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USDA-ARS potato genetics lab drone data collection protocol

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This protocol describes the steps performed to collect multispectral data from field experiments using a small unmanned aerial system (sUAS). Our group uses a MicaSense 10-band multispectral camera system (MicaSense RedEdge-MX and RedEdge-MX blue sensors) affixed to a DJI Matrice 600 Pro hexacopter to perform this task. Flight planning and data acquisition are performed using the MicaSense Atlas Flight App and the orthomosaic data is generated using Pix4DFields.

Max J Feldman 2022. USDA-ARS potato genetics lab drone data collection protocol. **protocols.io** https://protocols.io/view/usda-ars-potato-genetics-lab-drone-data-collection-b2z8qf9w

Drone, sUAS, Multispectral, orthomosaic, DJI, M600, MicaSense, RedEdge

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To perform a sUAS mission there needs to be at least one authorized pilot who is certified by the Federal Aviation Administration (FAA). Certification can be obtained by passing the Remote Pilot of Small Unmanned Aircraft Systems exam Part 107.
https://www.faa.gov/uas/commercial_operators/become_a_drone_pilot/

We recommend taking a dedicated training course in sUAS operation. Here is a training center located near our station in Prosser, WA.
https://galvinflying.com/learn-fly-drone/

Flights are to be performed each week throughout the growing season from the first signs of plant emergence until vine kill.

At the beginning of the week, a flight schedule should be outlined for each location where trials occur. The date of data acquisition is dependent upon weather. Precipitation and high wind speed are detrimental to the data collection process so a forecast for the week should be checked on Monday at the following web-site:
https://www.weather.gov/

We fly a DJI Matrice 600 Pro so flights cannot be performed in the rain or when temperatures are expected to exceed 104 F.

Generally, we consider wind speed < 10 MPH to be good conditions, wind speed 10-15 MPH to be questionable, and wind speed > 15 MPH to be avoided.

Flights need to be conducted within 2.5 hours of solar noon. In fields close to our research station in Prosser, WA solar noon occurs around 1 PM for a majority of the summer field season (April – September). This can be checked at the following web-site:
https://sunrise-sunset.org/

DJI Matrice 600 Pro
DJI Matrice 600 Pro receiver/remote control
DJI Hex Charger
https://www.dji.com/matrice600-pro

DJI TB47S or TB48S Batteries (12, this represents 2 sets of 6 batteries)
https://m.dji.com/product/matrice-600-tb47s-intelligent-flight-battery

MicaSense RedEdge-MX sensor
https://micasense.com/dual-camera-system/

MicaSense Calibrated Reflectance Panel (CRP)
https://support.micasense.com/hc/en-us/articles/360005163934-Calibrated-Reflectance-Panel-Care-Instructions

Berntsen Ground Marking Drone Targets (RSL512)
https://www.berntsen.com/Surveying/Flagging-Targets/Aerial-Targets-Aerial-Paneling/ctl/ViewProduct/mid/754/ItemID/1730?gclid=Cj0KCQiA5OuNBhCRARIsACgaiqXCDE0vHvhJdDSc4XFjyCR-SBI3X03MlBAVdxXwvDDt_3TwhGO0NMwaAvOzEALw_wcB

iOS device with Wi-Fi + Cellular capability (iPhone or iPad)
https://www.apple.com/shop/buy-ipad/ipad-mini

You will need the following apps installed on the iOS device

DJI GO
https://www.dji.com/goapp

MicaSense Atlas
https://micasense.com/atlas-flight/

Aloft/Kittyhawk
https://www.aloft.ai/

Lightning-to-USB cable
https://www.apple.com/shop/product/MD819AM/A/lightning-to-usb-cable-2-m?cid=aos-us-seo-pla

Hex Key Set – Metric
https://www.homedepot.com/p/Husky-Short-Arm-Hex-Key-Set-Metric-10-Piece-HSAHKM10PCN-06/317213890

Flight log notebook
https://www.safeway.com/shop/product-details.960125660.html

Safety is the most important consideration. Be aware of all hazards both on the ground and in the air surrounding the location where data collection is to occur. Do not forget to bring drinking water and apply sunscreen at regular intervals while out perform field work.

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Read the Guidelines & Warnings section of this protocol.

The day before the flight make sure both sets of batteries are fully charged. Before leaving to the field site double check to ensure all items listed in the Materials section are packed up.

Before flying

1 Upon arriving at the field site, place the ground control point (GCP) indicators in their proper location. Generally, four ground control points are placed around the perimeter of the target field. We use a set of two flags (each a different color) to denote the location GCPs should be placed at.

2 Unpack the drone and checked for vulnerabilities (loose screws affixing the propeller props to the rotors, rubber dampers that suspend the MicaSense camera from the DJI Z30 Matrice 600 Pro gimbal adaptor plate).

Connecting to the drone

3 The iphone/ipad, receiver (remote controller), and drone is then powered on (in that order) and a connection is established between the components using the DJI GO app. https://www.dji.com/goapp

Note: This can be problematic. In some cases changing the order in which each component is powered on can help establish a connection. In some field locations (particularly around Hermiston Agricultural Research and Extension Center, which is < 3 miles from Hermiston Municipal Airport), DJI GO will indicate that the drone is in a “Do Not Fly Zone” and the drone will not be able to take-off. If this occurs, ensure that the area you are trying to fly is not a restricted area using the Aloft/Kittyhawk app on the iphone/ipad device.

If you are in restricted airspace you will need to receive approval from the Federal Aviation Agency (FAA) to perform your mission. In some cases, this can be performed using the Low Altitude Authorization and Notification Capability (LAANC) system. We use the Aloft app which has this request capability built into the app.
https://www.aloft.ai/feature/laanc/

If the airspace is NOT restricted by FAA but the DJI GO app does not allow you to take off try powering off the drone, moving it several meters, and powering it up again. It may take several cycles to get it off the ground.

4 Use the MicaSense Atlas Flight app (https://micasense.com/atlas-flight/) to generate a flight plan. In the app select the top menu option on the right hand side. This will allow you to set the parameters of the flight including altitude, ground speed, and overlap.

We generally prefer to perform the complete data collection in a single flight without changing batteries.

Some guidelines on flight planning using the MicaSense RedEdge can be found here:
https://support.micasense.com/hc/en-us/articles/224893167-Best-practices-Collecting-Data-with-MicaSense-Sensors

Step 4 includes a Step case.
Parameters for small fields (3 acres or less)
Parameters for medium size fields (3 - 10 acres)

Connecting to the sensor

step case

Parameters for small fields (3 acres or less)

We use the following parameters for fields are equal to or less than 3 acres (Ground sampling distance ~2 cm/px)

Altitude = 30 M
Speed = 5 M/s
Overlap = 80%
Padding (ON)
Skyport (OFF)

5 Establish a connection between the Micasense sensor and the iphone/ipad. Set the iphone/ipad into airplane mode, and connect to the sensor through WiFi by following the instructions here:
https://support.micasense.com/hc/en-us/articles/215173567-How-do-I-connect-to-RedEdge-Wi-Fi-

Once a connection is established check to ensure that there is adequate storage available

(Storage), enough signal from satellites are available (GPS Stats), the downwelling light sensor is active (DLS Status) and date/time information (Time) is accurate. Each of these reporter boxes should be green.

If not (some of the boxes are red, not green), power down the drone and sensor and try again

6 Next set the parameters of the sensor. We capture images of fields using only the "Overlap" option and enter the sensor settings to match those already entered into the MicaSense Atlas Flight app in protocol. See Step #4.

go to step #4

Sensor calibration

7 Now that the sensor and iOS device are connected, capture images of the MicaSense Calibrated Reflectance Panel (CRP). We use a model RP04 CRP.

Place the panel on the ground in an open area. Hold the sensor/drone with the sun to your back facing the CRP at about 1 M above the ground. Now take a step to either side of the CRP so that no shadows fall onto the grey reflectance standard. Using the MicaSense Atlas Flight App, click on the camera icon and capture images of the calibration panel.

More information about the calibration protocol can be found here:
https://support.micasense.com/hc/en-us/articles/224893167-Best-practices-Collecting-Data-with-MicaSense-Sensors

Here:
https://support.micasense.com/hc/en-us/articles/1500001975662-How-to-use-the-Calibrated-Reflectance-Panel-CRP-

Capturing the calibration images can also be performed using the sensor's QR mode (we have not tried this yet). Details about this process can be found here:
https://support.micasense.com/hc/en-us/articles/360018618774

More information about the benefits of calibration for downstream data analysis can be found here:
https://micasense.com/lets-talk-about-calibration/

Flying the mission

8 At this point you are ready to fly the mission. Repeat the steps needed to connect the sensor to the iOS device and ensure that the drone, receiver, sensor, and MicaSense Atlas App on the iOS device are communicating then launch the mission. See Step #5 and Step #6.

You will know that the sensor and iOS device are communicating if

During the mission always ensure to keep the drone within your line-of-sight. Be aware of your surroundings and keep an eye out for low flying aircraft (This is a major issue near HAREC).

In the cases where a low flying aircraft may enter your flight zone pause the flight immediately and lower the UAV closer to the ground to avoid any chance of collision. Once the aircraft has passed, click the pause icon again to resume the mission.

Post flight

9 Once the mission is complete check to ensure that data collection was successful. On the MicaSense App home screen it will list the storage space remaining on the sensor's SD card.

Generally speaking, a set of images from a single 5-band MicaSense camera taken over a 3-acre field using the configurations listed in Step #4 will take up 8-10 GB of storage space.

If the amount of storage remaining reported on the SD card is substantially more than you would expect it is likely that some element of data collection failed. Here is a list of commonly observed errors that effect triggering of the camera: https://support.micasense.com/hc/en-us/articles/360010451674-Troubleshooting-Triggering-Issues

10 If it looks like the flight was successful, collect post-flight images of the CRP by repeating Step #7.

Before packing up the drone examine the quality of data collection using Pix4DFields. Remove the SD card from the sensor, plug it into your computer, and generate an orthomosaic from the data.