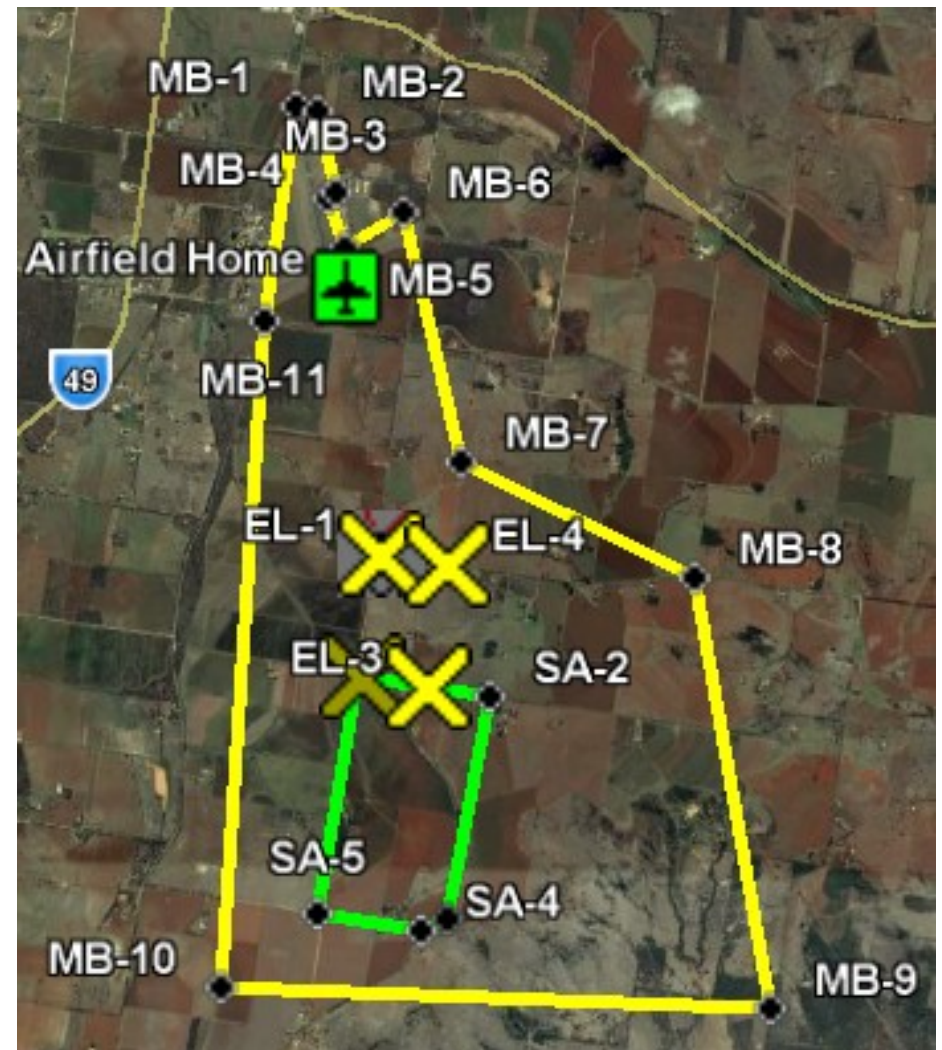


Rescuing Joe



Outback Challenge

- Search for lost bushwalker
 - Kingaroy, Queensland in September
 - 53 teams, 10 countries
 - 2.2 by 1.2 km search
 - 1 hour for 68 km flight
 - computer vision/search
 - fully automatic flight
 - auto takeoff/land
 - geo-fencing
 - documented safety system
 - drop water bottle
 - don't hit Joe!



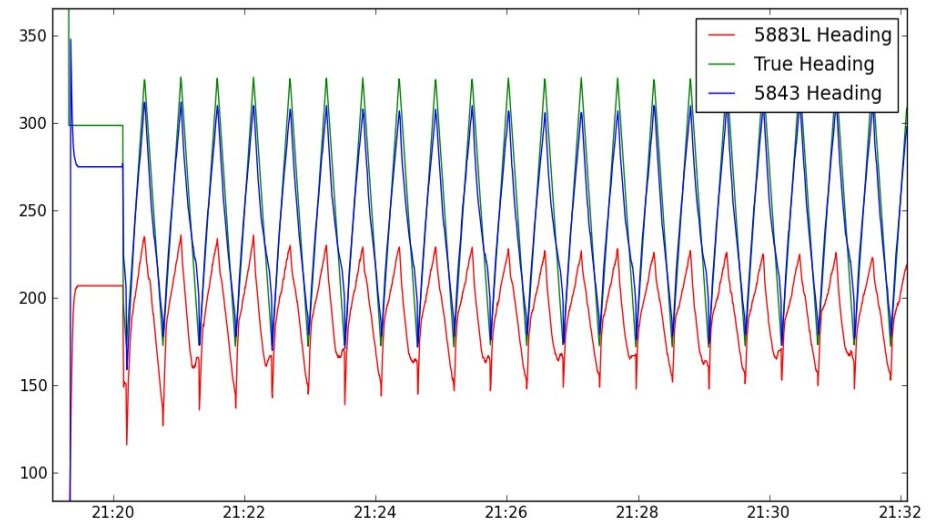
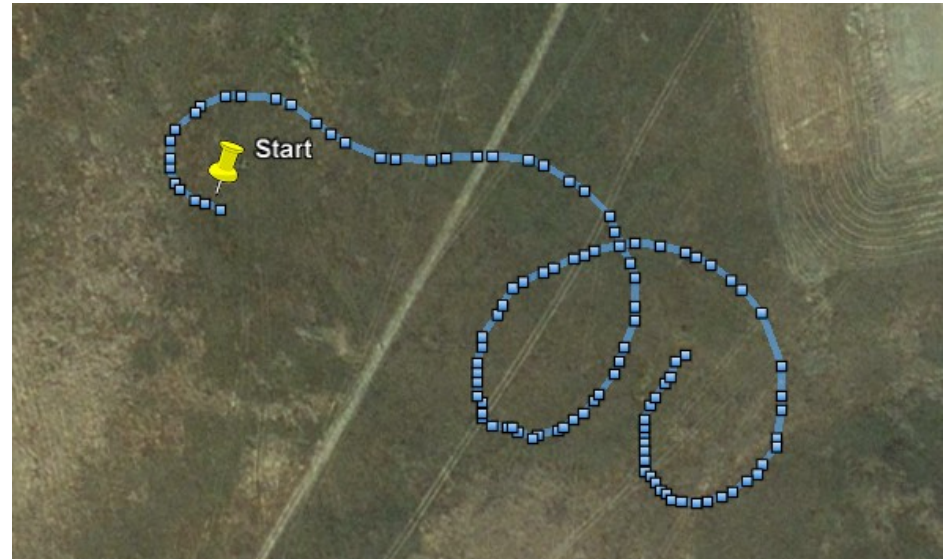
CanberraUAV

- Diverse team
 - aeromodelling
 - amateur radio
 - electronics
 - computer vision
 - software
- Open project
 - All code and schematics released
- Affiliations
 - Canberra Model Aircraft Club
 - Dickson College school team
 - MakeHackVoid hackerspace



Technical Challenges

- Not an easy task!
 - building airframe
 - autopilot
 - navigation
 - accurate sensors
 - reliable radio links
 - machine vision
 - camera control
 - ground station
 - vibration control



SkyWalker

- Early test plane
 - 1.7m wingspan
 - 2.5 kilograms
 - electric
 - 1 hour flights
 - easy/slow flight



Senior Telemaster

- Test workhorse
 - 8 foot wingspan
 - 7 kilograms
 - electric
 - 30 minutes flight



Mugin (CyberHawk)

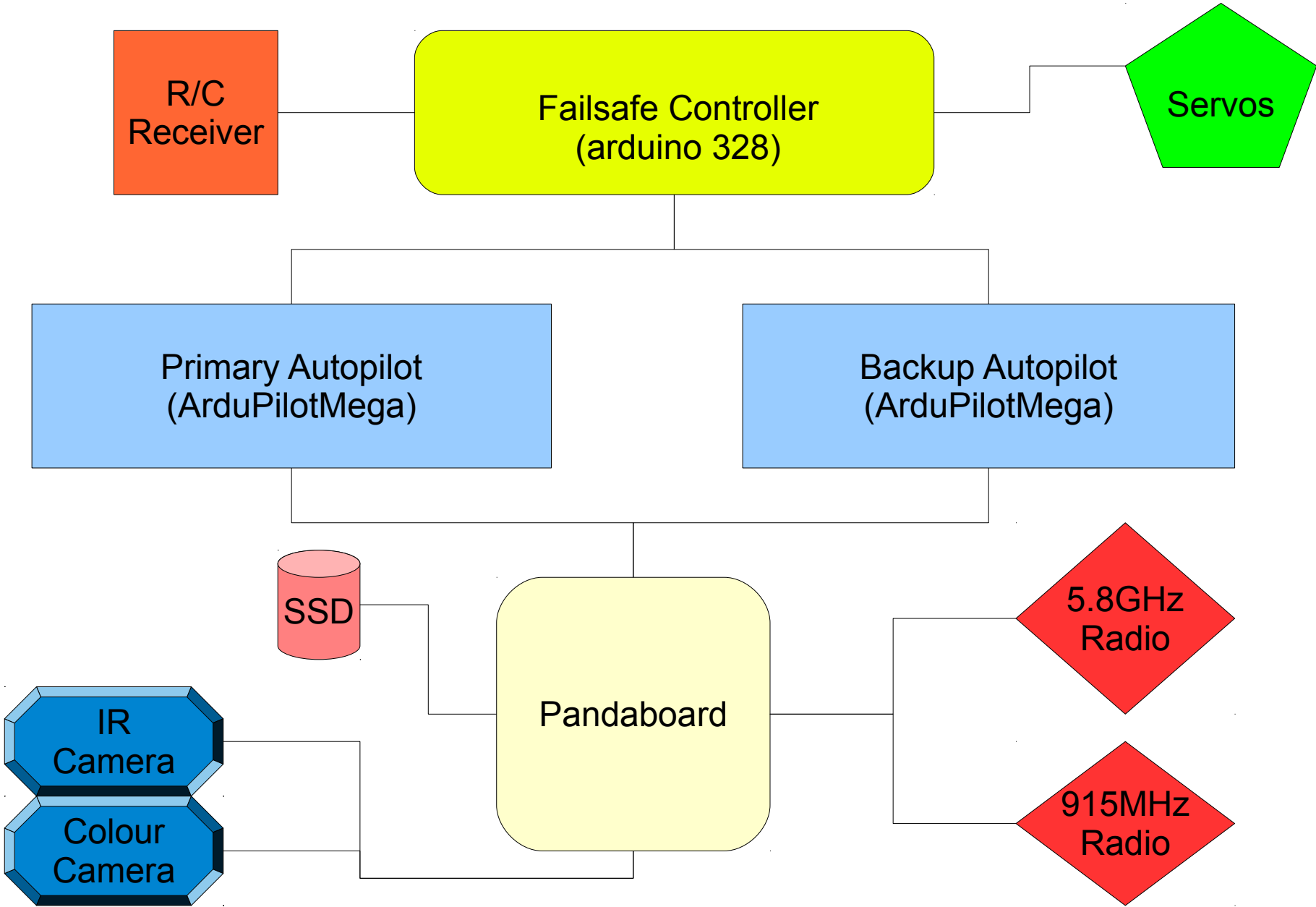
- Competition airframe
 - 3m wingspan
 - 20 kg takeoff weight
 - 50cc petrol motor
 - ~3hrs flight time



additional test aircraft...



Avionics

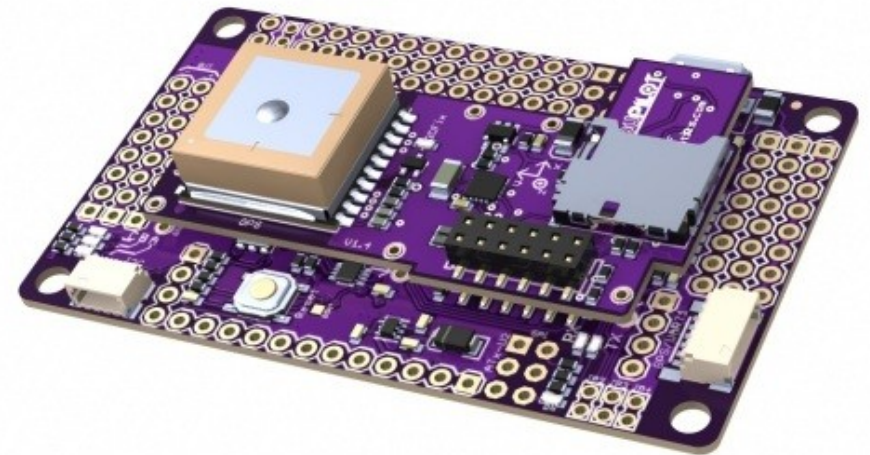


what it really looks like ...



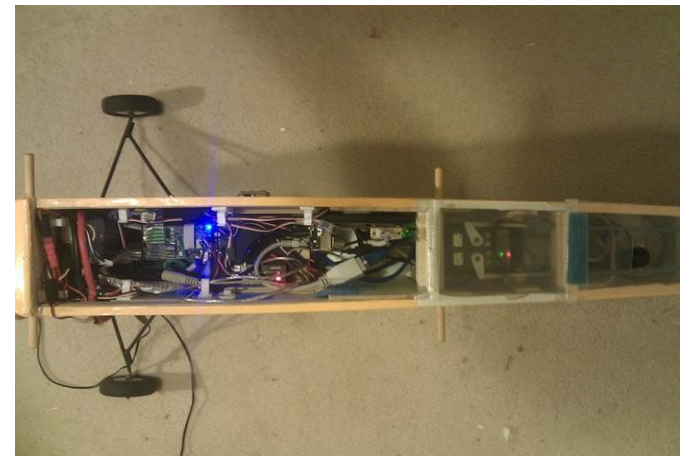
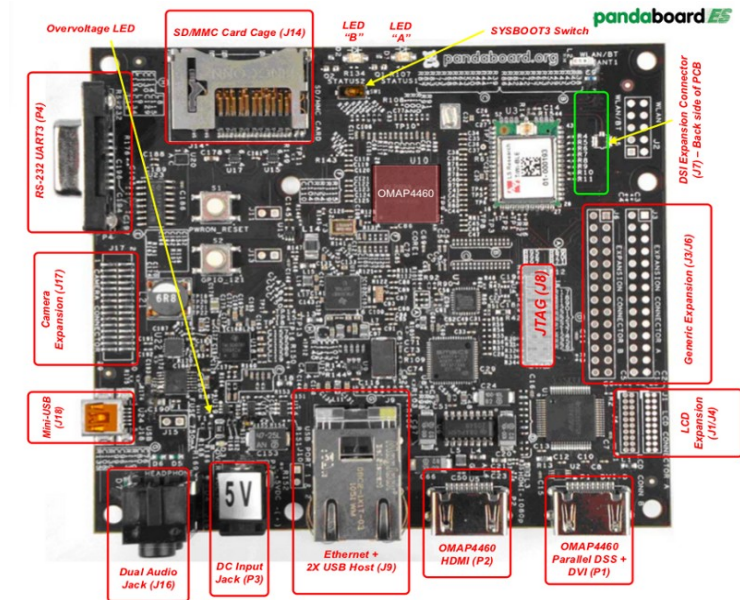
Autopilots

- ArduPilot
 - AVR2560 CPU
 - 8kb ram/256kb flash
 - 8 channel RC in/out
 - 4 UARTs
 - 3 axis gyro + 3 axis accel
 - 3 axis magnetometer
 - barometer (altitude)
 - GPS
 - airspeed (pitot)
 - sonar (low level altitude)
 - Open hardware/open software



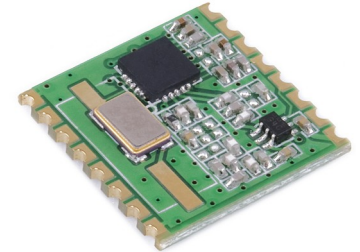
On-board computer

- Pandaboard
 - dual core 1GHz ARM
 - SSD storage
 - Ubuntu Natty
 - mission control
 - logging
 - machine vision
 - radio comms
 - lots of python scripts!



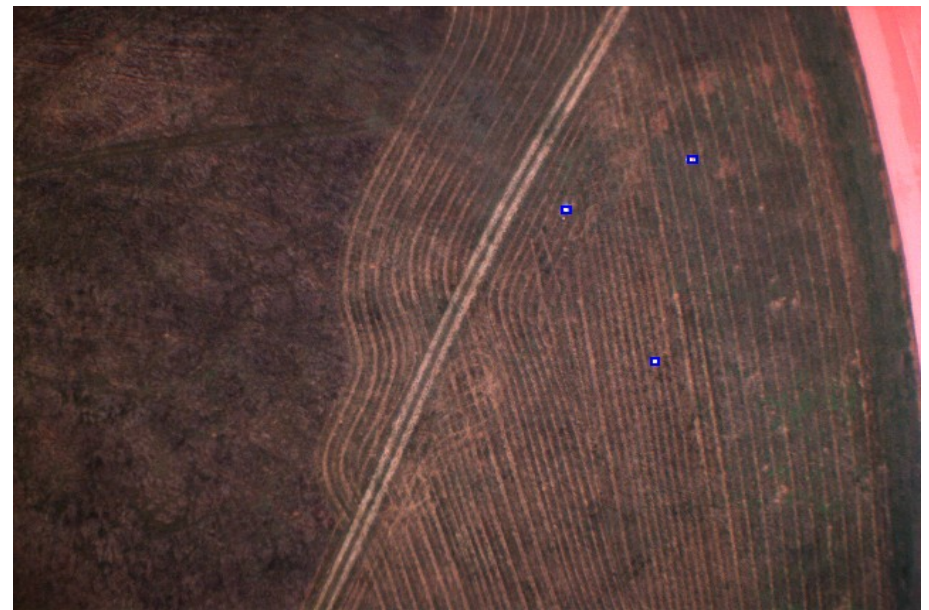
Radio links

- High bandwidth link
 - for images, control and high rate telemetry
 - Ubiquity 5.8GHz bullet
 - plus 5.8GHz amplifier
 - ethernet bridge
 - about 1.5Mbps
- Low bandwidth link
 - for telemetry/control
 - needs to be very reliable
 - RFI or HopeRF 915MHz
 - 9600 baud



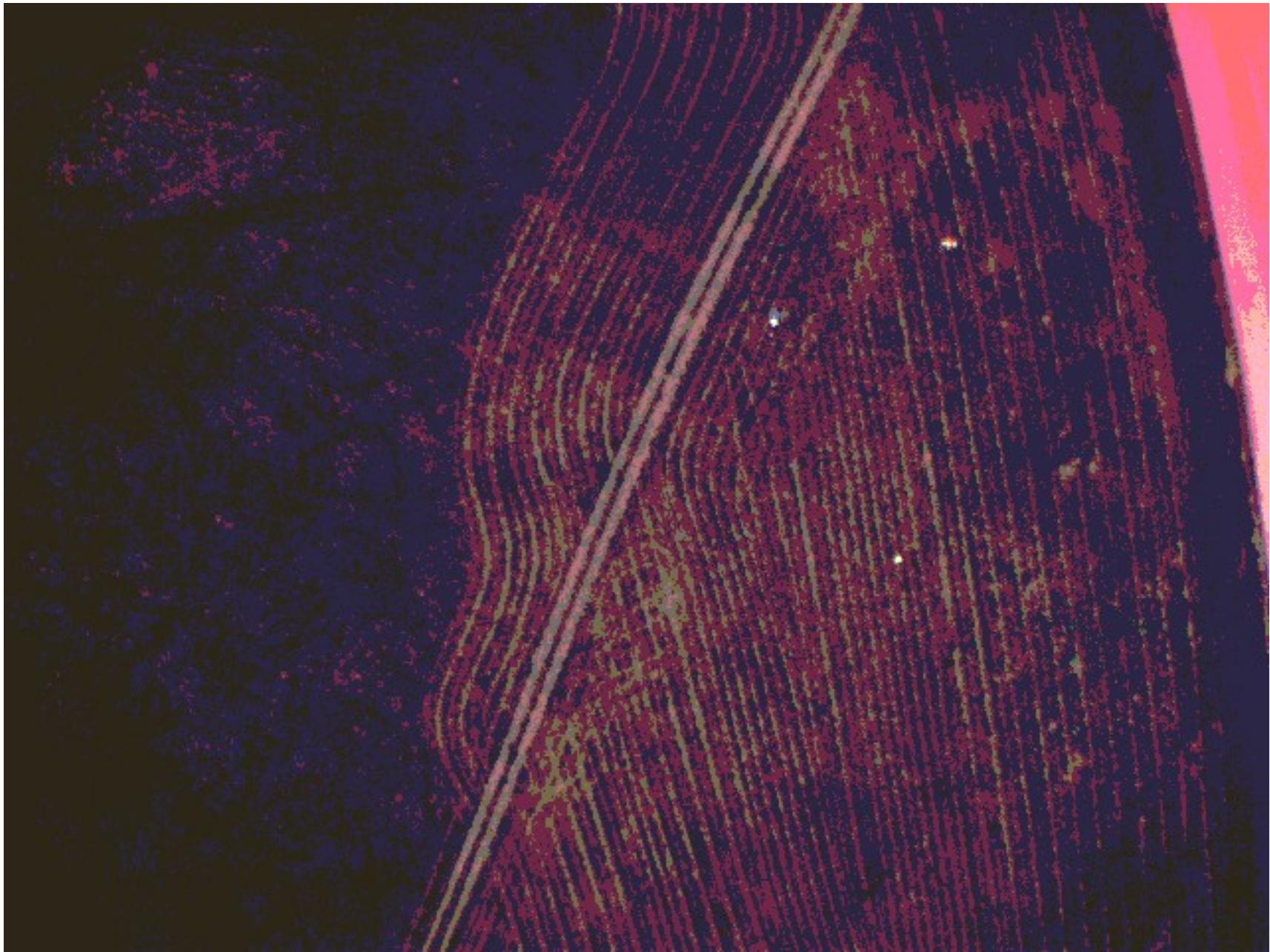
Computer Vision

- Fast cameras
 - PtGrey chameleon
 - 1 IR/grey, 1 colour
 - 8 frames/second
 - ~70 microsec exposures
 - point down with gyro driven servos
- Drivers and software
 - new driver based on DC1394
 - image recognition in C
 - geo-referencing in python
 - needs to be fast!





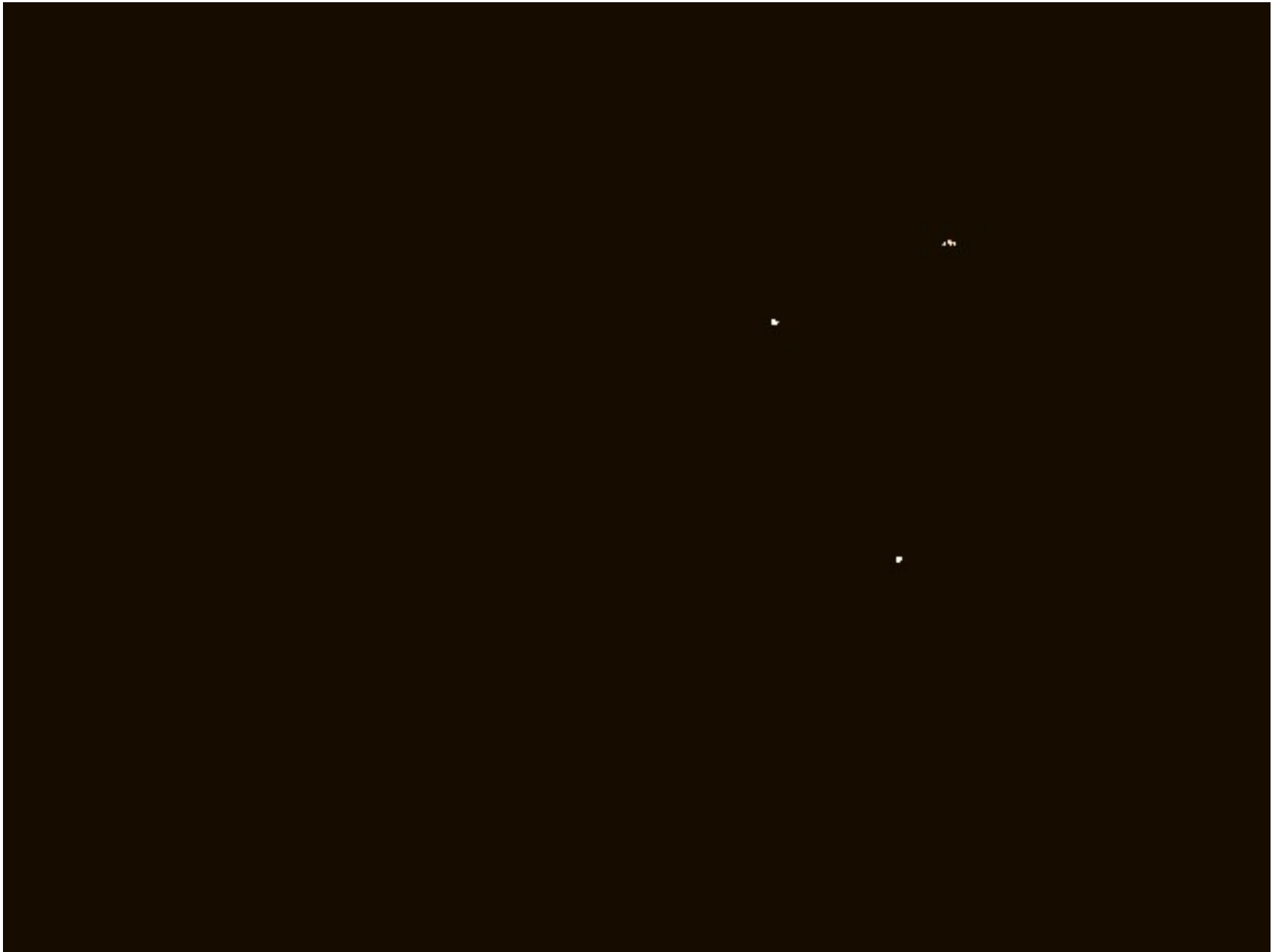
...debayered image



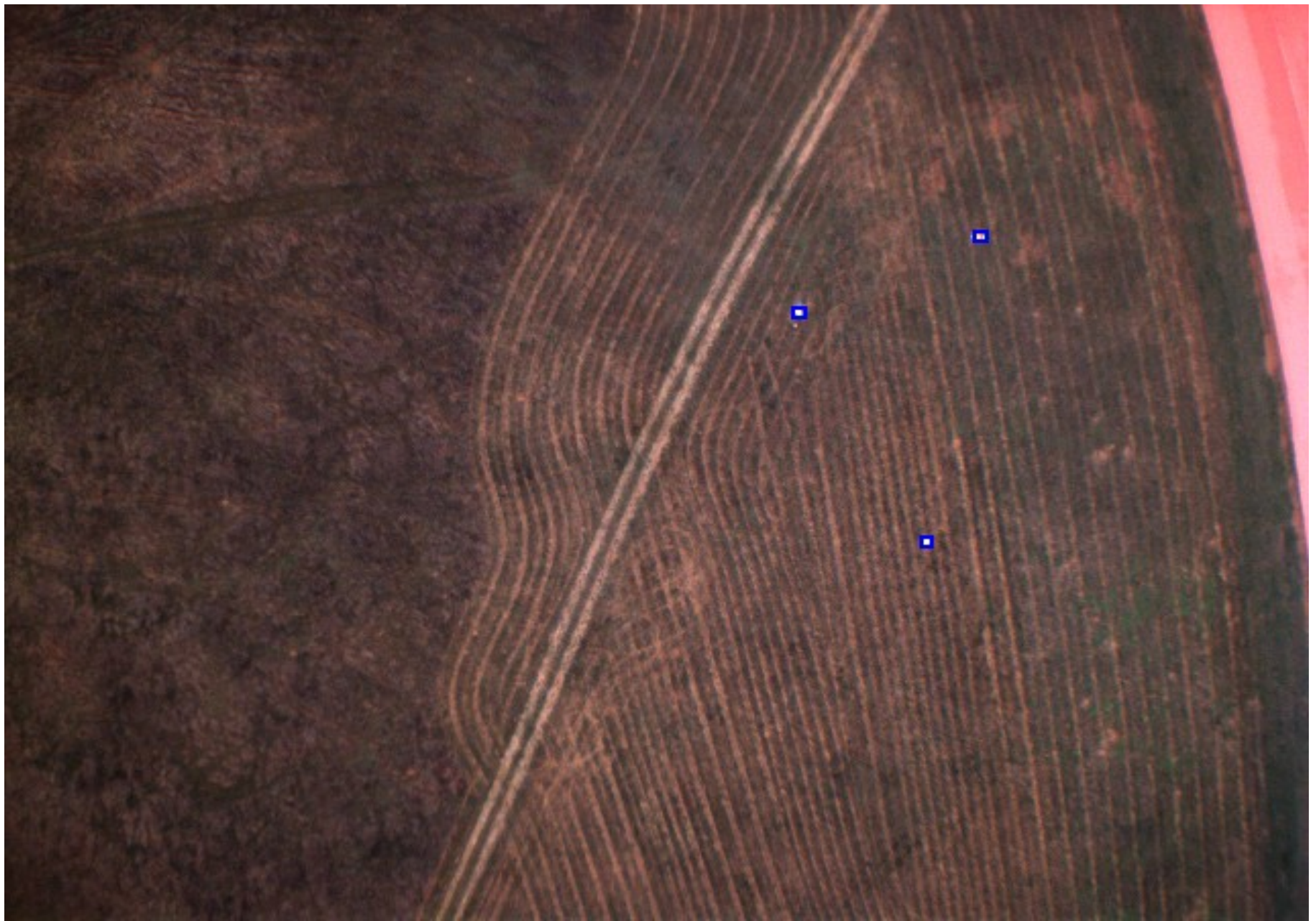
...RGB quantisation



...thresholding



...neighbour expansion



final selection and geo-referencing

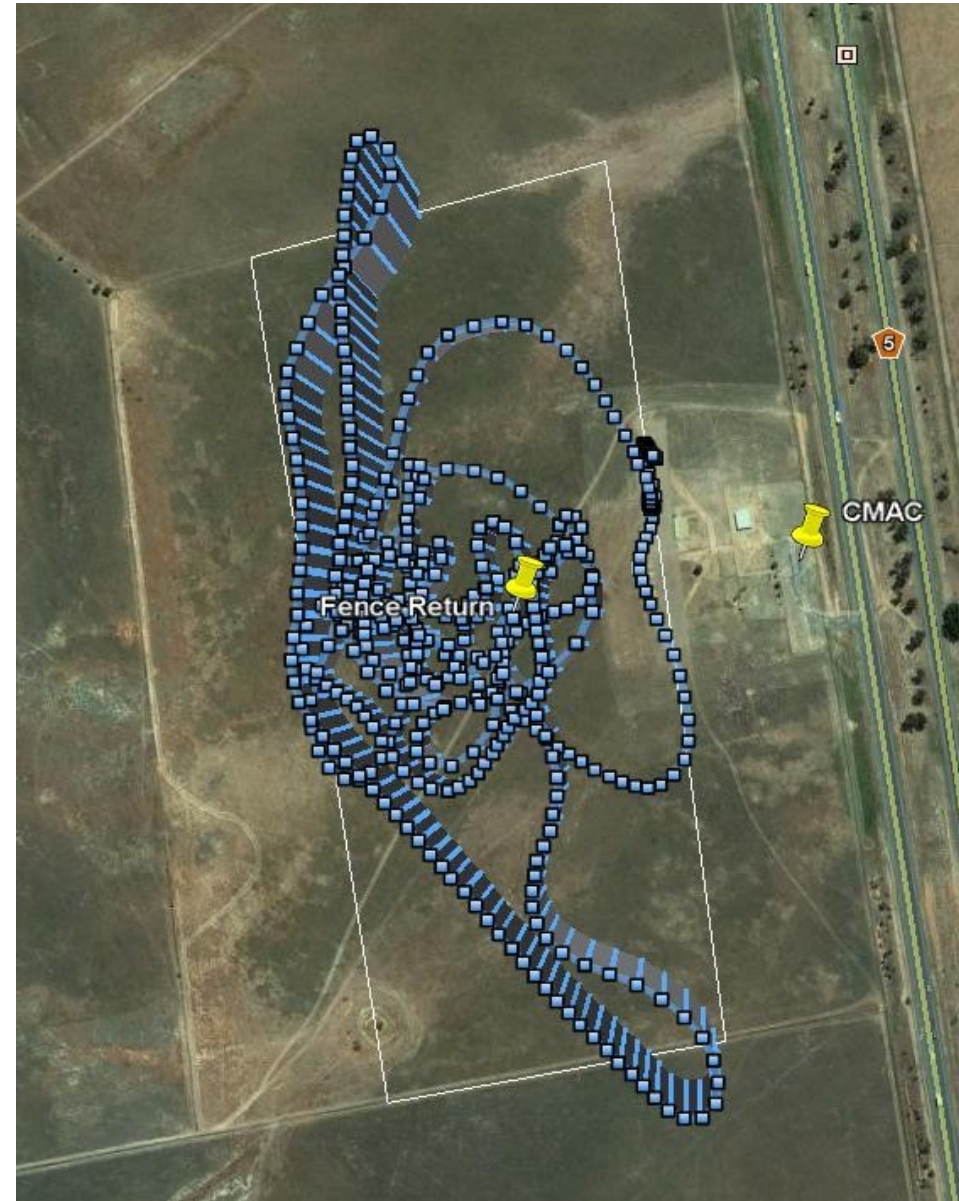
Bottle drop

- Rescue package
 - servo release mechanism
 - GPS location from image recognition
 - ballistic trajectory
 - no early release, no breakage!
 - repeatability is key
 - small drogue chute



Geo-Fencing

- GPS Fence
 - 11 point mission boundary
 - failsafe activation on fence breach
 - dive into the ground!
- pilot training
 - added as general ArduPilot feature
 - flies back to return point on fence breach
 - also min/max altitude

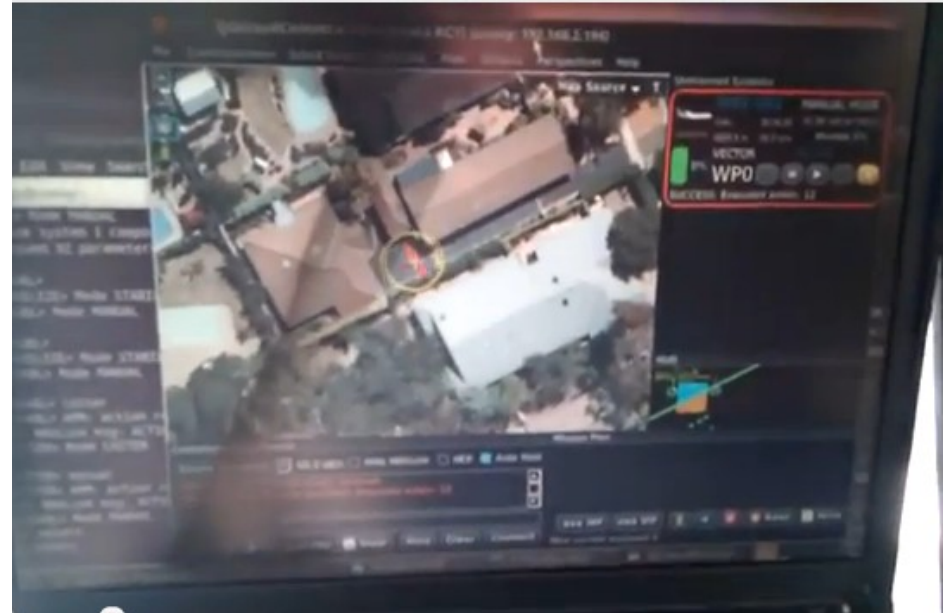


our youngest test pilot



Ground station

- Hardware
 - old thinkpad
 - sunlight readable display
- Software
 - MAVProxy (CLI)
 - qgroundcontrol
 - APM Planner



Search mission

- Dynamic search
 - base pattern of 150m wide strips
 - 50% overlap
 - interleaved pattern
 - 30m/s cruise speed
 - 68km total flight
 - controlled by python on pandaboard



Simulation and regression testing

- Extensive simulation framework
 - HIL (hardware in the loop) and
 - SIL (software in the loop)
- Python simulation framework
 - connects to C++ simulation of autopilot board
 - register level simulation of sensors
 - JSBSim flight simulation backend at 1kHz
 - python physics simulation for multicopters
- Automatic regression testing
 - runs on every git commit at <http://autotest.diydrones.com/>

MAVLink protocol

- Speciality protocol
 - designed for autopilots and ground stations
 - auto-generated compact code from XML (python and C)
 - wide range of tools
 - analysis and graphing
 - playback into sim



More information

- Lots more info if you want it!
 - <http://www.canberra UAV.com/>
 - <http://www.diydrones.com/>
 - <http://autotest.diydrones.com/>
 - <http://photos.tridgell.net/v/CanberraUAV/>