Open Source Field Repairable 3D Printed Drone Design

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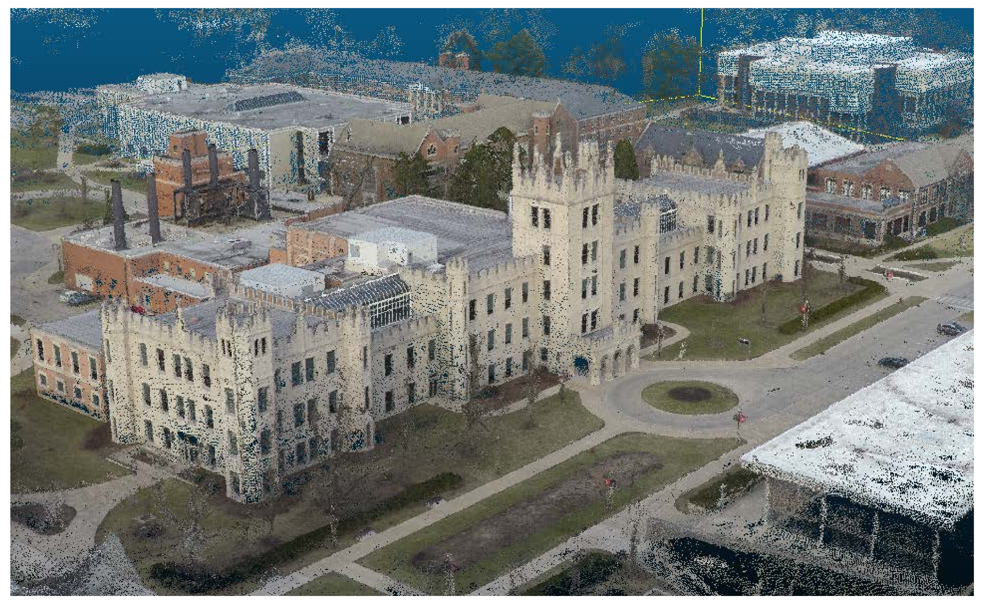
Why do geographers use drones?

Geographers use drones (also known as unmanned aerial vehicles or UAVs) for mapping and aerial photography. The drones we use are equipped with cameras and other sensors. These cameras capture images and video, which can then be assembled into an aerial photo – like a satellite photo, but taken from just overhead. This makes for an image that is of a much higher resolution than a typical satellite photo.

The photo at left of the front of Altgeld Hall was taken with a drone, while the photo at right was taken with a satellite.

Photographs and video taken from the drone can be assembled using software. We use the software Pix4D to create 3D models based on 4K resolution images and video taken with a GoPro camera.



A digital 3D model of the area near Altgeld Hall at Northern Illinois University.

Why open source?

- It keeps costs to a minimum. Proprietary drones can be very inexpensive to purchase initially, but repairs can be costly.
- Once the design is released, other researchers that use it can make modifications to improve it.

Why field repairable?

- Geographers often work abroad and/or in remote areas.
- As 3D printing becomes more common, we believe that 3D printing will allow for faster repairs than finding and/or mailing proprietary parts.

Education

- Since this design is easy and inexpensive to repair, it's ideally suited for training new UAV pilots.

Current Design

Three-piece main body

The current design, *Symetrix-Wing*, has only three unique, 3D printable pieces: the body plate, the horizontal arm plate and the vertical arm plate. Minimizing the number of unique pieces is important, because it reduces the need to carry spare parts.

Protection for wiring

When assembled, the arms and body form a hollow area through which wires and electronics can be routed to protect them from the elements. In the current design, the ESCs (Electronic Speed Controllers) and wires are mounted in the arms.

Interlocking pieces

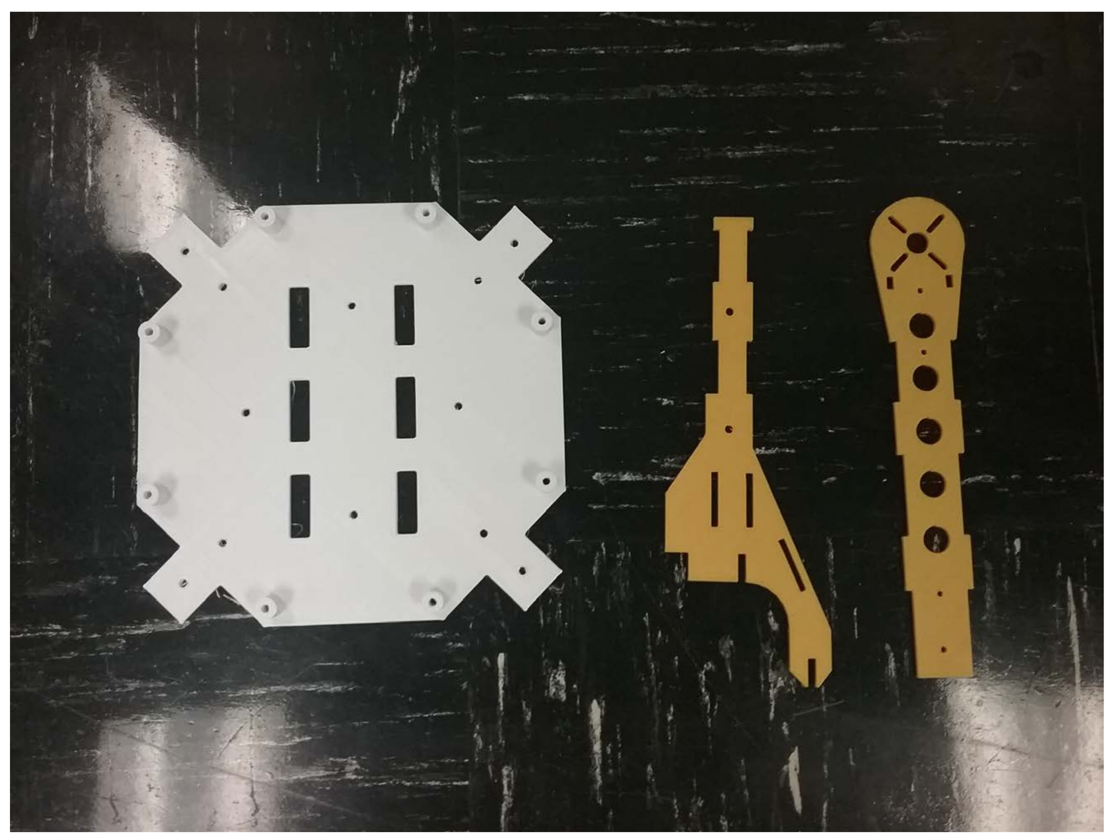
The pieces interlock when assembled, leading to added strength and rigidity. The two arm pieces interlock at the edges and the arms interlock with the main body. In addition, all pieces are held together with high-strength, lightweight nylon screws.

Flexible instrument mounting

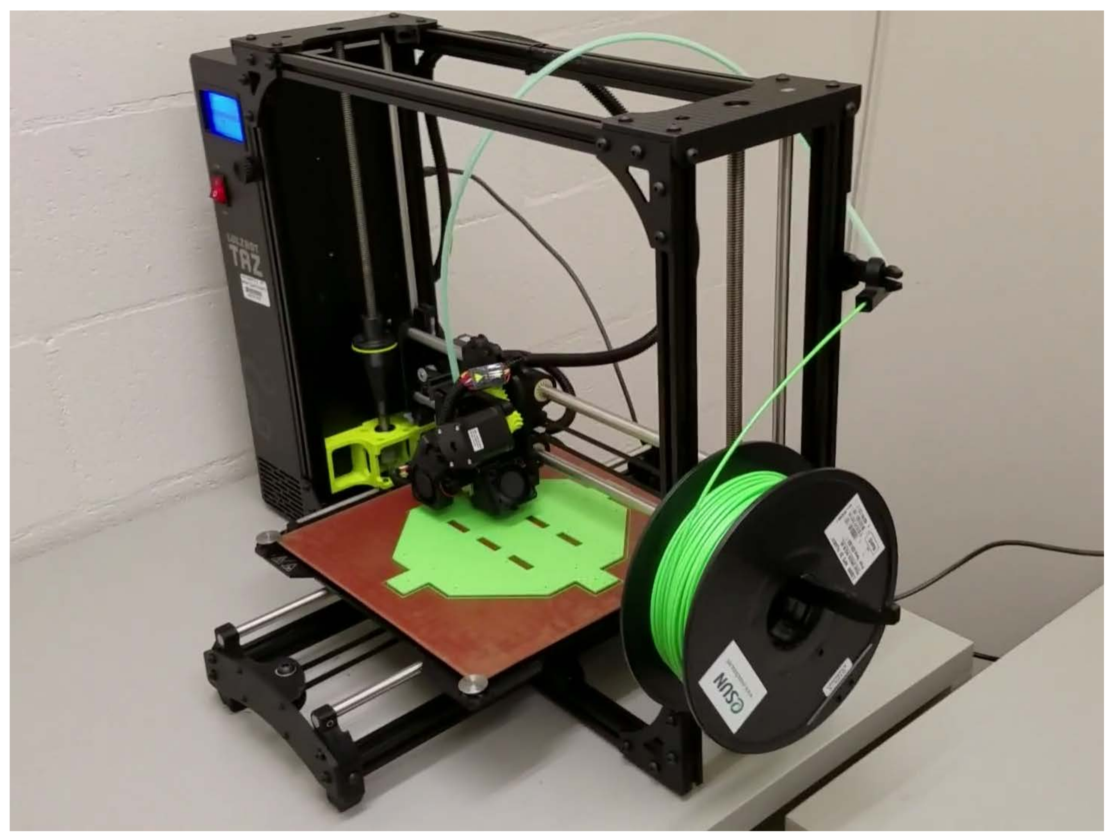
Scientific instruments and sensors come in all shapes and sizes. This design is modular and extensible, making mounting easy. In contrast, conventional drones are often sleek and highly polished, but are also interface-unfriendly.

The fully assembled Symetrix-Wing with motors and flight controller.

One of the four Symetrix-Wing arms detached from the main body.



The three unique pieces of an early version of Symetrix-Wing unassembled.



3D Printing the main body plate of the Symetrix-Wing design.

Future Design

OpenBeam

The next step for the drone will involve a simpler design that uses only two unique 3D printed pieces and an extruded aluminum bar called OpenBeam – itself an open source design.

Using OpenBeam for the arms will add strength and reduce weight, while also providing additional mounting surfaces for instrumentation. The aluminum arms should be able to withstand most crashes, and we will develop a 3D printed version of the arm for emergency replacement. Many hobbyists use carbon fiber tubing for the same purpose, but we think OpenBeam leads to more flexibility in configuration and mounting.

OpenBeam slotted aluminum extruded bar at left, with configuration of the new design at right.

Pixhawk 2.1

The current flight controller is a 3DR APM 2.5. Our next flight controller is the significantly more advanced Pixhawk 2.1, an open source, user community designed flight controller with the capability to support multiple GPSes with enhanced, centimeter-level precision and support for onboard processing through an Intel Edison expansion board.

Pixhawk 2.1 flight controller with advanced GPS and sensor suite.

Acknowledgments

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