# DESIGN AND FABRICATION OF DRONE FOR SURVEILLANCE

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**Introduction**

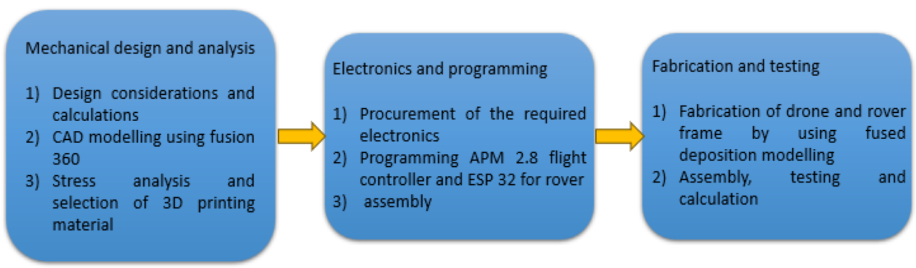
Navigating diverse and challenging terrains has long been a significant obstacle for traditional wheeled or tracked robots. These systems often encounter difficulties when operating on uneven, loose, or unpredictable surfaces such as sand, gravel, rubble, or rocky ground. The primary issue lies in their reliance on fixed-directional movement, which limits their ability to manoeuvre efficiently in complex environments. For example, tracked robots may struggle to gain traction on loose terrain, while wheeled robots often face difficulties with sharp turns or obstacles. Such limitations make traditional robots less effective in applications requiring high mobility and adaptability, particularly in fields like disaster response, surveillance, and search and rescue operations.

**Objective**

The objective of this project is to develop and evaluate a surveillance drone equipped with Mecanum wheels, enabling omnidirectional movement for enhanced navigation across diverse and challenging terrains. By leveraging the unique design of Mecanum wheels with rollers positioned at a 45-degree angle, the drone aims to achieve seamless mobility, maneuverability, and stability on uneven, loose, or unpredictable surfaces. The project further seeks to optimize the drone's design, control algorithms, and performance, ensuring it meets the demands of real-world applications such as disaster response, surveillance, and search-and-rescue missions.

## Methodology

### 3.1. Overview of the methodology




- **Design and analysis of the model**
  The rover and drone frames will be designed in Fusion 360 with design calculations, focusing on lightweight yet durable structures for efficient mobility and flight. Finite Element Analysis (FEA) will be performed in **ANSYS** to evaluate the mechanical strength, stress distribution, and deformation of critical components under varying loads, ensuring optimal performance and reliability.

- **Integration of Rover and Drone Capabilities**
  The design combines a ground-based rover with Mecanum wheels for omnidirectional movement and a drone with short-flight capabilities. This hybrid system enables smooth ground traversal and quick aerial access to overcome vertical obstacles or hard-to-reach areas.

- **Enhanced Surveillance and Navigation**
  Integrated with high-resolution cameras and control systems, the hybrid drone-rover enables real-time surveillance and autonomous navigation. Its

dual ground-aerial perspective enhances data collection for reconnaissance, search and rescue, and perimeter monitoring tasks.

**Material selection**

1. **Factor of Safety (FoS)**

The Factor of Safety (FoS) is an important metric that indicates how much stronger a material is than required for a given load. It provides insight into the material's ability to withstand stresses without failure. In our analysis, PLA exhibited a higher FoS of 4.22, compared to ABS at 3.32.

2. **Eco-Friendly Considerations**

PLA stands out for its sustainability as it is biodegradable and derived from renewable resources such as corn starch or sugarcane. This makes PLA a more environmentally responsible choice compared to ABS, which is a petroleum-based plastic and non-biodegradable.

3. **Ease of Printing**

When considering 3D printing, PLA offers several advantages. It prints at lower temperatures (typically between 180°C and 220°C) and is less prone to warping, which simplifies the printing process. PLA can be used effectively with or without a heated bed, making it easier to handle, especially for home-based or small-scale production environments.

4. **Safety Considerations**

PLA is a safer material to use during the 3D printing process due to the fewer toxic fumes it emits. It produces a mild, sweet odor, which is generally considered non-toxic and less likely to cause health issues. In contrast, ABS releases styrene fumes, which can be irritating to the respiratory system and potentially carcinogenic with prolonged exposure.

**Results**

The required weight reduction od 15 grams is achieved and the working model is tested

| Drone arm material | Weight (in grams) |
|---|---|
| Stock glass fibre arm | 54 |
| fabricated PLA arm | 39 |
| Weight reduction | 15 |
| Percentage reduction (%) | 28 |

**CONCLUSIONS**

1. **Maximum Thrust of the Drone Propeller**

   From the experimental setup, it is found out that using a 1045 propeller and a 1000 kV motor, the maximum thrust generated by the drone was determined to be **9 N**.

2. **Flight Time of the Drone**

   The flight time of the drone was calculated to be **17 minutes**, considering the battery capacity, energy consumption of the motors, and overall system efficiency.

3. **Rover Run Time**

   For the rover, the run time was computed to be **40 minutes** based on its battery capacity, motor power consumption, and load. This ensures sufficient operational time for exploration or transportation tasks on moderate terrain.

4. **Material Analysis of the Drone Arm**

Using **ANSYS**, a finite element analysis was conducted to compare the mechanical properties of PLA and ABS plastic for the drone arm. Results concluded that:

- PLA exhibits **49% lower deflection** under load compared to ABS, ensuring better rigidity and structural stability.

5. **Weight Optimization of the Drone Frame**

The overall weight of the drone frame was reduced by **60 grams** by selecting a lighter PLA material without compromising structural integrity. This optimization contributes to improved flight efficiency and longer operational time

**TYPE:** The project is a **working model** that performs all the operations mentioned with simulations done

**Outcomes:**

- Enhanced Terrain Navigation: The surveillance drone equipped with Mecanum wheels successfully demonstrated the ability to navigate a wide range of terrains, including sand, gravel, rubble, and uneven ground, where traditional robots typically struggle.
- Omnidirectional Mobility: The use of Mecanum wheels enabled smooth omnidirectional movement, allowing the drone to maneuver in tight spaces and perform complex navigation tasks without the need for traditional steering mechanisms.
- Improved Stability and Control: The integrated control algorithms provided stable and responsive movement across various surfaces, enhancing the drone's reliability during surveillance operations.

**Learnings:**

- Importance of Mobility Design: The project highlighted how crucial advanced mobility mechanisms are for effective terrain handling, and how Mecanum wheels offer a significant advantage in complex environments.
- Integration Challenges: Combining mechanical systems with sensor-based navigation and control algorithms required careful calibration and testing to achieve smooth, coordinated movement.
- Terrain-Specific Tuning: Different terrains required fine-tuning of control parameters to maintain optimal performance, revealing the need for adaptive algorithms that can respond dynamically to changing environments.
- Power and Efficiency Considerations: The increased mechanical complexity and power demands of the omnidirectional system emphasized the need for efficient power management and lightweight structural design.

**Scope For Future Work**

1. **Electronics Integration and Battery Management**

The drone and rover electronics are integrated with a centralized battery management system (BMS) to optimize energy usage and extend runtime. This ensures seamless operation of critical components like motors, sensors, and communication modules, even during simultaneous use.

2. **Robust Suspension and Detachable Mechanism**

A robust suspension setup enables the rover to handle rough terrains while protecting sensitive electronics. A detachable mechanism allows for modular assembly, easier maintenance, and adaptability to mission-specific needs.

3. **Enhanced Sensor Suite**

Additional sensors, such as GPS for location tracking and LIDAR for 3D mapping, enhance surveillance and navigation. These provide better obstacle detection and autonomous navigation capabilities, improving mission accuracy

4. **Automatic Docking and Reattaching System**

   a. Guidance System: Sensors for alignment during docking.

   b. Docking Locks: Ensuring a secure physical connection.

   c. Automation: Software-controlled docking for autonomous operation.