TYTO ROBOTICS

Custom Windshaper Datasheet
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Windshapers

Custom wind walls for UAV testing and validation

Made in Switzerland

Introduction

Windshapers are a wind tunnel alternative used for testing full size drones and more.

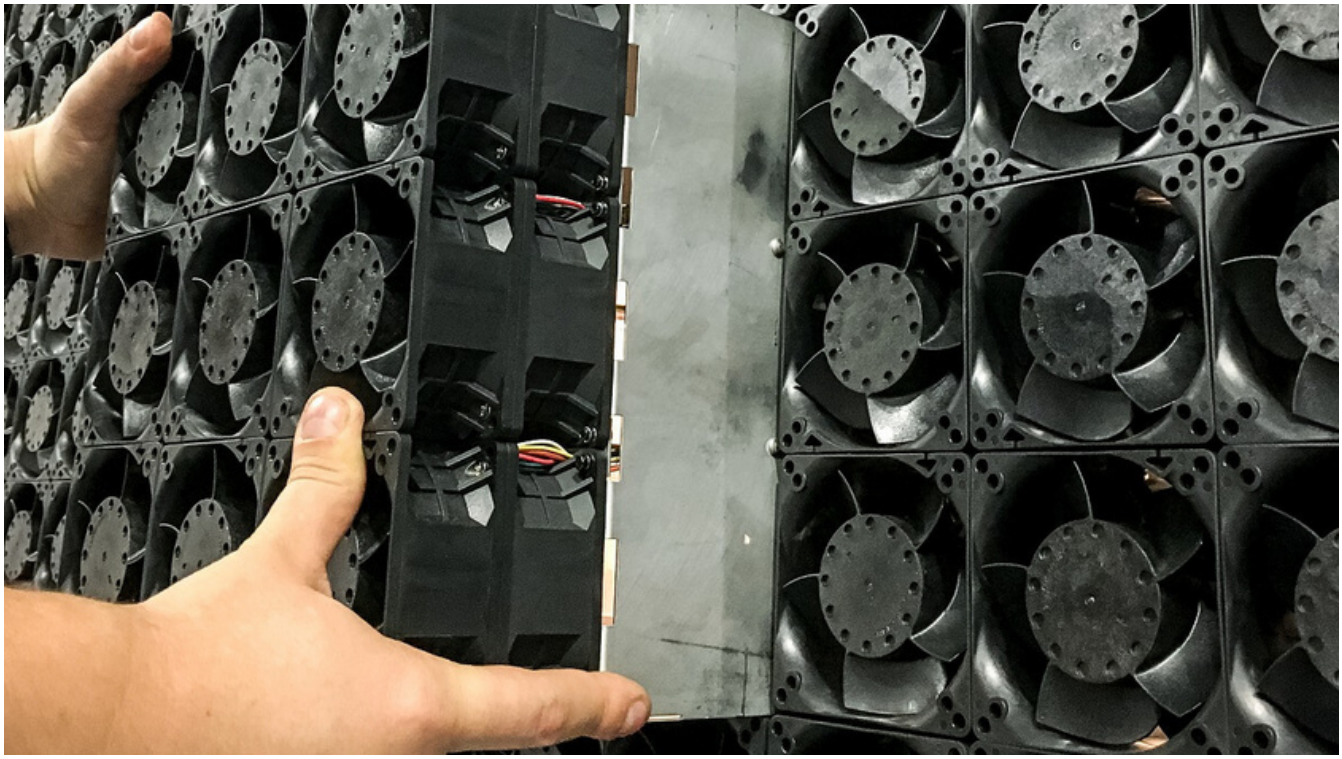
The Windshaper itself is composed of a wall of fans surrounded by a frame. Each fan is controlled independently so you can design and create unique 3D wind profiles like turbulence, gusts, take-off and landing conditions, and more.

How it Works

Windshapers can be built to any size and shape thanks to their modular infrastructure.

The Windshaper is composed of stackable modules that each have 9 ‘wind pixels’. Each wind pixel is equipped with 2 counter-rotating fans that can generate a flow speed up to 16 m/s (or greater with a convergent, see page 8).

The Windshaper is managed with the WindControl software (page 9) that allows you to precisely control each wind pixel's settings with simple commands or code.



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Applications

Below is a non-exhaustive list of possible use cases for Windshapers:

- **Free flight tests:** fly your drone directly in front of the Windshaper in 3D wind flows designed by you. Use gusts or time-variable flows to simulate terrain and obstacles.
- **Optimize fixed wing profiles:** study how the air flow interacts with your aircraft's frame.
- **Determine turbulence limits:** manufacture increasingly turbulent conditions with the Windshapers fans to identify your drone's limits.
- **Practice tiltrotor transitions:** practice one of the most complicated phases of flight.
- **Quantify/ validate flight time:** measure flight endurance in realistic conditions or validate the manufacturer's flight time figure.
- **Simulate failures (loss of GPS, motor, sensors, etc):** safely study drone performance when one or more systems fails.
- **Landing phase optimization:** use a Windshaper with a 180° tilting mechanism to produce vertical wind flows, simulating landing conditions like ground effect.
- **Troubleshoot problems encountered in a previous flight:** recreate problematic segments from a previous flight in order to troubleshoot potential issues.
- **Characterize your propulsion system:** pair your Windshaper with a thrust stand like the Series 1585 (5 kgf) or Flight Stand (15 kgf+) to characterize your motors and propellers.

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WINDSHAPERS ALLOW YOU TO PERFORM DYNAMIC TESTS IN CUSTOM CONDITIONS THAT ARE CONTROLLED AND REPEATABLE

Technical Specifications

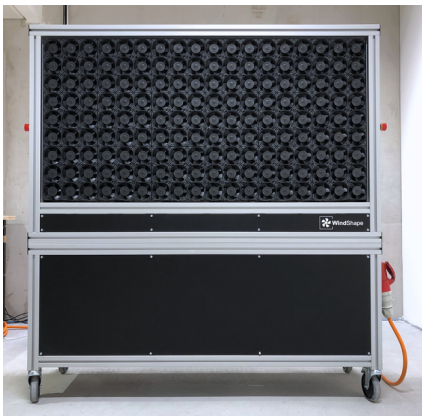
	Specification	Units	Value
Fan module specifications	# of wind pixels per wind module	n/a	9
	# of fans per wind pixel	n/a	2
	Total # of fans per wind module	n/a	18
	Single wind module width/height	meters	0.243
	Single wind module surface area	meters	5.905
Flow specifications	Minimum flow speed	m/s	2
	Maximum flow speed (without convergent)	m/s	16
	Maximum flow speed (with convergent)	m/s	Depends on size - ask our sales team for more information
	Ramp-up flow acceleration (hot wire at 1 m from the fans)	m / s2	4
	Ramp-down flow deceleration (hot wire at 1 m from the fans)	m / s2	3.6

Common sizes

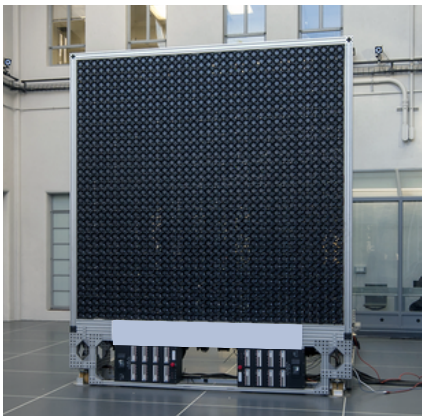
Windshapers can be built to any size and shape you need. Below are some of the frequently requested sizes.

2x2 Modules

6x3 Modules



12x12 Modules



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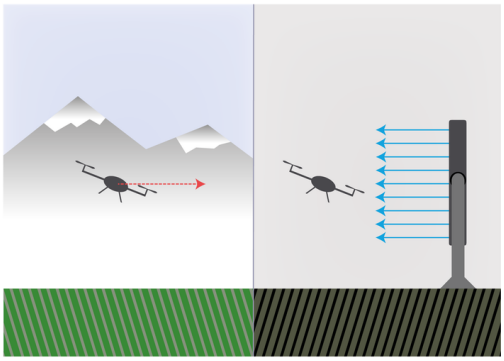
Wind Profiles

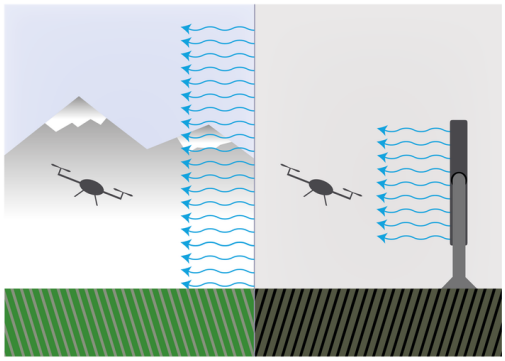
What makes Windshapers unique is their ability to create dynamic wind flows.

Traditional wind tunnels produce a uniform flow, whereas Windshapers use 3D input ($u = f(x, y, t)$) to generate diverse patterns such as these:

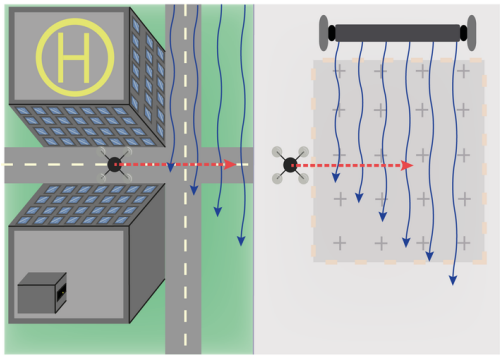
Uniform Laminar Flow



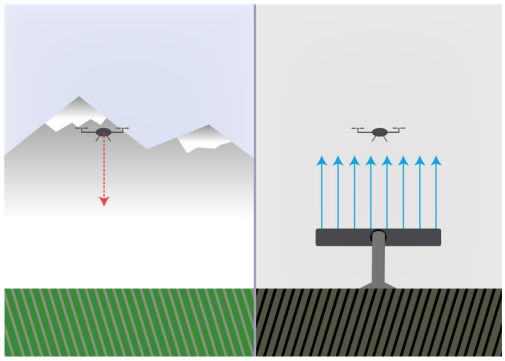
Turbulent Flow



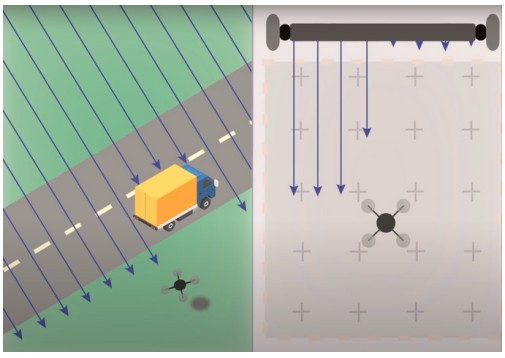
Shear Flow



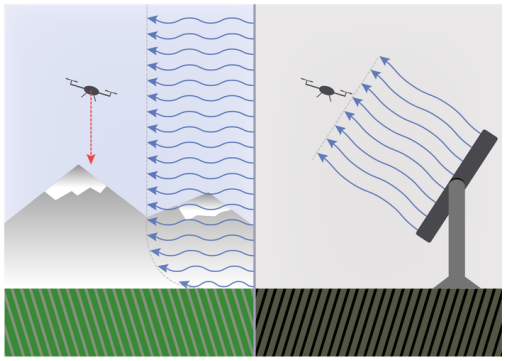
Vertical Wind



Time Variable Flow



Simulated Terrain



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Hardware and Electronics

Windshapers arrive fully equipped with hardware, electronics, and software (page 9).

Here's what's included:

Structure

- The Windshaper itself consists of a wall of fans that generates both horizontal and vertical flows (1). Side walls (2) can also be installed to generate cross wind profiles. The system is powered by two main distribution boxes (3) and a control network consisting of Ethernet switches, routers, and an onboard computer (4).

Power and Control Unit

- Each wind module is connected to a Power and Control unit. This unit contains two systems: a control system and a power system. The power system can convert input AC tension into 12 VDC, which is needed to power the fans. The control system is controlled with a microcontroller.

  The microcontroller is connected to the Windshaper's Local Area Network (LAN) and communicates with the onboard computer via an Ethernet protocol. The integrated microcontroller interprets the signals and pilots the fans accordingly. The status of the module (power status, health, fan status, etc.) is sent to the main onboard computer

Optional Features

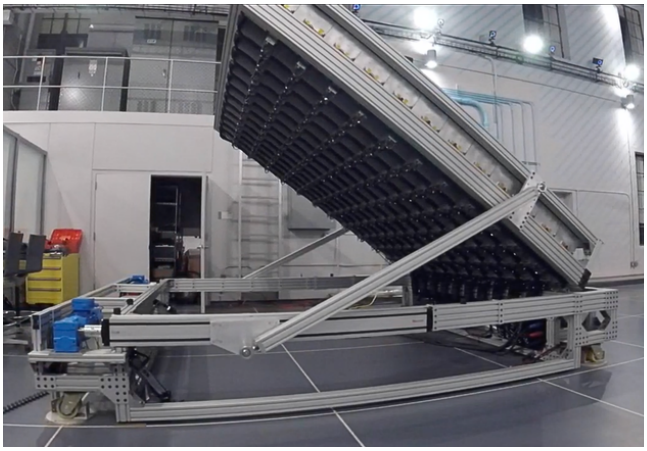
These features are optional add-ons you can use to enhance your testing capabilities.

Flow Filter

The Windshaper can be equipped with a flow filter to reduce unwanted turbulence. This feature ensures an even flow of air and is a great option for studying ground effect and a multicopter's ability to fly in its own landing-phase turbulence.

Tilting Mechanism

The Windshaper can be constructed with a tilting mechanism to allow for wind flow in any direction. With tilting capability up to 90°, an entire progression can be simulated from take-off to forward flight and back to landing.



Flow Convergent

A convergent device can be added to your Windshaper to increase the speed of the wind from 16 m/s up to 45 m/s, depending on the test section dimensions. Ask our sales team for more information about this add-on.

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Software

Your Windshaper is managed with the WindControl software that allows you to fully and precisely control the wind settings with simple commands. You can manually select the wind pixels that you wish to activate or you can input a mathematical function to produce a steady wind profile or a time-variable wind profile. You can also control your Windshaper directly from a Python script using the Python control API.

Features:

- Dynamic control of the wind profile u = *f*(x, y, t)
- Smallest possible time step with dynamic control: 0.1 s
- Ready swirl control for each wind pixel
- Cross-platform portability (operating system)
- Network communication between user and Windshaper through Ethernet connexion
- Custom scripting interface using Python control API
- Web-based graphical user interface