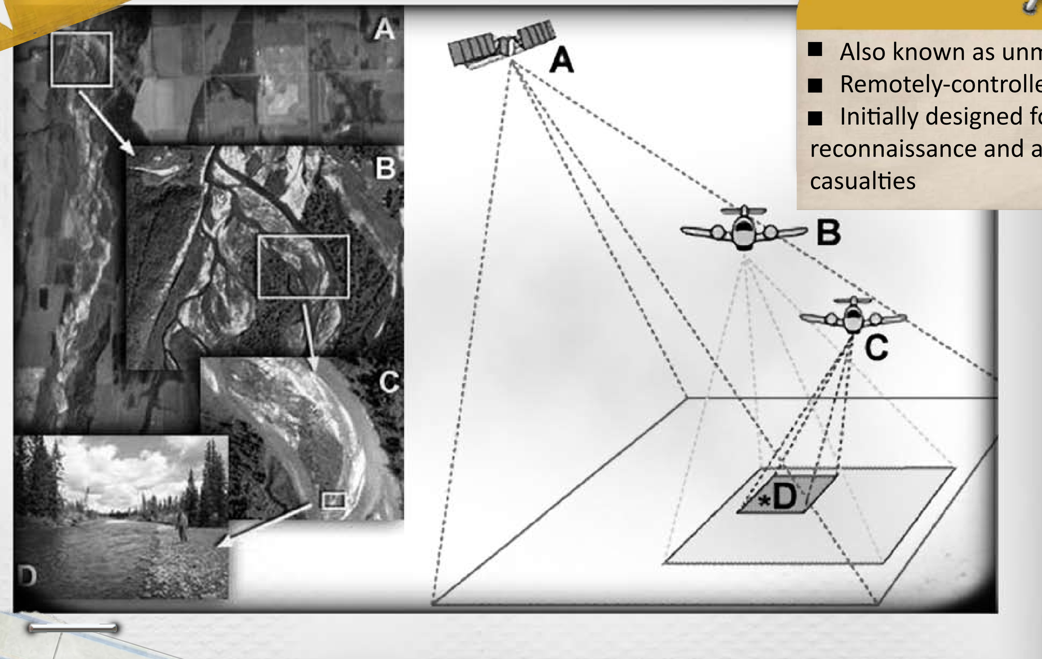
explore

SENSING REMOTE EDUCATION

INNOVATE

Unmanned Aircraft Systems: Why and What for?



- Also known as unmanned aerial vehicles or drones
- Remotely-controlled or autonomous pilotless aircraft
- Initially designed for military purposes, to perform reconnaissance and attack missions while reducing casualties

Successful research in remote sensing relies on multiple-view approaches to data collection:
Multi-spectral remote sensing
Multi-temporal remote sensing
Multi-stage remote sensing

Gathering and analyzing information at several geographic scales.

Low-altitude, high-resolution aerial observations are necessary to bridge the gap between in situ and satellite-based observations.

Recent developments have opened up the UAS market to the scientific community, but it is not without challenges: e.g. cost, regulations, training, payload miniaturization, image processing.

Civil Airspace Regulations and UAS Training.

An application for a SFOC is evaluated by Transport Canada. It aims at demonstrating the predictability and reliability of the UAS, especially its ability to perform in the desired environment. It also assesses the aptitude of the flight crew to operate the UAS without putting at risk the safety of the public and other users of the airspace.

My training to become a safe and responsible UAS operator and the first UAS pilot at Athabasca University:

1) Commercial UAS training course @ CCUVS
2) MAAC wings training program @ Strathcona Remote Controlled Flyers Association
3) Private Pilot Ground School @ Cooking Lake Aviation Academy
4) Restricted operator Certificate with Aeronautical Qualification, Industry Canada)

Section 602.41 of the Canadian Aviation Regulations (CARS) states, "no person shall operate an unmanned air vehicle in flight except in accordance with a **Special Flight operation Certificate**".

The Penny Belle UAS Fleet of Athabasca University.

Inexpensive at Purchase; Easy to Transport and operate; Durable; Endurant; Reliable and Precise; All-weather flying capability; Low Maintenance and operation Costs (e.g. it consumes less than 5% of the fuel used by a Cessna 172, and less than 0.5% of the fuel used by a Twin otter; also, it uses readily available high octane unleaded gasoline)

... AU's UAS fleet is composed of Two small unmanned aircraft systems, with good autonomy (6+ hours) and payload capability (up to 10 Kg), and a cruise speed of 22 m/s.

Penny Belle

Equipment List

1. **Strong composite airframe** (UAVFactory) with 80W alternator /generator system to power the payload and electronics & recharge onboard batteries. — $15,000
2. **Powerful, versatile autopilot** (MP2128g/MicroPilot) – electronic circuit board (28g) that allows autonomous flight while providing real-time attitude of flight. It includes: — $4,500
   - a Global Navigation Satellite System (GNSS) that continually measures the geographical position for tracking the UAS and automating its navigation;
   - an Inertial Measurement Unit (IMU) to manoeuvre the UAS and report on the aircraft's speed, orientation, and gravitational forces, a set of variables required, later, for correcting the UAV imagery from distortions;
   - a digital compass (for dead reckoning), ultrasonic altimeter (for autonomous take-off/landing), & airspeed probe.
3. **Real-time kinematic GNSS** (AsteRx2e/Septentrio) – to support the georeferencing of the imagery with a precision down to 5 cm — $10,975
4. **Ground Control Station (GCS)** – a tracking antenna provides real-time communication between the drone and a ground-based rugged laptop equipped with a wireless modem and control software. The GCS is used to pre-schedule the flight trajectory, upload changes during the flight, and to collect the data recorded by the payload. — $5,000
5. **Payload (for aerial photography)**: high-resolution, digital single lens reflex camera (Nikon DSLR camera D300s, 12.3 megapixels; Nikon lens AF-S 50mm f/1.4G). — $2,500
6. **Miscellaneous**: Futaba 8FG Tx/Rx (for manual piloting), toolbox, Lion batteries, etc. — $1,500

Less than $40,000! For comparison, the Aerosonde, first civilian UAS to cross the Atlantic, costs $175,000 and offers similar performance.

Alternatives?

RENEW REUSE RECYCLE

The world – with both its physical and human aspects – is the geography laboratory. "In many respects fieldwork is geography's signature pedagogy at the undergraduate level".

Hovorka and Wolf, 2003. Activating the Classroom: Geographical Fieldwork as Pedagogical Practice. Journal of Geography in Higher Education, 33(1), pp. 89-102.

Exposition to fieldwork in **conventional geography programs:**
- Field research (primarily advanced undergraduate and graduate students)
- Field excursions, such as field lectures on campus, local field trips (1–2 days), and residential field courses off campus (1–2 weeks).

field trips

Implementing fieldwork is the greatest challenge in developing online courses in geography at Athabasca University!

Traditional Field Trip?!

mFieldtrips: Mobile Technology-Guided Fieldtrips

A true, flexible, and affordable alternative to authentic fieldwork experiences!

mFieldtrip 101

A mFieldtrip is a field trip undertaken by students, individually or as a group, in the absence of direct supervision from an assigned instructor. Instead, it is facilitated by a mobile device that acts as a guide by drawing students' attention to geographical features of interest. The mobile device also delivers a list of tasks and reflective questions to students as they undertake the field trip. Finally, it enables data collection and annotation in the field.

Long-term Objective

Searchable repository of mFfieldtrips located within a convenient radius of a student's home, for most of Canada, suitable for a 1- to 2-day trip max. These could be taken during a week-end, without impinging on annual vacations or family activity!

2012/2013

Prototype mFieldtrips in Alberta are in construction for Geography 266,306,201,311

Simulated Mock mFieldtrip.

The Rest of the mFieldtrip Team:
Dr. Tan, Dr. Zhang, Dr. Evans

CVGES

Collaborative Virtual Environment in Support of Virtual Fieldwork and Learning for an Online Course on Snow and Ice Dynamics

Near-Realtime Simulation of Snow Cover Conditions

SnowModel is a spatially distributed model that simulates the spatio-temporal variability of snow accumulation and ablation.

This variability is controlled by atmospheric forcing conditions and how these forcings interact with the local topography and vegetation cover.

Required Inputs:

1) Temporally varying fields of meteorological variables within or near the simulation domain.

2) Spatially distributed topography and vegetation type.

SnowModel is designed to run grid increments of 1m to 10 km and temporal increments of 10 min to 1 day.

SnowModel is an aggregation of four submodels:

- **MicroMet**
  - Produces high-resolution meteorological forcing distributions.
  - 8 variables, from meteorological station datasets (single station to thousands of stations), remote sensing observations or gridded atmospheric model or analyses datasets.
- **EnBal**
  - Calculates surface energy exchanges.
  - Surface latent and sensible heat flux and snowmelt.
- **SnowPack**
  - Calculates SD and SWE evolution in response to the precipitation and melt fluxes.
  - Simulates snow density changes in response to snow temperature, weight of overlying snow, and snowmelt.
- **SnowTran-3D**
  - Simulates snow-transport processes in variable topography and vegetation cover.
  - Includes 23 predefined and 7 user-defined vegetation types.

Liston, Glen E., Kelly Elder, 2006: A Distributed Snow-Evolution Modeling System (SnowModel). Journal of Hydrometeorology, 7, 1259–1276.

Wx | DEM | VEGET

The CVGE Concept / What Will it Do?

Representation of a real scenario through a 3D virtual environment populated by autonomous agents capable of interacting with the VGE and the objects it contains (i.e. snow cover).

The students avatar will be able to perform all the tasks real students can perform in the real field: e.g. explore their surroundings, gather information and memorize it, plan the sampling of snow cover according to what they see and what they know, interact with the snow pack (i.e. sample collection), interact with other agents (students or virtual field instructor).

Data/Material

1-km grid cells: AVHRR Land Cover Map of Canada + 30 arc-seconds Canada3D DEM.

30-m grid cells: Landsat ETM+ land cover + ASTER DEM 30m.

<10-m grid cells: Unmanned Aerial Survey with the AU's Penny Belle UAS.

Athabasca University Weather Station

The Wx station provides the 8 variables for SnowModel: Air temperature, relative humidity, wind speed, wind direction, incoming solar radiation, incoming longwave radiation, surface pressure, and precipitation.

2012/2013 Missions

everything begins with that first small step

Partners (External)
PACTEAM
Dr. Calmels @ University of Alberta
N. Kinar @ University of Saskatchewan

Funding
Health Canada
churchillnorthernstudiescentre
MicroPilot

Permafrost vulnerability and landscape changes related to climate change in the Jean Marie River First Nation, NWT

Mapping of Snowmelt patterns at treeline, Churchill, Northern Manitoba

Future Applications

Until you spread your wings you will not know just how far you can fly...

Aerobiological sampling of pollens and pathogens (fungi, bacteria, & viruses)

Monitoring populations of free-range mammals (i.e. wild horses of Alberta): aerial counting and habitat survey.

CubeSat/magnetometer calibration and validation. communications.

Multiple UAS cooperation, navigation, and collision avoidance within civilian airspace.

Virtual Geographical Environments for Distance Education in Geography.

Only the Sky's the Limit...

... When We Work Together!

Collaborators:
Dr. Reckseidler-Zenteno; Dr. Treu, Dr. Eley, Dr. Connors (AU/Centre for Science); Dr. Tan, Dr. Lin, Dr. Kumar (AU/School of Computing and Information Systems)
Dr. Theau (U. Sherbrooke), Dr. Notzke (U. of Lethbridge)

Frederique Pivot, PhD
Assistant Professor in Physical Geography