systems and provides a strong foundation for future applications such as simulation, analysis, and real-time implementation of multi-terrain robotic systems.

1.INTRODUTION

1.1 Introduction

Robotics is one of the fastest-growing fields in modern engineering, contributing significantly to automation and advanced design technologies. With the development of modern design tools, robotic systems can be efficiently modelled and prototyped with high accuracy.

A multi-terrain spy rover is a mobile platform designed to move on different types of surfaces such as rough terrain, uneven paths, and confined spaces. The design of such systems requires proper structural planning and component arrangement. The main aim of this project is to design and model a multi-terrain spy rover using Autodesk Fusion 360 and fabricate its components using 3D printing technology. The focus is on creating accurate 3D models of components like the chassis, wheels, and outer body, and assembling them into a complete system. The use of 3D printing enables rapid prototyping, reduces cost and saves time. This project highlights the importance of computer-aided design and digital manufacturing in developing mechanical models of robotic systems.

1.2 Background

In earlier days, surveillance and

monitoring tasks were carried out manually, which significant risks to human life. In situations like war zones, fire accidents, or chemical industries, human involvement can be dangerous.

To overcome these challenges, robotic systems have been developed to perform such tasks. The introduction of microcontrollers and single-board computers such as Raspberry Pi has made it possible to design compact and cost-effective robotic systems.

In addition, the development of CAD tools like Fusion 360 has improved the design process by enabling:

- Accurate 3D modelling
- Simulation and analysis
- Easy modification of designs

The use of 3D printing technology further simplifies manufacturing by allowing rapid prototyping and customization of components.

1.3 Problem Statement

Despite advancements in robotics, many existing systems still face several limitations:

- Limited ability to operate on multiple terrains
- High cost of manufacturing and maintenance
- Complex design and assembly
- Lack of integration between mechanical and electronic systems
- Limited real-time monitoring capabilities

These issues highlight the need for developing a system that is:

- Cost-effective
- Simple in design
- Efficient in performance
- Capable of operating on different terrains

1.4 Objectives

- To design and model a multi-terrain spy rover using Autodesk Fusion 360 with accurate dimensions and parametric design.
- To fabricate and integrate the rover system, including 3D-printed components and a robotic arm for object handling.
- To develop a reliable surveillance system with real-time monitoring, ensuring structural strength, balance, and performance across different terrains.

1.5 Scope of the project

The scope of this project focuses on the design, modelling, and analysis of a multi-terrain spy rover using Autodesk Fusion 360. The project primarily emphasizes the development of a virtual prototype that can operate efficiently on different types of terrains such as rough surfaces, uneven paths, and confined environments.

The scope includes detailed 3D modelling of major components such as the chassis, robotic arm, and outer body frame using parametric design techniques. These components are designed with proper dimensions, constraints, and assembly relationships to ensure accuracy and ease of modification. The use of Autodesk Fusion 360 allows integration of design, simulation, and analysis within a single platform, improving overall design efficiency.

The project also covers structural and stress analysis of the rover components to evaluate their strength, durability, and performance under different loading conditions. This ensures that the designed model can withstand real-world operational challenges. In addition, the scope extends to the use of 3D printing technology for prototyping, enabling rapid fabrication of lightweight and cost-effective components.

1.6 Applications

1.6.1 Military Applications

- Surveillance in border areas
- Monitoring enemy movements
- Bomb detection and disposal
- Bomb detection support

1.6.2 Disaster Management

- Searching for survivors in collapsed buildings
- Monitoring hazardous areas
- Fire rescue operations
- Hazardous and hard-to-reach areas

1.6.3 Industrial Applications

- Inspection of pipelines
- Monitoring industrial equipment
- Detecting gas leaks

2.LITERATURE REVIEW

2.1 LITERATURE REVIEW

In recent years, robotics has become an essential field in engineering, especially in applications related to surveillance, automation, and hazardous environment operations. Multi-terrain spy rovers are widely used in military, rescue missions, and industrial monitoring where human intervention is risky.

These robotic systems are designed to operate on uneven surfaces and perform tasks such as real-time monitoring, data collection, and remote operation. The integration of robotic arms further enhances functionality by enabling object handling and manipulation.

In addition, the use of 3D printing technology has revolutionized the manufacturing process of robotic components by reducing cost, time, and material wastage. Modern CAD tools such as Autodesk Fusion 360 allow accurate modeling and simulation before fabrication.

However, existing systems still face limitations in terms of cost, design complexity, and performance. Therefore, studying previous research is essential to develop an improved multi-terrain spy rover system.

2.1 REVIEW OF EXISTING SYSTEMS

Vijay Palled and Dr. M.S. Hebbal designed and implemented a robotic arm for pick-and-place applications using Arduino and servo motors. The system consists of multiple joints providing flexibility and precise movement. The robotic arm was developed with multiple degrees of freedom, enabling accurate object handling in industrial applications. The study demonstrates that robotic arms can efficiently perform repetitive tasks with high precision and reliability.

Rishabh Jain et al. presented the modeling and analysis of an articulated robotic arm used for material handling applications. The robotic arm was designed using CAD tools and analyzed using simulation software to evaluate performance and efficiency.

3.METHODOLOGY

3.1 Flowchart

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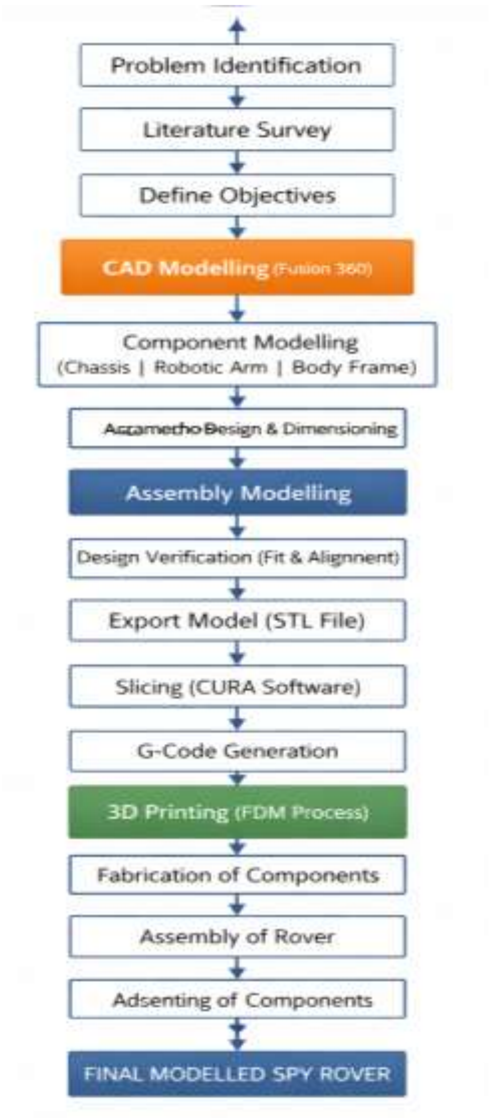

4.MODELLING

4.3 Procedure for Modelling the Four Wheel Chassis

The four-wheel chassis is the base structure of the rover that supports all components such as motors, wheels, battery, and electronics. The modelling procedure in Autodesk Fusion 360 is carried out step by step as follows:

The modelling of the chassis in Autodesk Fusion 360 begins by creating a new design file and setting the appropriate units, typically in millimeters, for accurate dimensioning. A base sketch is created by selecting the top (XY) plane and drawing a rectangle that represents the chassis base, followed by defining its length and width according to design requirements. Geometric and dimensional constraints such as horizontal, vertical, and parallel are applied to fully define the sketch and ensure accuracy. The 2D sketch is then converted into a 3D model using the extrude tool by assigning a suitable thickness to form the chassis plate. Side walls or supports may be added by sketching along the edges of the base and extruding them upward. Motor mounts are designed at the four corners by creating sketches and adding holes or slots using circle and slot tools, followed by extrusion or cutting operations as needed. Wheel mounting points are created by adding holes for wheel shafts at appropriate and symmetrical positions to ensure proper alignment. A battery and electronics compartment is designed by sketching a cavity at the center of the chassis and using the extrude cut feature to create space for components.

Additional holes and slots are provided for mounting sensors, circuits, and the robotic arm, often using pattern tools to maintain uniform spacing. Fillets and chamfers are applied to edges and corners to improve strength, safety, and overall finish. Finally, all dimensions and alignments are verified to ensure proper spacing, balance, and symmetry, after which the design is saved and exported in STL format for 3D printing.

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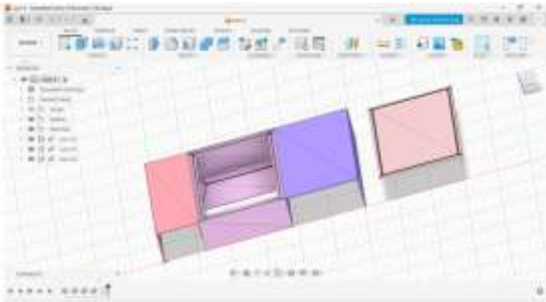
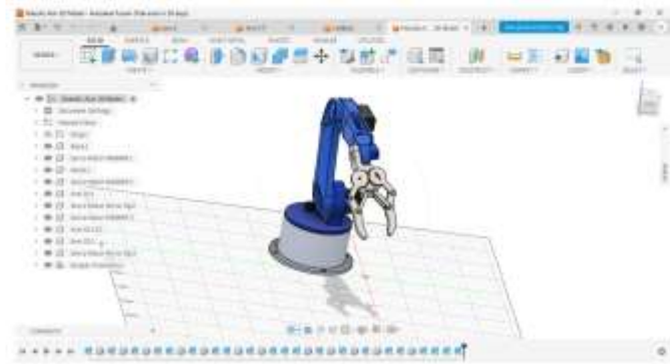


4.4 Procedure for Modelling the Robotic Arm

The robotic arm is an important component of the rover used for object handling and manipulation. It is designed as a multi-link mechanism with several joints to provide flexibility and movement. The modelling procedure in Autodesk Fusion 360 is as follows:

The modelling of a robotic arm in Autodesk Fusion 360 begins by creating a new design file and setting the units to millimetres for precise modelling. The overall structure is first planned by identifying key components such as the base, shoulder, elbow, wrist, and gripper, along with their approximate dimensions and required degrees of freedom. The base is created by sketching a circular or rectangular profile on the top plane and extruding it into a solid body, including a central hole for mounting a servo motor. The shoulder and elbow links are designed by creating sketches on vertical planes, extruding them into 3D shapes, and adding holes for proper joint connections. The wrist is modelled as a smaller link to enable flexible movement and rotation. The gripper mechanism is designed by sketching two jaws, extruding them, and adding pivot holes to allow opening and closing motion. Parametric dimensions are applied to ensure easy modification of sizes and thickness. Additional features such as fillets and chamfers are added to improve strength and remove sharp edges.

Finally, all components are assembled using revolute joints, checked for smooth motion, and exported as STL files for 3D printing.



4.4 OUTER BODY FRAME DESIGN

The outer body frame is an essential component of the rover used for protection and structural support of internal parts. It is designed as a protective enclosure that covers the chassis and other components, ensuring safety from external conditions such as dust, minor impacts, and environmental exposure. The modelling procedure in Autodesk Fusion 360 is as follows:

The modelling of the outer body frame in Autodesk Fusion 360 begins by creating a new design file, which serves as the starting point for developing the structure. A base sketch is then created on the top plane to define the overall size and shape of the outer body frame. Geometric constraints and precise dimensions are applied to ensure proper shape definition and accuracy. The 2D sketch is converted into a 3D model using the extrude tool by assigning an appropriate thickness to form the base structure. Side walls may be added by creating vertical extensions around the base to form an enclosure that protects internal components from external conditions. Motor mounts are designed within the frame by creating slots or supports to ensure proper alignment and smooth motor operation.

Wheel mounting points are provided by adding holes or brackets to securely attach the wheels and ensure stable movement. A dedicated compartment is created for the battery and control units to ensure proper placement and safety of components. Additional holes and slots are included for ventilation and wiring connections, which help in heat dissipation and cable management. Fillets and chamfers are applied to smooth sharp edges, improving strength, safety, and overall appearance. Finally, all dimensions and alignments are verified to ensure proper fitting with the chassis, and the completed model is saved and exported in STL or STEP format for fabrication or 3D printing.

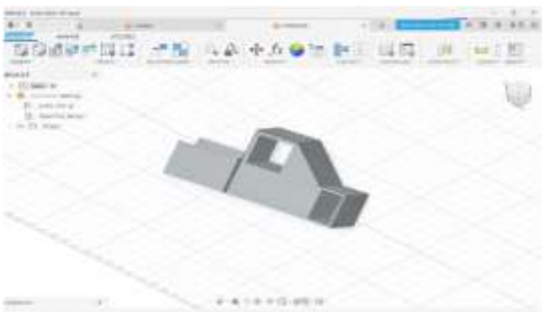


Fig: 4.4 Input Outer Body Frame

4.5 Easy of Assembly

The multi-terrain spy rover is designed with a focus on easy assembly to ensure quick and efficient construction of the system. A modular design approach is adopted, where individual components such as the chassis, robotic arm, and outer body frame are designed separately and later assembled together.

All components are provided with proper mounting points, holes, and slots, allowing easy alignment and fitting during assembly. Standard fasteners such as screws and bolts are used to connect different parts, which simplifies the assembly process and allows easy replacement of components if required.

The assembly process follows a step-by-step approach, starting with the chassis, followed by the mounting of motors, wheels, electronic components, robotic arm, and finally the outer body frame. This systematic procedure improves efficiency and reduces assembly time.

Overall, the design ensures that the rover can be easily assembled, disassembled, and modified, making it suitable for prototyping, maintenance, and future improvements.

4.6 Summary

This chapter provides an overview of the design and modelling of the multi-terrain spy rover using Autodesk Fusion 360. It covers the modelling of key components such as the chassis, robotic arm, and outer body frame using parametric design techniques for accuracy and flexibility. Important design considerations including structural strength, weight optimization, material compatibility, and manufacturing constraints are also discussed. The chapter briefly explains the 3D printing process, where models are converted into physical parts using FDM technology. Additionally, it highlights the modular design approach, which ensures easy assembly, maintenance, and future modifications of the rover system.

5.FABRICATION OF SPY ROVER

5.1 Introduction of 3D Printing

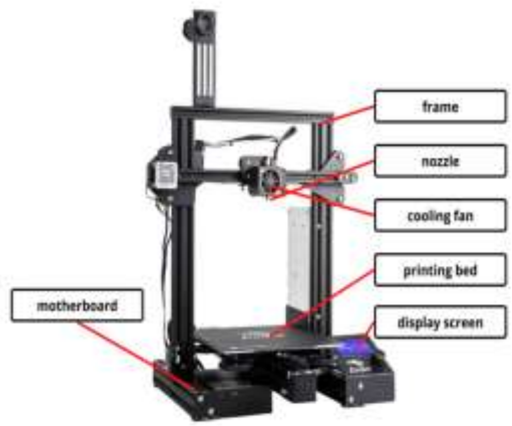


Fig 5.1 3D Printer

3D printing, also known as additive manufacturing, is a modern manufacturing process used to create three-dimensional objects by adding material layer by layer based on a digital model. Unlike traditional manufacturing methods that remove material (subtractive manufacturing), 3D printing builds components from the ground up, making it more efficient and flexible.

In this process, a digital 3D model created using CAD software is converted into a format suitable for printing, typically an STL file. This file is then processed using slicing software, which divides the model into thin layers and generates instructions (G-code) for the 3D printer. The printer follows these instructions to fabricate the object layer by layer.

One of the most widely used 3D printing techniques is Fused Deposition Modelling (FDM), where a thermoplastic filament such as PLA, ABS, or Nylon is heated, melted, and extruded through a nozzle. The material is deposited layer by layer and solidifies to form the final object.

3D printing offers several advantages, including rapid prototyping, reduced material wastage, design flexibility, and the ability to create complex geometries that are difficult to achieve using conventional methods. It also allows easy customization and modification of designs, making it highly suitable for engineering applications.

Due to these benefits, 3D printing is widely used in industries such as automotive, aerospace, medical, robotics, and product design. In this project, 3D printing is used to fabricate the components of the multi-terrain spy rover, ensuring lightweight structure, cost-effectiveness, and accurate reproduction of the designed models.

3D printing also reduces production time and allows quick design modifications without additional cost. It is especially useful for prototyping developing components with high precision.

5.2 Materials

In this project, different thermoplastic materials are selected for 3D printing based on their mechanical properties, strength, flexibility, and ease of fabrication. The choice of material plays a crucial role in determining the performance, durability, and efficiency of the rover components.

Fig 5.2 Materials

1.PLA (Polylactic Acid)

PLA is one of the most widely used 3D printing materials due to its ease of use and good surface finish. It is a biodegradable thermoplastic made from renewable resources like corn starch. PLA is lightweight and provides sufficient strength for non-load-bearing components. It requires low printing temperature and shows minimal warping.

In this project, PLA is mainly used for the outer body frame and lightweight parts.

2. ABS (Acrylonitrile Butadiene Styrene)

ABS is a strong and durable material with high impact resistance. It can withstand higher temperatures compared to PLA, making it suitable for structural components. ABS is commonly used for parts like the chassis and motor mounts where strength is important. However, it requires higher printing temperature and proper ventilation due to fumes and possible warping.

3. Nylon

Nylon is a high-performance engineering material known for its excellent strength, flexibility, and wear resistance. It is suitable for moving and load-bearing components such as joints and robotic arm parts. Nylon provides good toughness and can handle repeated stress, but it requires controlled printing conditions and proper storage to avoid moisture absorption. Nylon also exhibits excellent fatigue resistance, making it suitable for components subjected to repeated motion. It has a low friction coefficient, which helps in smooth movement of joints and mechanical parts. Additionally, Nylon provides good chemical resistance and durability in harsh conditions. These properties make it highly suitable for advanced engineering and robotic applications.

4. Material Selection Criteria

The selection of materials is based on factors such as strength, weight, durability, flexibility, and ease of printing.

Each material is chosen according to the specific requirement of the component to ensure better performance and efficiency.

5. Effect of Printing Parameters

The final strength and quality of printed parts depend on parameters like layer height, infill density, print speed, and temperature. Proper selection of these parameters ensures good layer bonding and structural integrity.

6.RESULTS AND CONCLUSION

6.1 Results

- ✓ The modelling of the multi-terrain spy rover using Autodesk Fusion 360 was successfully completed with high accuracy and precision.
- ✓ Major components such as the chassis, robotic arm, and outer body frame were developed as detailed 3D models with proper dimensions and alignment.
- ✓ The use of parametric modelling techniques enabled easy modification, design optimization, and improved flexibility throughout the modelling process.
- ✓ The assembly modelling ensured proper fit, alignment, and structural consistency of all components within the rover system.
- ✓ The developed 3D models enhanced visualization and provided a clear understanding of the overall system design and component interaction.
- ✓ The modelling process improved design accuracy, reduced potential errors, and supported efficient development of the rover structure.
- ✓ The final CAD model serves as a strong foundation for future applications such as analysis, fabrication, and real-time implementation.

6.2 Conclusion

- ✓ The project successfully accomplished the modelling of a multi-terrain spy rover using advanced CAD methodologies, focusing on accurate representation of system components.
- ✓ Autodesk Fusion 360 was effectively utilized to design and develop precise 3D models of key components such as the chassis, robotic arm, and outer body frame.
- ✓ The application of parametric modelling techniques enabled easy modification, improved flexibility, and ensured high dimensional accuracy throughout the design process.
- ✓ The modelling approach ensured proper alignment, fit, and integration of all components, resulting in a well-structured and realistic rover assembly.
- ✓ The developed 3D models enhanced visualization and understanding of the system layout, supporting better design evaluation and refinement.
- ✓ The project emphasizes the significance of CAD modelling in reducing design errors, improving efficiency, and facilitating systematic product development.
- ✓ The final model provides a strong foundation for future work such as simulation, fabrication, and real-time implementation of multi-terrain robotic systems.

6.2 Future Scope

- ✓ Integration of advanced sensors to enhance surveillance and monitoring.
- ✓ Implementation of AI and ML for autonomous navigation and decision-making.
- ✓ Use of GPS and communication systems for real-time tracking and control.
- ✓ Adoption of advanced materials and improved robotic arm for better performance.

PROJECT IMAGES

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