250 mm X-Frame Hover-Capable Quadcopter

07.07.25
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v0.1

Purpose:
- Build and demonstrate a micro-controller-based quadcopter that can hover for several minutes indoors and outdoors.

Scope:

- Designing 250 mm X-frame and motor mounts in Siemens NX
- Performing FEA drop-tests and modal analysis
- Creating GD&T drawings for key structural parts
- Flashing and configuring iNav + BLHeli firmware for hover modes
- Conducting bench-tests, sensor calibrations, and a controlled tethered hover to a set altitude
- Modeling hover in Simulink and comparing simulated vs. logged attitude data
- Writing up phase reports in a final PDF documenting CAD, analysis, firmware, and flight results
- Performing targeted research on drone control theory, iNav configuration, and hover stability to inform design choices and simulation parameters.

Objectives:

1.) Stable Altitude Hold: On power-up, the quadcopter ascends to a preset altitude and maintains hover within ±2.0 m for at least 30 s.
2.) Simulation Correlation: Show that the Simulink hover model predict attitude response within 20% of the logged flight data.
3.) Complete Documentation: A one-page Project Charter, fours phase reports (CAD, FEA/GD&T, bench and hover testing, simulation), and a final combined PDF with all key screenshots, plot, and a hover video link.

Deliverables:

- Siemens NX CAD models & rendered assembly views
- FEA report & GD&T drawings (PDF)
- Electronics schematic
- Flight logs
- Simulink hover model & Comparison plots
- Final report & portfolio web page

Milestones & Timeline:

- Project Charter Complete (Day 1) (v0.1)
- CAD & Parts Ordered (End of Week 1) (v0.2)
- FEA & GD&T Complete (End of Week 2) (v0.3)
- Firmware Flash & Bench Tests (End of Week 3) (v0.4)
- Tethered Hover Achieved (End of Week 3) (v0.5)
- Simulation vs. Attitude Validation (End of Week 4) (v0.6)
- Final Report & Publish (Week 5) (v1.0)

Budget Estimate:

- **Frame & Hardware ~$40:**
    - 250 mm frame (CAD design + 3D print)
    - Standoffs, Screws, Damping Pads
    - Battery Strap (Velcro)
    - 4x Propellers Materials & Printing
- **Motor Hardware ~$45**
    - 4x Brushless Motors
    - 4x ESCs
    - 4x 5" Props
    - Flight Controller
- **Power System ~$35**
    - LiPo Charger
    - XT60 Connectors, Wires
- **RC Control ~$80**
    - Receiver
    - Transmitter
- **Extra Tools ~$30**
    - Soldering Iron Kit
    - Heat Shrink, Zip Ties
    - MicroSD Card
    - MicroUSB Cable
    - Safety Tether

Total Estimated Budget: ~$230

Key Risks & Mitigations:

- **Risk:** Structural failure under load or landing
    - **Mitigation:** Perform FEA drop-test; start with low-altitude tethered hovers.

- **Risk:** Hover instability due to vibration or poor sensor isolation.
    - **Mitigation:** Mount flight controller on vibration dampeners.
- **Risk:** Loss of drone or flyaway
- **Mitigation:** Use tethered testing for all initial flights; set failsafe protocol in iNav; test indoors initially.

Assumptions & Constraints:

- **Assumptions:**
    - Access to Siemens NX, Simulink, and a basic electronics bench.
    - Availability of a safe indoor/outdoor area for tethered flight tests.
- **Constraints:**
    - Project duration limited to five weeks.
    - Budget capped at $250.
    - No custom PCB fabrication.