Simple, extensible and low cost hardware and software for micro UAVs

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Introduction 1

With the prevalence and increased development in drone technology, consumers can now purchase development kits with extensible hardware and software provided by drone developers to create their own customised drones.

However, a flaw with the currently provided products and services is its lack of affordability. This lack of affordability results in many developers unable to have access to a drone development kit.

To combat this issue, this project provides an cheaper alternative MAV development platform to the current costly options.

Aims and Objectives 2

The aim of this project is to design and develop a cheap, simple, modular and expandable micro UAV drone including both a hardware and software platform to facilitate users to create custom drone systems at a low cost.

The project contains several key requirements to achieve the above aim:

1. Quadcopter contains basic functionality to perform balanced flight with additional processing capacity for software extensions.
2. Possess flight time of no less than 5 minutes.
3. Possess ability to communicate wirelessly with base station for control.
4. Total device cost less than $100AUD
5. Maximum volume less than 200mm X 200mm X 200m
6. Frame components are feasibly 3D printable
7. Contain code that is available cross platform
8. Design must be well documented to allow others to reproduce the drone

Circuit Design 3

The circuit board of this drone needed to have processing capacity for control systems algorithms, switch high currents for motor driving, host multiple different sensors, communicate wirelessly and fit in a small form factor. This board accomplishes all of that, and comes in at approximately $30-70 AUD, depending on sensors.

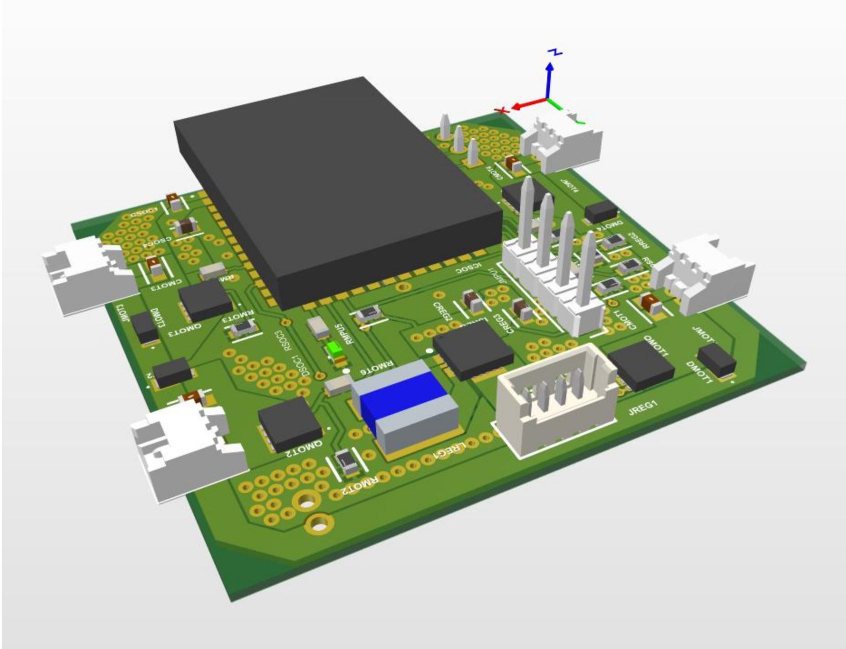

Figure 1. Finalised PCB

Battery Testing 4

The drone requires quite a large amount of power to keep itself in the air, meaning that the selection of a battery is very important. To test that the batteries satisfy the flight duration requirement of 5 minutes, they were discharged at the estimated power draw of all four motors, plus a safety margin. Battery discharge curves revealed that the batteries could sustain the voltage required to hover for approximately 8.5 minutes.

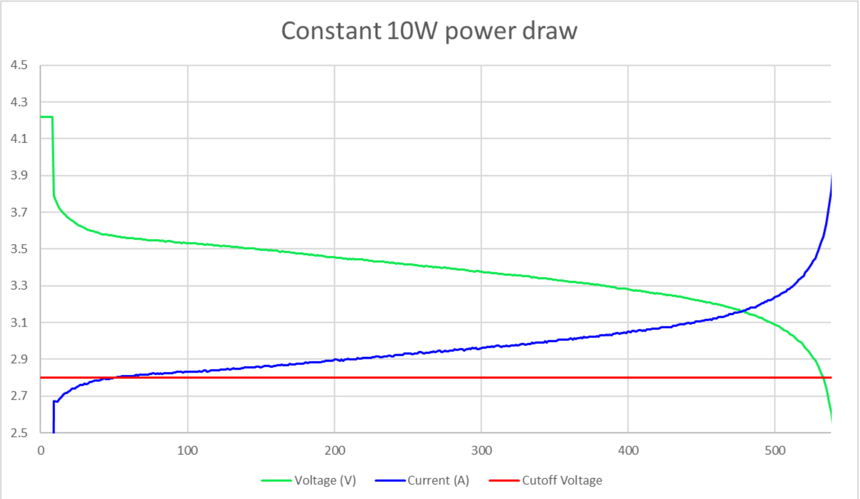

Figure 2. Battery capacity test

Chassis Design 5

Key requirements for the chassis are remaining within the required size limits and remaining lightweight to allow flight due to limited motor torque and increase flight time. Through developing three versions, the final MAV chassis when printed using PLA weighed 8g and is under the size limit. All the components are stable and tightly housed within the chassis, allowing stable flight.

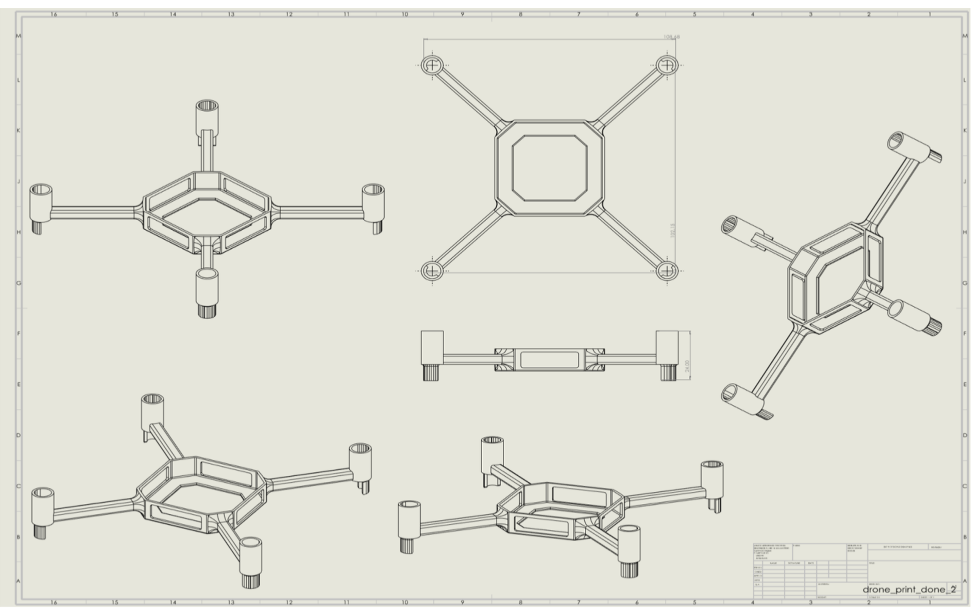

Figure 3. Final drone chassis version

Software Design 6

The software design section can be divided into three subsections, **firmware**, **operating system (OS)** and **control system**. The firmware interacts with the sensors and retrieves raw data, the OS deals with communications and commands sent from a host computer, and the control system uses sensor data to achieve some behaviour. The firmware and operating system have been implemented in the Arduino Core, making them independent of the microprocessor. The control system regulates state variables of the drone such as the pitch, roll, yaw angles, and the three spatial positions and velocities.

Integration Testing 7

Once all of the components of the drone were designed and produced, they were combined and tested to ensure they behave as expected. This phase included connecting sensor development boards to the ESP32 development board to verify the sensor firmware and comms protocols. Additional testing involved powering the drone motors from the chosen battery, installing each of the parts into the 3D printed chassis, and tuning the implemented control system. Figure 4 shows a test rig used for controller tuning and thrust tests.

Figure 4: Drone Suspension Rig

Conclusion 8

The developed drone has satisfied all of the initial requirements, and the drone has demonstrated its flight capability. This project proved that it is possible to build a versatile micro air vehicle development platform for a competitive price, without having to sacrifice hardware capabilities. Implementing a fully featured firmware and control system was beyond the scope of this project, however a future extension of this project would be to port an open source drone firmware and accompanying control system. This recommendation combined with the findings of this project will enable a highly cost effective and functional product to be produced for micro air vehicle related research.