Experiences deploying low-cost camera systems in the Arctic

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Introduction

Low cost, low power cameras for taking images at rates from every 15-minutes to 1 per day.
Introduction

Why:
- Sky conditions
- Plant growth
- Detect icing
- Out reach
- Fun!
Introduction

Constraints:

- Power
- Temperature
- Vibration
- Light extremes
- Bandwidth
- Embedded Linux
Survey of Camera Types
CCD Imagers and DSLR Cameras

NICT Poker Flat ASI
- All-sky imager (ASI)
- Aurora
- Optical dome
- Controlled environment

Plato HRCAM
- Canon EOS 50D
- Sigma fish-eye lens
- Specialized enclosure
- Rated to -80C
- Embedded ARM computer
Point and Shoot

- Firmware hacks (CHDK)
- Remote control
- Mechanical movement
- Product lifetime cycles
- Needs housing and power

[gphoto.org](http://gphoto.org)
[chdk.wikia.com](http://chdk.wikia.com)
Extreme Sport Cameras

GoPro

Pros
- Oh, so close to what we want!
- Designed for outdoor use
- Weather proof
- Shock resistant
- Good optics

Cons
- Appliance-like
- Closed systems
- No remote control / access
- Short term operation

Ion Air Pro
Campbell Scientific CC5MPX

**Pros**
- 5 megapixel (2592x1944)
- Temperature rated (-40C)
- Self-contained
- Still images and video
- Low power
- Window defroster

**Cons**
- Data logger oriented
- Limited web interface
- Configuration changes
- Data access
Ethernet Netcams

Pros
- Well suited, easy to use
- Temperature rated
- Web and telnet interface
- Easy configuration mods
- Panoramas

Cons
- Ethernet draws power
- Manual focus issues
- Need for a housing

StarDot

Sony PTZ
Cell Phone Cameras

- TI OMAP35X processors support serial camera interface (CSI)
- Omnivision OV5642 5MP sensor
- Temperature rated to -30°C
- Connected close to processor
- Limited to 1–2 cameras
Serial Camera Modules

- RS232 interface
- Single image
- Simple communication protocol
- Changeable lenses
- Multiple cameras
Webcams

Pros

- Off the shelf ready
- USB connection
- Low power
- Inexpensive

Cons

- Video only
- Product lifetime cycles
- Need housing
- Not temperature rated

Logitech C910
The Gotchas
Things to Look For In A Webcam

- **UVC**
  - USB video class
  - “Driver free”
  - Works on Windows/Mac/Linux
  - Interface for controls

- **Functions in hardware**
  - Auto gain
  - Auto exposure
  - Auto focus
  - Most cameras do these in software

- **User community**
  - Where will you find information?
  - Decent tech specs
  - Good forums and mailing lists
Gotcha: Focusing
Greenland Netcam Deployment

- Manual focus ring adjust and locked down before shipping
- Became loose or knocked during installation
- Required creative work around in field to see image
- Hardware control focusing helps
- Computer sets camera to focus at infinity
Gotcha: Frosting
OBuoy-4 Arctic Ocean

- Frost build up happens
- Usually just wait for it to clear
- Auto focus needs to be disabled
- New OBuoy deployed with heater ring around lens
Gotcha: Exposure Settle Time

IceLander Buoy

- Internal hardware only adjusts settings when stream starts
- Need to wait for a minute to settle
- White balance, gain, brightness settings
Gotcha: Resolution

Why is my HD camera only 640x480?

- USB webcams really just stream video
- There is no still image capture
- You pick a frame out of the stream
- USB speed determines the frame rate
- The frame rate determines the resolution
- USB 2.0 Hi-Speed (480Mbps)
- USB 2.0 Full-Speed (12Mbps)
- Issues with multiple cameras
Example Deployments
Analtuvuk River Burn Site, Alaska
Is it Safe To Fly Today?
Analtuvuk River Burn Site, Alaska
Weather Station Monitor

Composed from our standard toolbox
Webcam Housings

- Hammond Manufacturing polycarbonate cases
  www.hammondmfg.com/1554FCLP.htm
- Waterproof zinc USB cables
  www.usbfirewire.com/usb-rugged-waterproof-zinc.html
- RAM mounts for connection to structures
  www.ram-mount.com
O-Buoy
Ice–Tethered Chemical Sensing Buoys
BROMEX12
March 2012, Barrow, Alaska

UAF IceLander-2

USNA IceGoat-1
Software

- fswebcam
  - Collect an image from the camera
  - www.firestorm.cx/fswebcam
- yavta
  - Set UVC controls (brightness, focus, etc)
  - git.ideasonboard.org/yavta.git
- ffmpeg
  - Movie generation
  - ffmpeg.org
- Data transport network
  - Scheduling, power
  - datatransport.org
Taking A Picture

Schedule

• Only take pictures during the day
• Sun position computed from GPS/Iridium position

Capture Sequence

• Power on USB ports
• Set UVC controls with yavta
• Take image with fswebcam
  ▶ Start stream
  ▶ Skip frames
  ▶ Save one
• Remove UVC device drivers
• Power off USB ports
Arctic Eyes
Real-time Global Camera Display