NCC Fab Lab UAV Project
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Abstract

A UAS system based on readily available parts and the Pixhawk 2 flight controller. Our UAV is designed for efficiency, ease of deployment, and use of commercially available parts. The project aims to strike a balance between flight time and lifting power, while prioritizing reliability and user friendliness.

Frame

Our UAV's frame will be a y6 hexacopter constructed from carbon fiber tubes and custom aluminum motor brackets. A y6 configuration allows for large propellers, while maintaining a smaller frame footprint. The frame will be completely modular to facilitate quick part swaps. For example, a broken arm will be replaceable with nothing more than an allen key.

A rail system will be added for connecting to the challenge's standard payload. In addition to use for Police/EMS, the UAV is ideal for mapping and photography due to its lifting capacity, smooth operation, and autopilot system.

Motors and Electronics

The UAV will use 6000mAh LiPo batteries. 12,000mAh is the goal for total capacity, but using multiple batteries in parallel will add redundancy, while allowing for different pack configurations under varying loads. The flight computer will use multiple redundant power sources, specifically a dedicated UBEC and an ESC's internal BEC.

Low kV motors will be used to power the UAV, specifically those in the range of 300-900kV. Lower kV motors allow for greater torque, larger propellers, and more lifting power. The propellers used will vary in pitch to allow for greater efficiency with a coaxial motor configuration.

To facilitate aforementioned part swaps, the ESC power connectors and signal wires will use bullet and JST connectors, respectively. The ESCs will be mounted along the arms to allow cooling from prop wash.
The FPV and telemetry antennas will be mounted underneath the UAV, and the GPS receiver/gyroscope will be mounted above to minimize interference. All electronics will be covered in a conformal coating and housed in a waterproof enclosure, and all connectors will be coated in dielectric grease to minimize damage from moisture.

Flight control system

A Pixhawk 2 flight controller will be used to control the UAV. In addition to being readily available, the Pixhawk provides precise, full autopilot capabilities. Once a flight path is defined, the UAV can execute the mission completely autonomously, even without a connection to the ground station. GPS stabilization during manual flight will greatly add to ease of use and deployment.

Redundancy

Redundancy is imperative to the safety of a system being used commercially. A y6 hexacopter is capable of sustained flight in case of a motor failure, due to its evenly distributed points of thrust. While coaxial configurations are less efficient, they allow for larger propellers, folding frames, and very smooth flight. The effect on efficiency will be mitigated by using different propeller pitches on the top and underside.

The Pixhawk is capable of auto RTL (return to launch area) on command or in the event of telemetry failure. Onboard sensors provide a “Six Pack” instrument cluster, similar to that of a small airplane.

Ground Control Station

The PX4 firmware provides several choices for ground control software, including options for Windows, MacOS, Linux, and Android smartphones. The UAV’s GCS will include a tablet computer, telemetry radio, GPS module, and handheld transmitter. Providing a handheld transmitter as part of a GCS ensures that the aircraft can be manually controlled and safely landed with loss of telemetry link.

While a desktop or laptop computer can be used as a GCS, the UAV uses a tablet and FPV monitor mounted to a handheld transmitter. This makes the system very portable, and adds to ease of use.

FPV Video System

The UAV will use an analog FPV camera for its lower latency. Because analog video transmission doesn’t rely on data packets, the video feed doesn’t completely drop and leave the pilot blind during interference. Multiple monitors set to the same channel can receive the video link without interference or additional setup.

A heads-up display (MinimOSD) will be used to quickly provide vital information, such as battery levels and heading. The HUD will continue functioning in the event of telemetry or GCS failure, further providing control redundancy.

First person view is necessary for landings, as Pixhawk's autopilot isn't capable of discerning a suitable landing site. It will also used for monitoring during autopilot missions.

Team and Production

I am currently working alone on this project, but there are several engineers and experts who may join. The NCC Fab Lab is fully equipped for machining, 3d printing, electronics, etc. In addition to teaching a complete drone construction/flight class, I have personally built several custom UAVs, including multirotor and fixed wing. The Fab Lab has everything necessary for this project, and I am confident in our ability to fully accomplish it.

Conclusion

The NCC Fab Lab's UAV project is aiming to build a system with a balance between high flight time and lift capacity. Our main goals goals are to use almost entirely commercially available parts and build a system under $2,000, while maintaining commercial grade reliability. I would like to thank the National Institute of Standards and Technology, the Public Safety Communications Innovation Accelerator, and challenge.gov for providing this amazing opportunity.