6 Degree of Freedom Autonomous UAV
Long Vo, Liam Berti, Ritesh Misra, Levi Burner
Department of Electrical and Computer Engineering

Background

- Quadcopters adjust orientation to translate; they can only control 4 Degrees of Freedom (DOF)
- This limits possible motions and decreases mobility
- A 6 DOF UAV is not restricted in this manner
- Designs found in literature are complex which makes construction and controller design difficult

Design Considerations

- Goals:
  - Full 6 DOF control when UAV is close to level
  - Maximum agility when in the level position
  - Autonomous height hold and velocity control
- Solution:
  - 4 side rotors mounted on an octorotor frame
  - Suitable for close tracking of moving ground targets and high-speed navigation in constricted environments

How it Works

- Optical Flow Sensor
  - Camera and ASIC compute translational velocity estimate at 50 Hz
- Custom Power Distribution and Sensor Interfacing Board
  - ATMEGA328P microcontroller reads sensors and commands side rotors
  - Isolates noisy motor circuitry from computing and sensing circuitry
  - Returns real time current and voltage usage statistics
  - 8 channel wireless circuit breaker safely shuts down motors
  - 30 A per channel - 240 A total
- Companion Computer
  - Raspberry Pi 3 runs ROS nodes
  - Motion profile generated at 10 Hz
  - Custom PID controller and plant model update at 50 Hz
  - Commands throttle, orientation, and side rotor thrust
- Range Finders
  - Range finders use reflected lasers to detect height of drone
  - First is used for 0-1.2 meters
  - Updates at 30 Hz
  - Second is used for 1-10 meters
  - Updates at 100 Hz
- Flight Controller
  - SPF4EVO (Common racing drone flight controller)
  - Runs orientation controller
  - Accepts throttle and orientation targets from companion computer
  - Relays IMU data at 100 Hz
- Side Thrust Motors
  - 1900 kV
  - 6" dia. 4.5" p. prop
  - 0.8 kg peak thrust
- Main Thrust Motors
  - 900 kV
  - 10" dia. 4.5" p. prop
  - 1.2 kg peak thrust

Testing Results

Autonomous setpoint tracking was tested using a custom motion capture system and onboard sensors; jerk and acceleration were greater than possible with a traditional quadcopter.

Acknowledgements

- Dr. Dickerson and Dr. Dallal for their support throughout the semester
- Dr. Mao for his mentorship and encouragement
- Jim Lyle, Bill Mcgahey, and Corey Weimann for the use of SERC resources
- Pitt’s Robotics and Automation Society (RAS) for providing parts
- Pitt SSOE ECE Department for providing funding to RAS and Senior Design
- Pitt’s 2016-17 and 2017-18 International Aerial Robotics Competition team whose previously developed software made the project feasible

References

- Pitt’s International Aerial Robotics Competition team’s code available at: github.com/Pitt-RAS/iarc7_common