UAV-based remote sensing tools for Smallholder’s cropping area determination

Presenters:
Gonzalo Cucho (CIP/U. Illinois), Elijah E. Cheruiyot (CIP/UoN), and R. Quiroz (CIP)
Reducing the cost of your UAV-platform through custom-made components and pre-processing software
INTRODUCTION

• RS applications for smallholder agriculture.
• Use of Satellite imagery and commercial UAV-based platforms.
• Proof of concept project → low cost solutions with comparable results for those commercial ones.
• Stakeholders.
• Openly available.

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SPECTRA CIP V2.0

Features
- < 1nm Res
- = Bandwidth

Price Comparison
- OO → $3K
- ASD → $15K

Developed with:
C++
QT Creator

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SPECTRA CIP V2.0

User Oriented:
- Measure Raw data (number of counts)
- Measure a reference (lambertian surface)
- Obtain the Reflectance percentage (by using the reference)

Remarks
a) Micro Spectrometers Ocean Optics are the less expensive in the market.
b) SPECTRA CIP V2.0 can work with any Ocean Optics spectrometer.
c) Theoretically, CIP has developed the framework to work with any spectrometer. Condition: Manufacturer provides the libraries for data access.
d) GNU GPL license
Multispectral Imaging System
IMAGri v2.0

Description:
The Multispectral Acquisition system IMAGri v2.0 allows the user to acquire two-band images (NIR 800nm and Red 650nm) with a resolution of 640 x 480 pixels.

Remarks:
• Blueprints, software, camera and optics selection are free access. Open hardware & software for developers.
• Adaptation for different indexes (e.g. PRI).
• Can be adapted to any UAV that can carry more than 800 gr.
• The upcoming version will incorporate correction for light conditions.

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NDVI IMAGrri v2.0 v.s. ADC TETRACAM

Altitude: 40m
Location: CIP-LIMA
NDVI IMAGri v2.0 v.s. ADC TETRACAM

Resolution: 2.8 cm/pixel
Altitude: 30m
Location: Morogoro

Resolution: 2.8 cm/pixel
Altitude: 74m
Location: Morogoro

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**IMAGE STITCHING FOR AERIAL MULTISPECTRAL IMAGES: ISAM V3.0**

**Description:**
- Stitch two or more images into one (mosaic)
- Tests were performed with TETRACAM Micro, Snap, ADC (3 bands) and IMAGri (2 bands).
- Current Version can join 5 bands MCA TETRACAM images

**Remarks:**
- Source code, final product, tutorials and sample image are free access in our website.
- **GNU GLP License**

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Building Local Capacity in East Africa

Training in Lima:
• UAV assembling
• Mission planning
• Data processing
Capacity in UAV Assembling

- UAV assembling
- Designing and printing new components
- Print parts for sensor adaptation
Capacity in UAV Maintenance

Replacing broken parts

3D-printed Quadcopter crashed

Crashed Octocopter

Fixed

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Capacity in Data Acquisition

- Field surveys
- Flight plans
- Sensor calibration
- Safety considerations
- Data quality considerations

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Field Missions

• Mwanza
• Kilosa
• Morogoro

Data Collection Sites in Misungwi District, Tanzania

Legend
- Misungwi_District
- Sweetpotato_fields
  - Field_1
  - Field_2
  - Field_3
  - LZARDI
- Other_crops
  - Cassava
  - Cotton
  - Millet
  - Rice
  - Sorghum
  - Sweet pepper
- AFISIS_Sentinel_Site_Locations
  - AFISIS Sentinel Sites

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Variety Discrimination at LZARDI

14 Sweetpotato varieties at LZARDI experiment, Mwanza

Optical spectra

Multifractal spectra
Mosaicking using ISAM
Field Mission at Kilosa

Kilosa District, Tanzania
Knowledge Sharing

UAV demonstration - Kigali

Seminar – Kenyatta University

Training at Ministry of Agriculture - Rwanda

Online community of practice – UAV4Ag

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Progress on:

- Statistical up- and down-scaling of remotely sensed data
- Monitoring NDVI throughout the phenology of crops & yield estimation
- New sensors
A: 2 m resolution satellite image.
B: close-up portion of the image which coincides with a UAV image coverage
C: focusing on a single field
D: 3.2 cm resolution UAV image
E: Close up of the field.
Monitoring NDVI in time

![Graph showing NDVI over days after planting for different crops: Sweetpotato, Corn, and Cassava.](image)
NDVI Signature-pests

Days after planting

Healthy Plants
Chemical controls
Plants with mites
Reflectance-Yield with and w/o stress

Potato yield and NDVI correlation
Normal irrigation

Potato yield and NDVI correlation
Alternative irrigation

r-Pearson

Nov 15  Dec 01  Dec 15  Jan 01
2014-2015
Potato yield and reflectance: Induced stress

Potato tubers = α + β * NDVI

Tubers = -20.32 + 482.2 NDVI

$R^2 = 0.79$
Spatial yield monitoring

NDVI

Crop Growth Model

Tuber Yield Prediction

Observed (t ha⁻¹)

Simulated (t ha⁻¹)

Light

Photosynthetic Apparatus

Ground Cover

Light Reflectance

Kg DM ha⁻¹ d⁻¹

Leaves

Stems

Roots

Tubers
Water stress detection

Both PRI and FF show evidence of a reversible water-stress.

NDVI and [Chl] remain constant

After a rainy day (247) we see the reversion of water stress on FF and PRI


Fs760 fluorescence flux as a proxy of CO₂ assimilation

Net Ecosystem Exchange versus Fs760 on a wheat field during its growth
Fluorescence and water stress

Source: Ismael Moya LMD Ecole Polytechnique
Thanks for your attention and patience

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