10TH ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

UAV - Microdrones and Multispectral sensing

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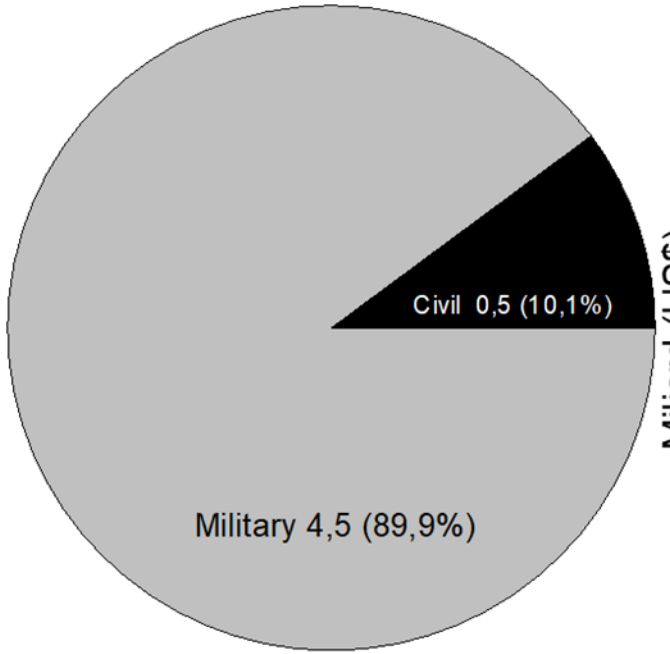
UAV - Microdrones and Multispectral sensing

UAV IN FOREST RESEARCH

- General features
- Micasense RedEdge

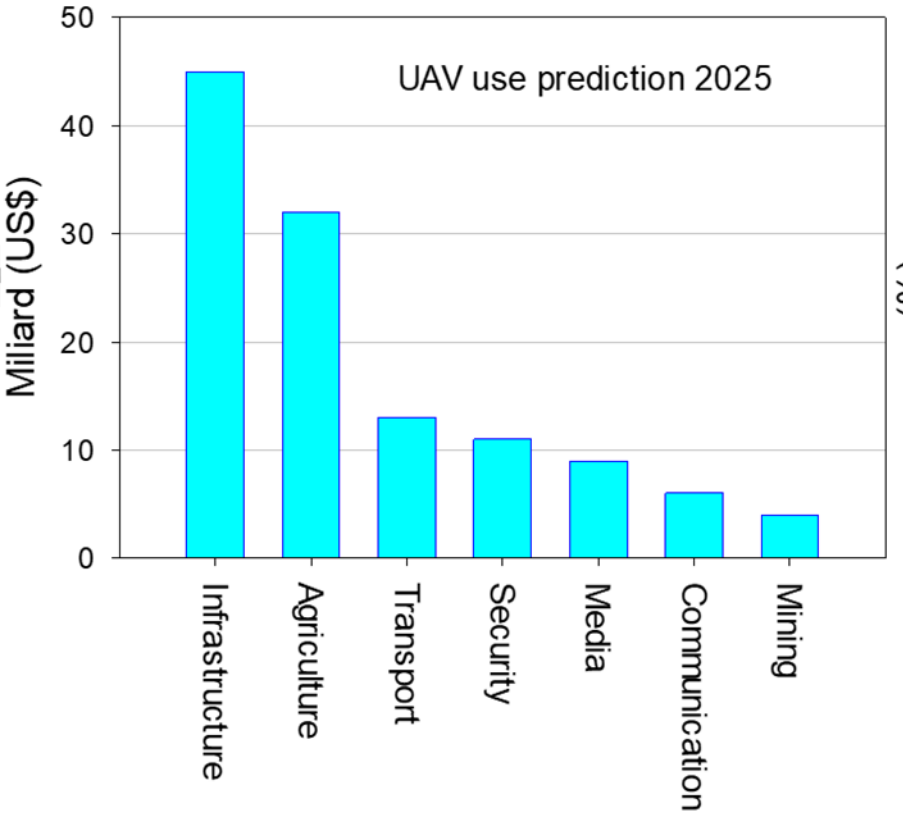
Slovenian Forestry Institute, September 2021

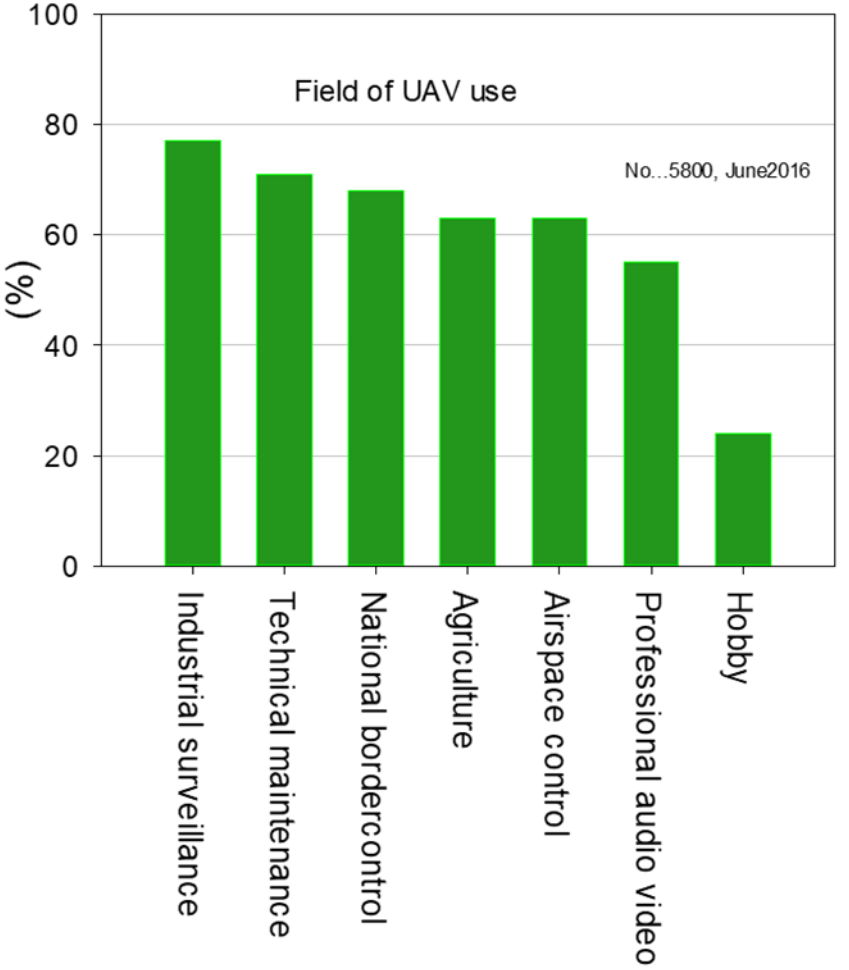
UAV - Microdrones and Multispectral sensing



UAV use (2015)

Handelsblatt 2017, 12. Jan





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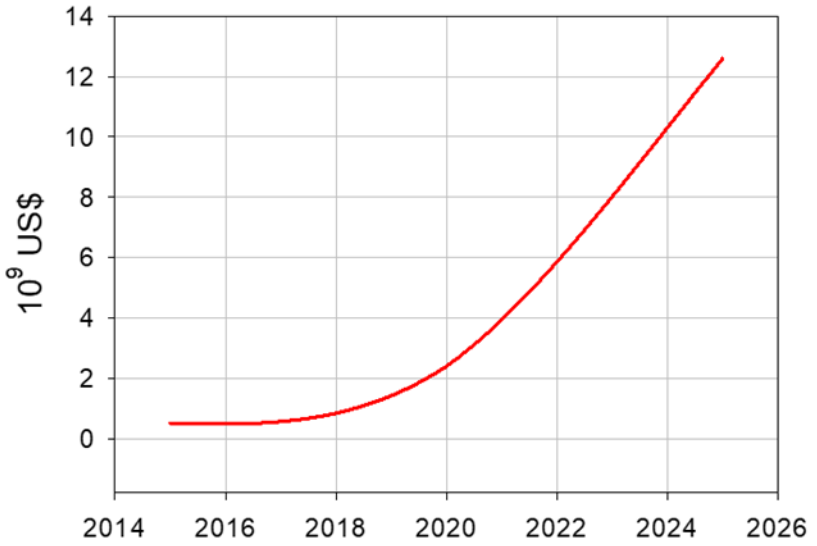
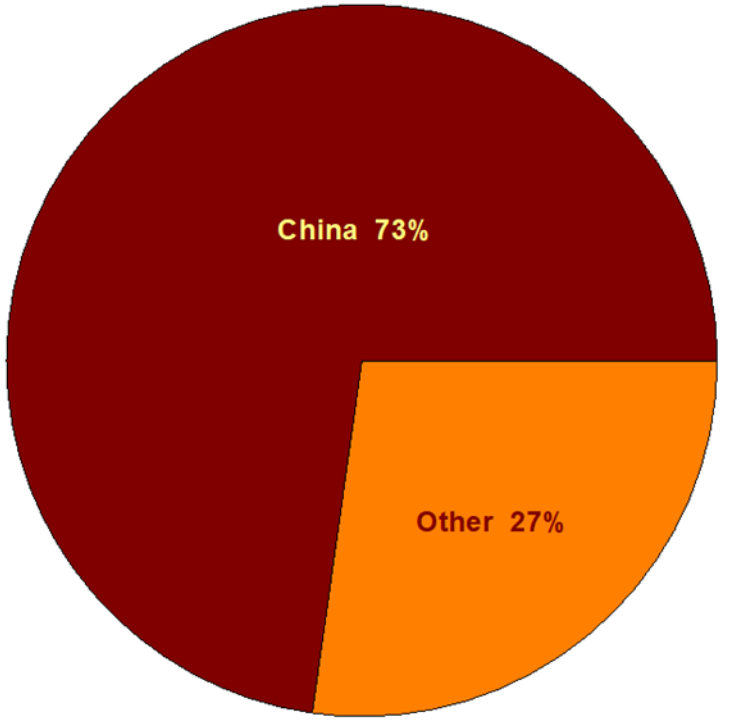




Proportion of UAV origin (2015)

UAV - Microdrones and Multispectral sensing

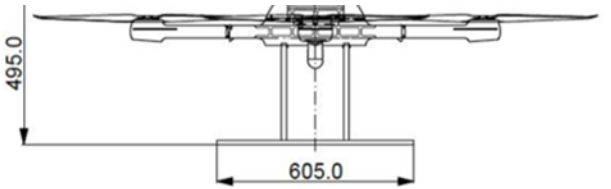
ESSENTIALS

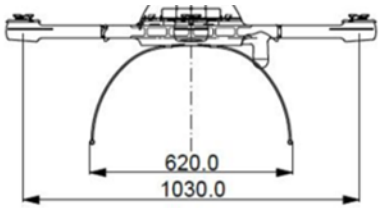
- UAV
- Remote control
- Payload
- Base station
- Batteries

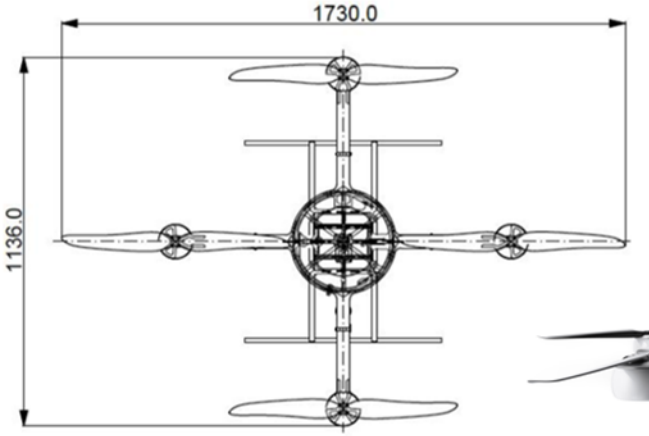
TECH. SPECIFICATION

- UAV mass: 2650 g
- Optimal payload: 800 g
- Max payload: 1200 g
- MTOW: 5000 g
- Battery: 6S2P LiPo 22,2V / 14,6Ah
- Ascending speed: 7.0 m/s
- Max. oper. velocity: 12 m/s
- Radius: 1000m/RC; 30km WP

- Temp range: -10° - 50° C
- Max air humidity: 90% RH
- Max wind speed: 12 m/s
- Optimal tolerable windspeed: 6 m/s
- Plafon: 2000 m ASL
- Max ASL: 4000m ASL (WGS 84)
- Max autonomy: 45 min







- Temp range: -10° - 50° C

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WEATHER RESTRICTIONS (UAV*)

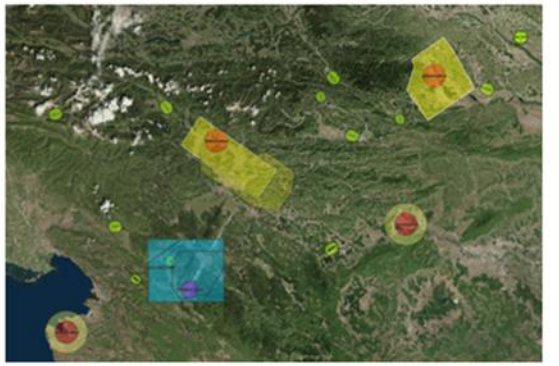
- Frost => compromised rotor airfoil, loss of lift
- T < -10° C ; > 50° C
- Windspeed / gusts or constant conditions > 12 m/s
- Rapid weather changes (pressure changes - barometer)
- Turbulence (vicinity of objects/ obstacles)
- Precipitation IP43 standard :

  "4" … airdrop diameter above nad 1mm

  "3" … precipitation (60° angle from vertical)

LEGISLATION & AIRSPACE (CAA)

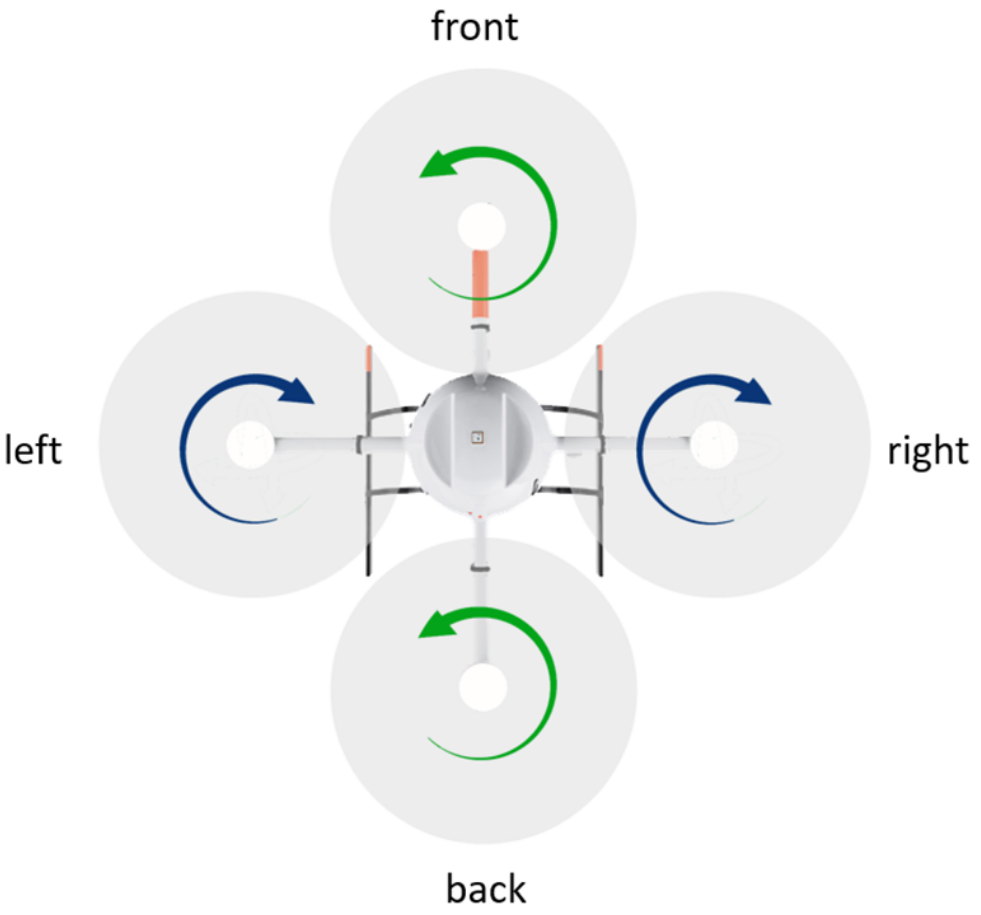
- Registration – several categories: mass/ op. area
- Insurance
- Flight announcement
- 500m from the takeoff, constant visual contact
- Obstacles (terrain, inhabited areas, powerlines…)
- Max 150m above ground
- 50 m (within CTR)
- Restricted: r= 5 km around airports
- Observe NOTAM



http://www.caa.si/index.php => UAV

BASICS

- Quadrocopter principle; rotors providing lift
- Torque is equalized
- Control provided by increasing/ decreasing thrust(RPM)
- Pilot controls 3 axes + alternating thrust by remote control



FNC: FLIGHT & NAV. CONTROLLER

- Maintaining UAV inflight stability
- Calculating flight and navigation parameters
- Executing guidance and emergency functions
- Control of UAV subsystems
- Temperature sensitivity
- Ambiental aclimatization (T) 12-15 min.

SENSORS

mdIMU

The Inertial Measurement Unit (IMU):

accelometer

gyroscope (angular velocities, roll & pitch)

Barometer

air pressure and temperature (determination of height)

Sonar

Automatic landing

Magnetometer

magnetic field

GNSS

GPS receiver

3D UAV location, navigation

REMOTE CONTROL (RC)

- Connection with UAV receiver
- In-flight real time telemetry

BASE STATION

- Telemetry display UAV
- Task planning UAV
- Task update UAV
- Data recording (optional)

BATTERY

LiPo cells.

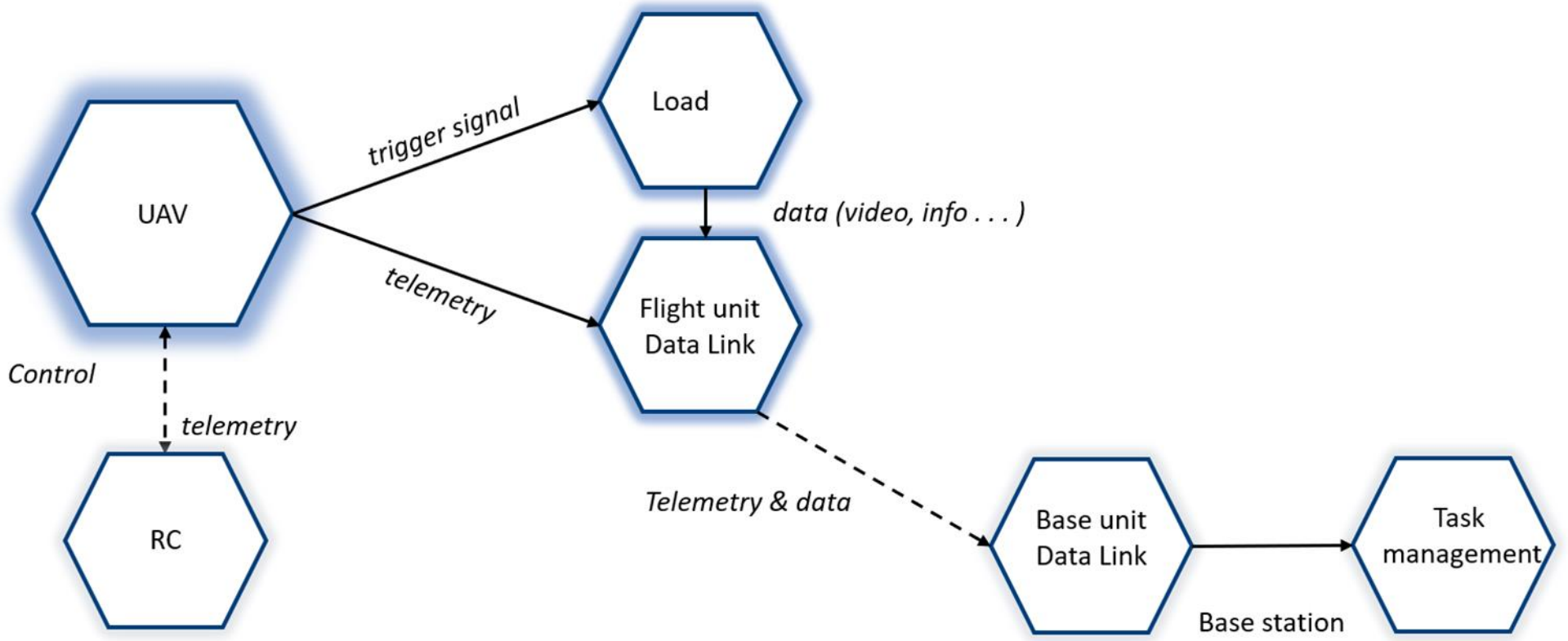
Proper handling & care

High power/ weight ratio

Lifetime: several 1000 charging cycles

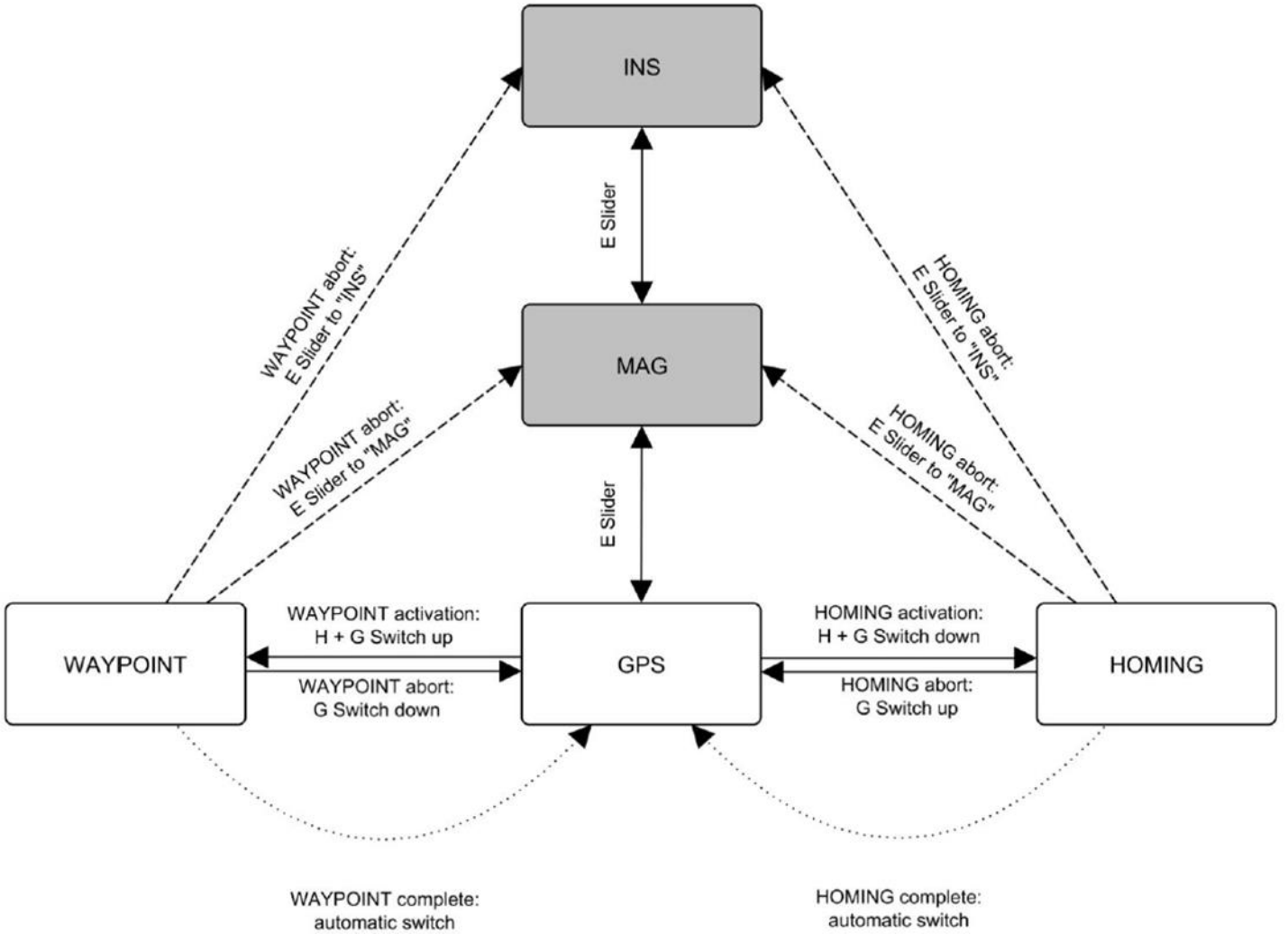
Max voltage	25.2 V
Min. voltage	22.4 V
$Critical_1$	22.2 V (homing)
$Critical_2$	21.7 V (auto landing)
Cell No	12
Temperature range	10° C - 40° C
Mass	1900 g
Charging time:	45 - 90 min

FUNCTION SCHEME



WAYS OF CONTROL

- GPS
- MAG
- INS
- WAYPOINT
- HOMING

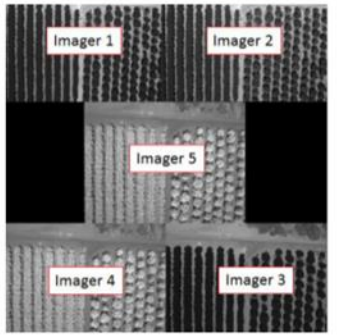


MULTISPECTRAL SENSING

- Vigor and health of crops/ vegetation
- Micasense RedEdge™ 3
- Capture of five discrete spectral bands
- Global shutter: more images per time unit

  higher resolution

  clear images in spite of short exposition times



- UAV
- Micasense RedEdge™ camera
- UAV housing with:
  - Light sensor (DLS)
  - GPS receiver
- SD memory card
- MicaSense calibration pane (CRP)

UAV - Microdrones and Multispectral sensing

Spectral bands:

1. blue (465 – 485nm) $\Delta = 20$ nm
2. green (540 – 580nm) $\Delta = 20$ nm
3. red (658 – 678nm) $\Delta = 10$ nm
4. red edge (707 – 727nm) $\Delta = 10$ nm
5. Near IR (800 – 880nm) $\Delta = 40$ nm

Speed: 1 exposure/s

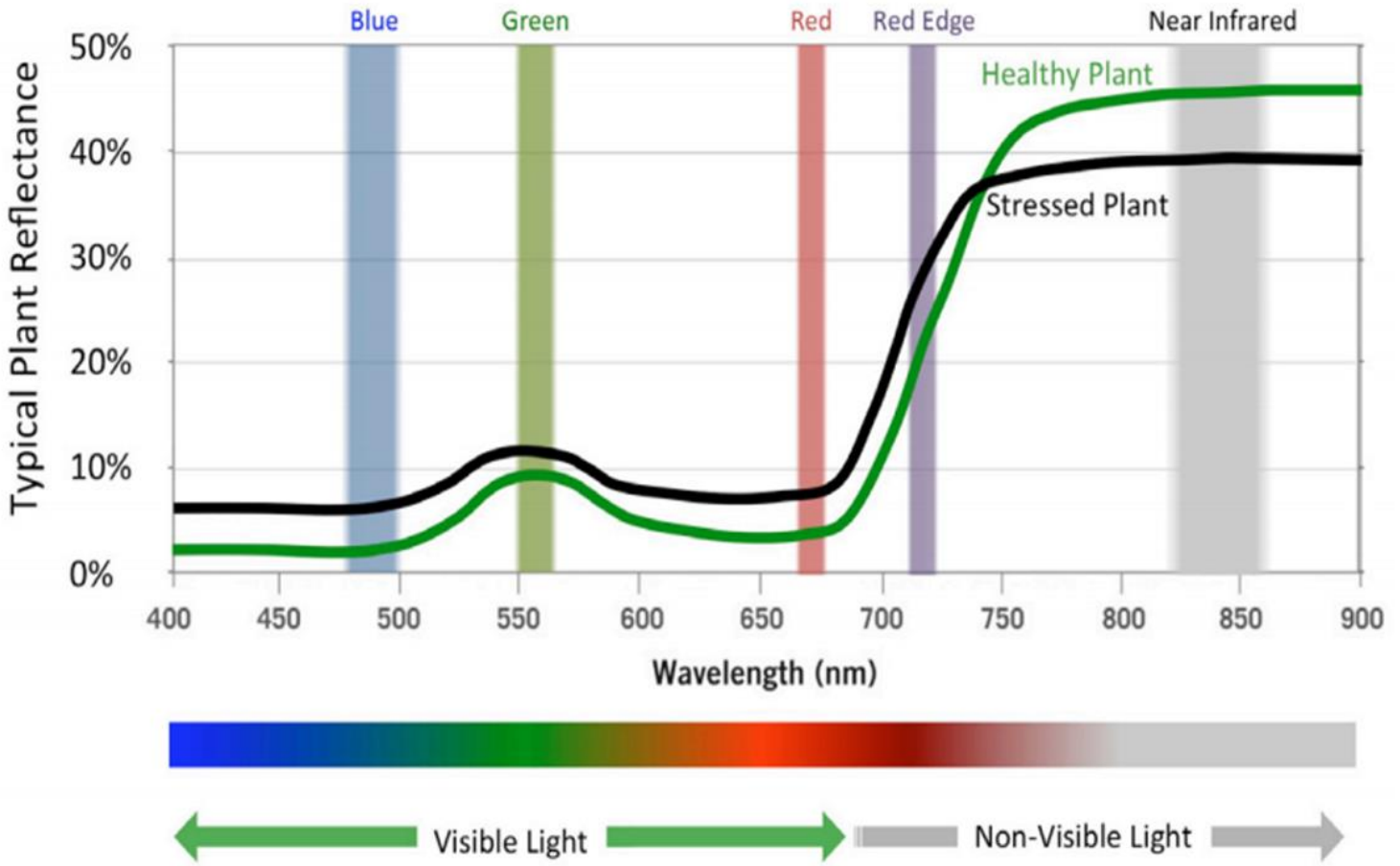
Functioning UAV, 5.0 V DC, 4 W nominal

mass: 150 g camera

50 g gimbal

60 g TCQM + GPS + DLS

Dimensions: 121 x 66 x 46 mm



UAV - Microdrones and Multispectral sensing

POSITIONING

MICASENSE REDEDGE GSD

SENSOR RESOLUTION 1.2 MEGAPIXELS

ALT m.	GSD cm/pixel
30	2.1
60	4.1
90	6.1
120	8.2

GSD... Ground sampling distance

UAV COVER (TCQM)

- Integrated GPS camera antenna
- Ambient light sensor

TCQM with GPS and DLS modules

RECORDING


SYSTEM PREPARATION
TASK EXECUTION
DATA TRANSFER AND EVALUATION
POST-PROCESSING, ANALYSIS

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PLANNING

Aplication md Cockpit / tablet

Definition of:
- takeoff
- starting / ending task point
- polygon
- optimisation / obstacles

- Recording parameter setting

- UAV parameter setting

- UAV task upload

RECORDING

UAV assembly
UAV acctivation

GPS coverage check
Telemetry check
Camera activation
Reflectance panel recording

Takeoff
UAV positioning, visual contact
Task execution
Task ending

Landing
UAV deactivation

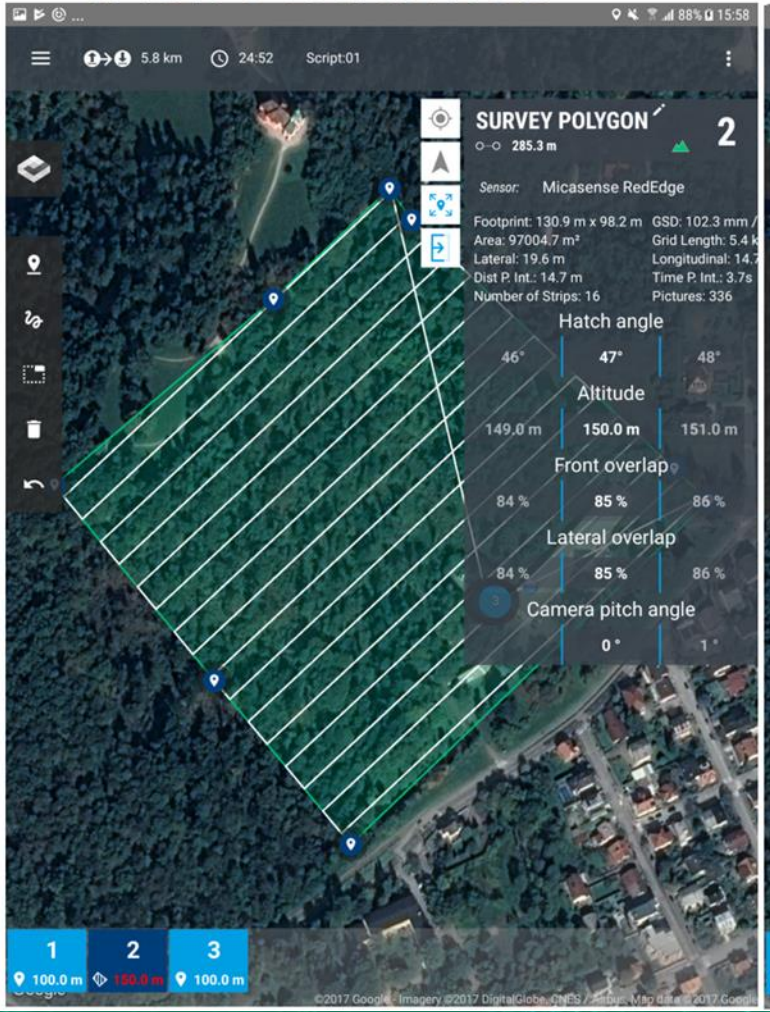
TRANSFER

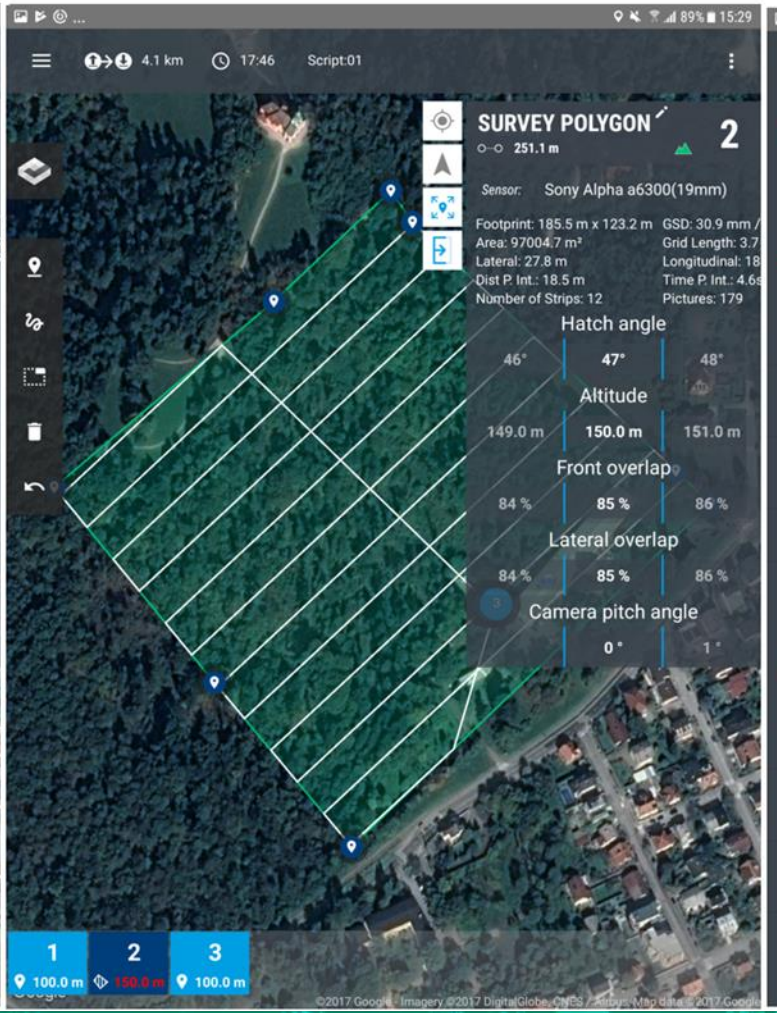
Data transfer
SD card => PC
Check

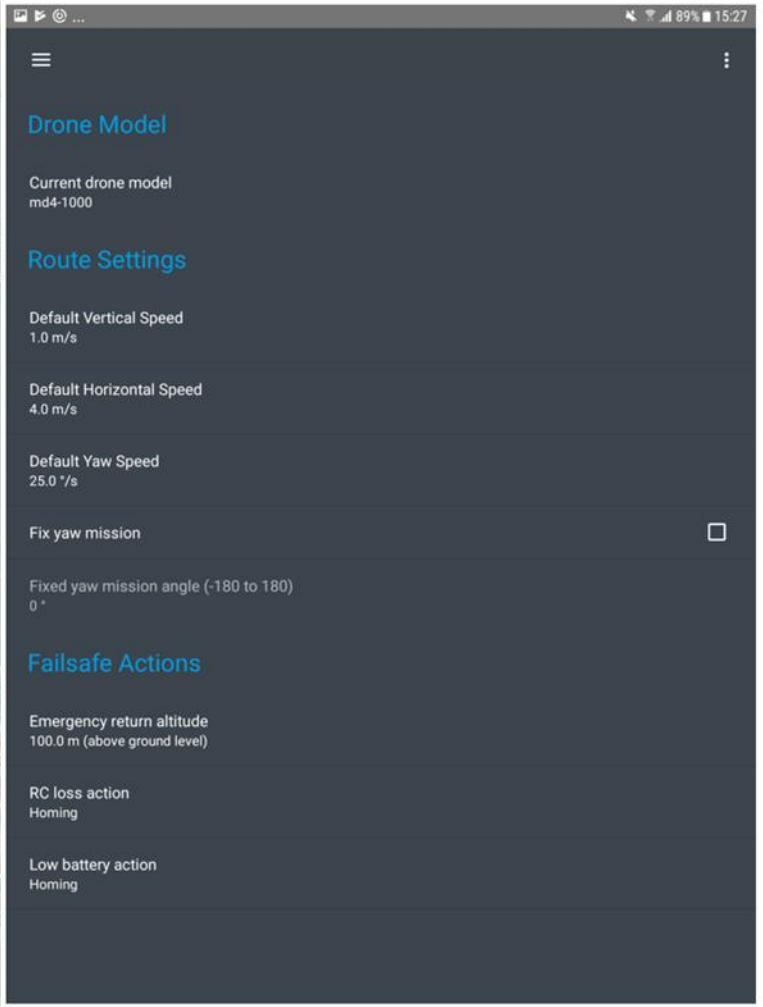
ANALYSIS

Agisoft pro

TASK PLANNING







Battery - duration

Terrain - highest polygon point

image quality

=> recording area

=> recording speed

=> overlapping %

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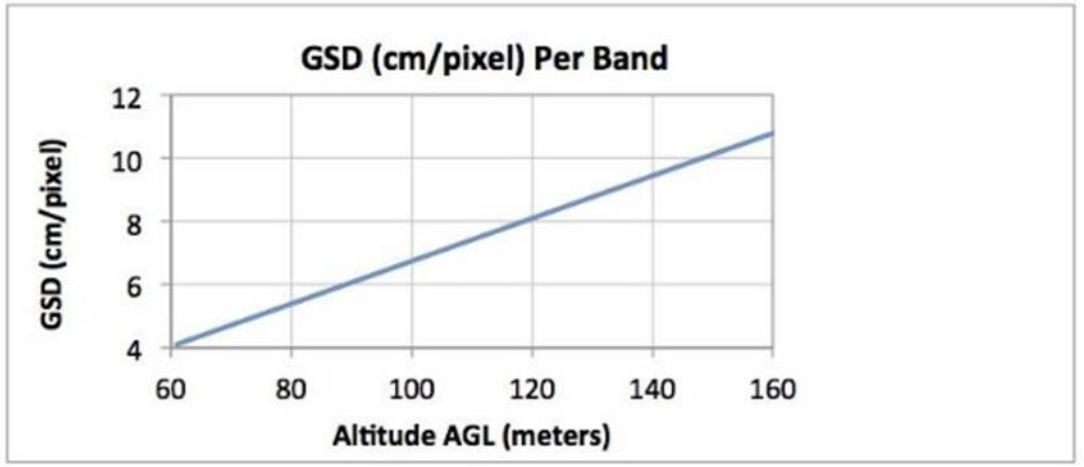

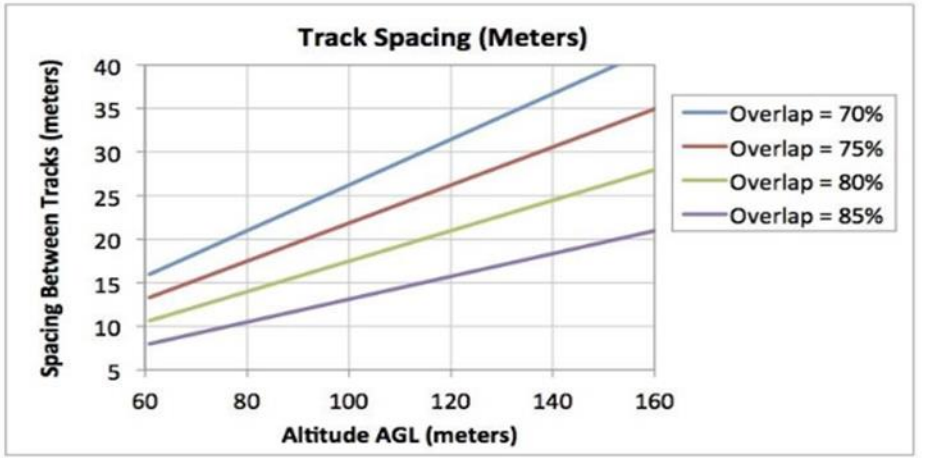

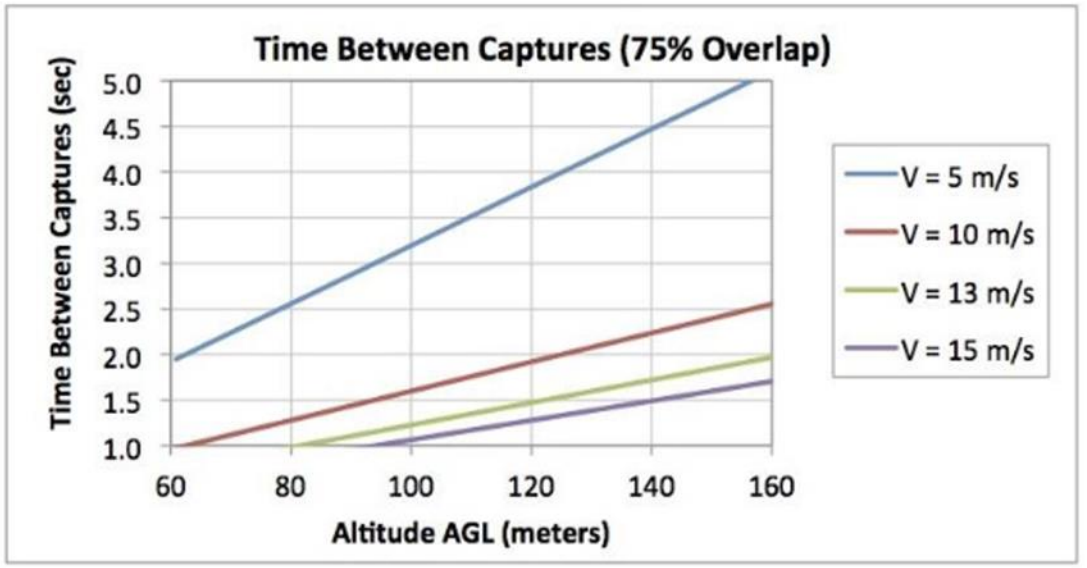

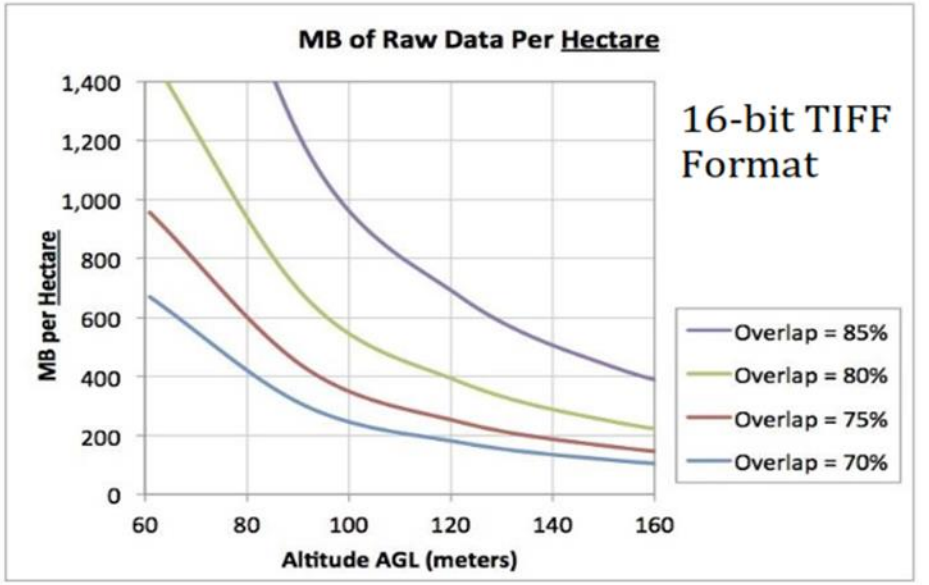

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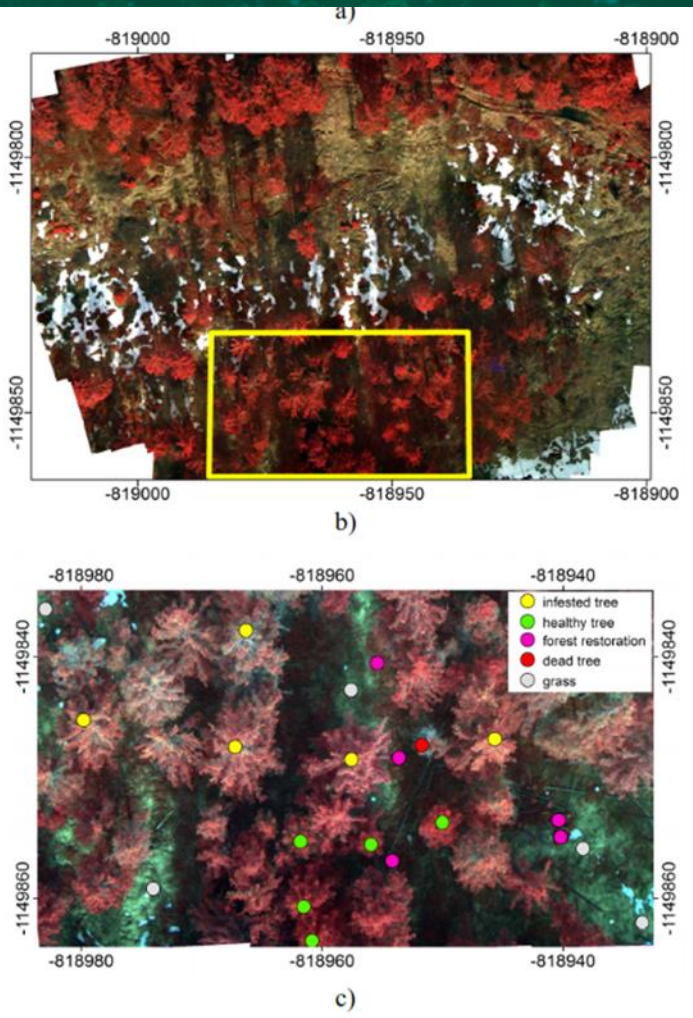


Minarik & Langhammer, 2016

Index	Formula	Reference
Greenness Index	$\frac{green}{red}$	Le Maire et al. (2004)
Simple ratio (SR) 800/550	$\frac{NIR}{green}$	Le Maire et al. (2004)
Simple ratio 800/650 Pigment specific SR B1	$\frac{NIR}{red}$	Blackburn (1998)
Datt 2	$\frac{NIR}{red\_edge}$	Datt (1999)
NDVI	$\frac{NIR - red}{NIR + red}$	Tucker (1979)
Green NDVI	$\frac{NIR - green}{NIR + green}$	Gitelson and Merzlyak (1997)
Red-edge index (NDRE)	$\frac{NIR - (red\_edge)}{NIR + (red\_edge)}$	Barnes et al. (2000)
Red-edge Green NDVI	$\frac{(red\_edge) - green}{(red\_edge) + green}$	Buschmann and Nagel (1993)
Red-edge NDVI	$\frac{(red\_edge) - red}{(red\_edge) + red}$	Ortiz et al. (2013)
Anthocyanin reflectance index 2 (ARI2)	$NIR\left[\left(\frac{1}{green}\right) - \left(\frac{1}{red\_edge}\right)\right]$	Gitelson et al. (2002)

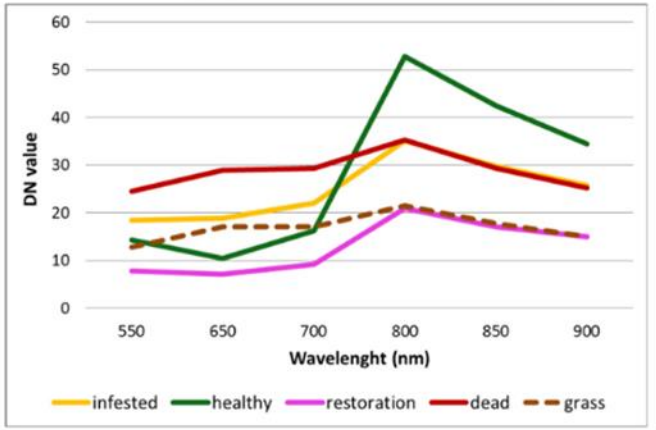
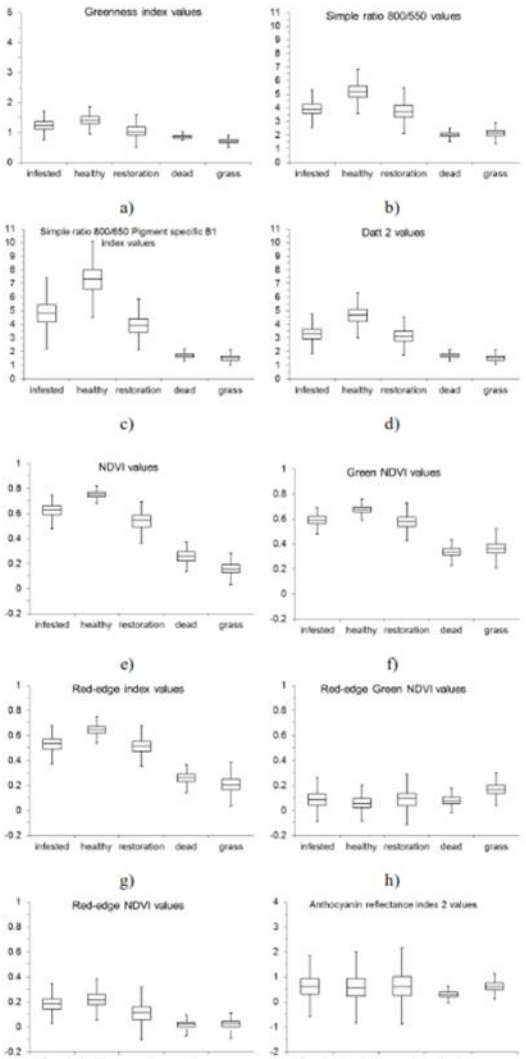


Figure 4. Average DN values of the established categories: infested trees, healthy trees, forest restoration, dead trees, and grass in the 550-900 nm spectral region.



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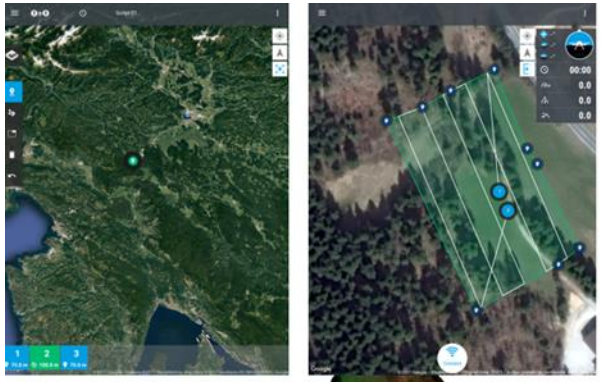

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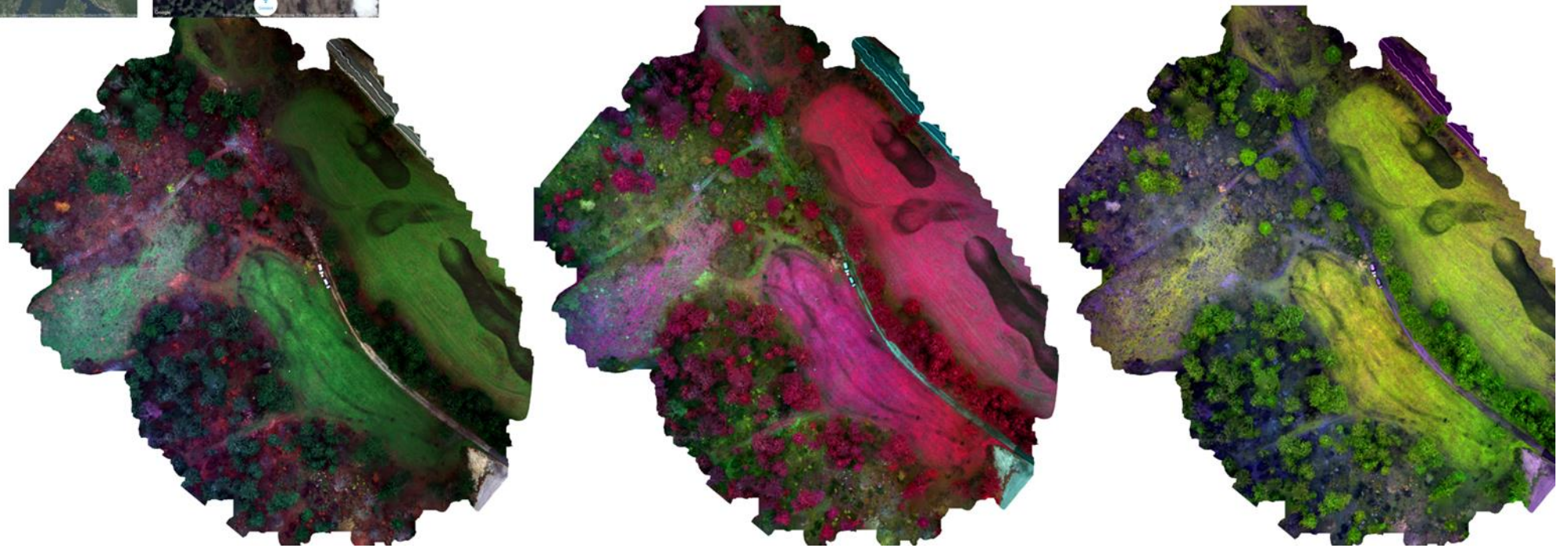

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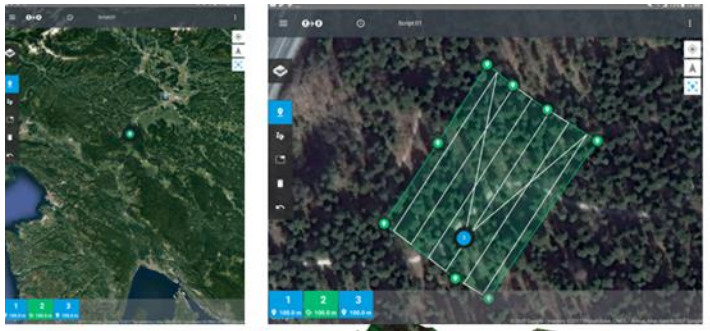

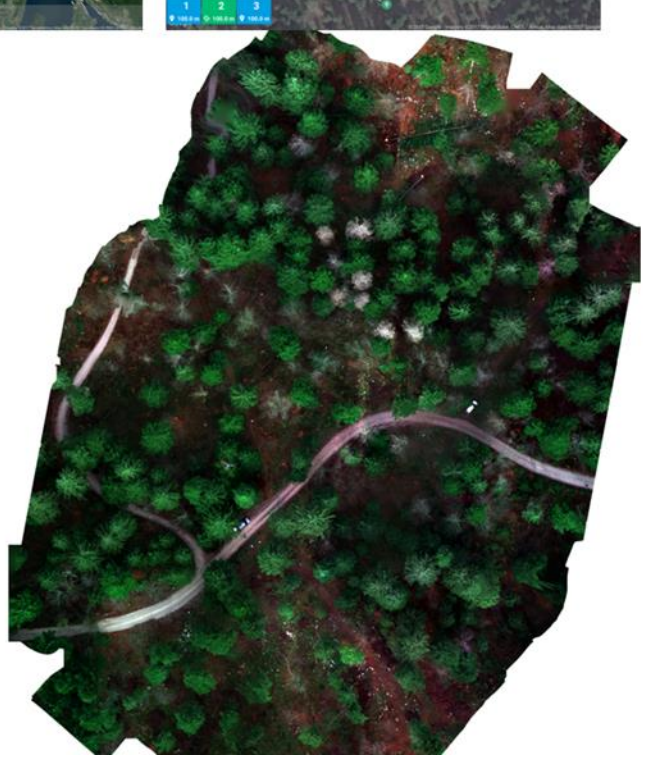

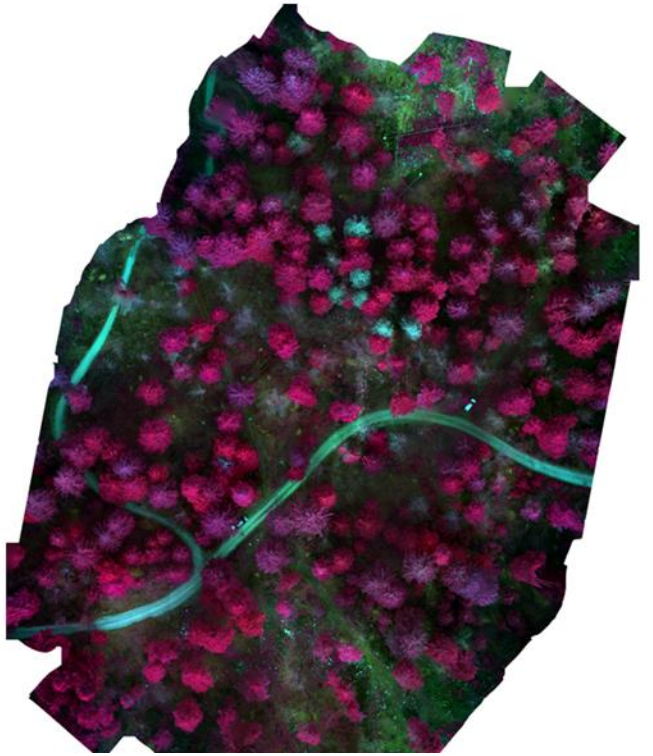

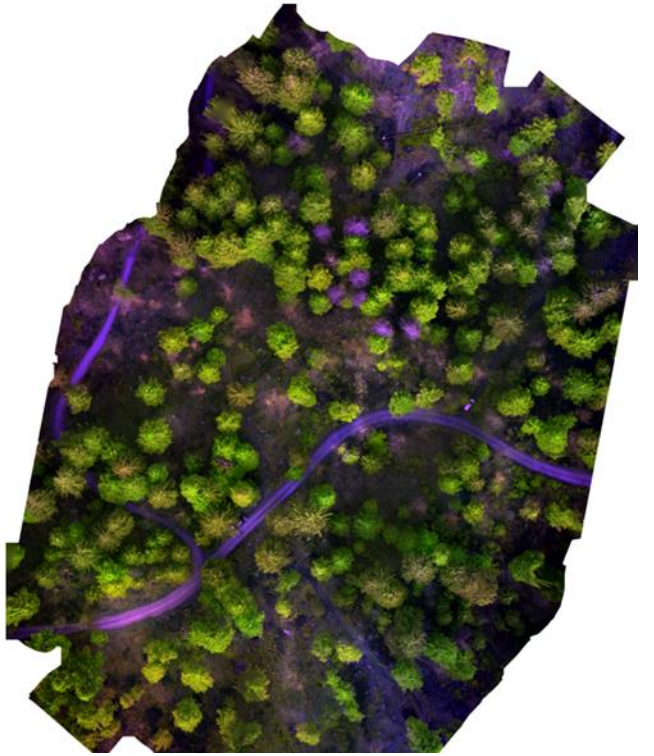

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