Project FireEye

Exploring Wildland Fire Applications with ARDi

Project FireEye

Western Willow Ventures Inc. (WWVi) built ARDi to explore its applications for aerial photography and aerial videography. The Government of the Northwest Territories (GNWT) partnered with WWVi on Project FireEye to explore the applications in wildland fire that ARDi and other micro-UAVs might provide today and tomorrow. Considering current costs for aircraft and fuel, UAVs like ARDi may be the key to lowering many operating expenses in wildland fire management.

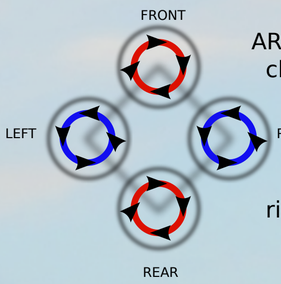
What is ARDi?

ARDi stands for Aerial Research Drone 1. ARDi is a quad rotor aircraft. The design was first flown in the early 1920s and made the first records for flying distance of any helicopter(1).

Helicopter designed by George De Bothezat, making descent at McCook Field after remaining airborne for two minutes, 45 seconds.; February 21, 1923(1)

ARDi is a very small UAV or Unmanned Aerial Vehicle. It is powered by a lithium - polymer battery that powers brushless motors. This make ARDi lightweight, inexpensive to operate, and has a zero carbon emmision footprint for operation and maintenance. ARDi can be charged by solar power, by vehicle electrical systems or directly from 110v electricity.

ARDi has a computer brain that manages stabilization and basic flight control. The flight physics used by this platform are unlike any commercial aircraft being used in wildland fire today. Conventional rotory winged aircraft require compensation of gyroscopic forces from the main rotor and add additional burden on the pilot and the mechanical equipment.



ARDi does not have this limitation since the front and back rotor turn clockwise and the left and right rotors turn counterclockwise thus cancelling out the gyroscopic effect. This coupled with fixed pitch propellors allows unparalleled control without mechanical linkages and other moving parts. Using gyroscopic principles the aircraft can rotate on the vertical axis, tilt foward, tilt left and right by simply changing prop rotation speeds.

ARDi - Evolution

ARDi 0.0
Flight Controller
Engines & Props
Altitude Sensor
Sony FPV Camera
Fox 2.4 Ghz Video Tx
Orientation Lighting

ARDi 1.0
Protective Dome
Prop Savers
Landing Gear
HD Camcorder
Low Vibration Cam Mount
Reverse Blinker
Video Tx Mount

ARDi 2.0
Radio RX Mount
Light HD Camera Mount
(More Harmonic Vibration but less overall weight)
New Lighter Battery pack
(With XT-60 Connectors)

ARDi 3.0
CMOS FPV Cam (pilot)
CCD FPV Cam (Co-pilot)
Tilt-Servo Camera Mount
5.8 ghz FPV Video TX
Vario Controlled Alt. Hold

ARDi 4.0+ The Future

As new technology becomes readily available, ARDi will continue to evolve. The following is a list of active features that are currently being developed for ARDi 4.0

- Cameras controlled by head movement of pilot and co-pilot
- GPS controlled position and altitude hold
- GPS navigation for automated missions
- bidirectional programming link for real-time modification to flight physics and mission paramaters
- Outboard co-pilot controls for cameras and sensors
- Groundstation with real-time mapping, logging and reporting
- Multiple monitoring options like goggles, mini monitors and full blown HD displays.
- On screen (in the goggle video) instrumentation and real-time flight data

Fire Detection

Detecting wildfire is one area where ARDi can assist in a very inexpensive way. ARDi can be piloted and observed from inside the cupola of a fire tower offering additional detection power to the tower personnel. While ARDi is used in observer mode, tower personnel can rise hundreds of feet above the cupola for a better airborne view. The vertical rate of climb is very high so it takes only moments to rise to high altitude to do a 360 degree video panorama for smoke detection later on the ground.

Future applications could include unmanned, pre-programmed smoke patrols using solar powered electrical fuel caches with built in charging and satellite communications for data delivery.

Observation

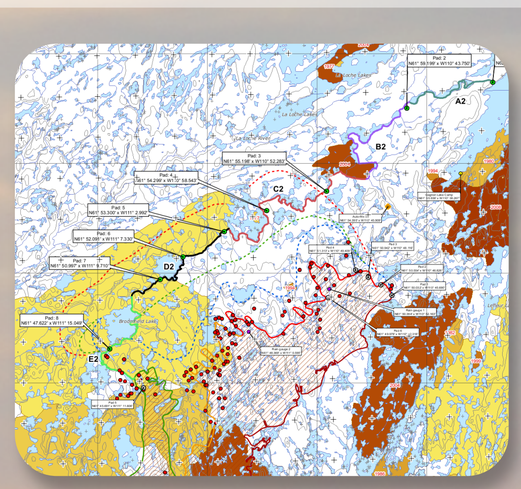
Observing wildfire behaviour is a risky business, and doing it from an aircraft is even more so. As we increase the tasks we give to our pilots, we increase risk to passengers. Better risk management includes safer ways to accomplish the same thing. ARDi can safely observe the most extreme fire behaviour with zero risk to human life. Both pilot and observer(s) are safely away from the extreme conditions being observed. In the future we may be able to use stereo HD video to create a safe, wholly immersive, 3D fire behaviour experience.

Monitoring

Monitoring of wildland fire is just as much a risk as behaviour observation, however, the risk factor increases with the frequency the fire is flown. Monitoring of wildfire is also used as a safety precaution for fire line personel and so is more common than behaviour observation. For this reason, safer and cost effective monitoring means safer fireline operations. ARDi can fly repeated exhaustive missions to monitor changes in fire behaviour, column development and weather changes. ARDi has onboard temperature and barometric pressure sensors and analysis of gps and engine data can reflect wind conditions. In the future, with the addition of infrared and RH sensors, ARDi could provide valuable feedback realtime as well as record sample data for computer based analysis and even detect spot fires.

Mapping

There are many options for mapping wildland fires including; fixed wing, rotary wing, satellite imagery, ground based mapping and more. Depending on why a fire is being mapped, the approach to mapping might be a compromise to keep costs low or because aircraft are not available. ARDi has the ability to create realtime maps or to capture fire perimeters after the fire is out. In the future, built-in high power GPS (higher than commercial hand held) and smart navigation technology with real time video make ARDi a cost effective mapping solution. Visually guided and temperature based mapping are both possibilities.



Documentation

Fire-line documentation activities can pose undue risk and expense. ARDi can address many of these issues. During planning; identification of escape routes & safe zones, During off-season; documenting values at risk, During operations; visually identify and confirm resources on the fire-line, Afterwards; documenting crown fraction burned, other burn indicators and fire cause investigation. In the future, ARDi may greatly improve FireSmart and community protection documentation.

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