

FIG

FIG WORKING WEEK 2017

Helsinki Finland

29 May - 2 June 2017

*Presented at the FIG Working Week 2017,
May 29 - June 2, 2017 in Helsinki, Finland*



Surveying the world of tomorrow -
From digitalisation to augmented reality

Organised by



Platinum Sponsors:





FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Augmented Reality and Remote Sensing: using multi-spectrum to exhibit our physical environment

Lingli Zhu Juha Suomalainen Eero Salminen Juhä Hyyppä

- *Department of Remote Sensing and Photogrammetry*
- *Finnish Geospatial Research Institute*
- *National Land Survey of Finland*



Platinum Sponsors:





FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

What is Augmented Reality (AR)?

- Combine or mix the view of the real environment with additional and virtual contents;
- Presented through computer graphics
- Advantages:
 - With the help of advanced AR technology, the information about the surrounding real world becomes interactive and digitally manipulable.
 - It can bring out the components of the digital world into a person's perceived real world.



Platinum Sponsors:





FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Why AR with RS (Remote Sensing)?

- Human visual spectral range (within the visible light):
390nm-700nm
- In our physical world, the electromagnetic spectrum (EMS) covers a wide range, typically from Gamma rays, x-rays, ultraviolet, visible light, infrared light, microwaves and Radio waves, between 1pm to 100Mm;
- Remote Sensing deals with most of EMS;
- In different EMS, objects exhibit different characteristics.



Platinum Sponsors:





FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Materials for our development

- A Near-Infrared (NIR) hyperspectral camera,
 - Resolution: 409x217 pixels
 - Spectral range: 600-875nm
 - Sensor active area: 25 Bands
 - Dimensions (without lens) WxHxD: 26x26x31 mm
 - Frame rates: up to 170 cubes/s
 - Weight: 32 g
- A smart phone with video camera and Android development platform,
- Matlab software.





FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Methods

i) to obtain the NDVI value of vegetation.

- *NDVI images can allow people to see additional information on health status of leaves and vegetation;*

ii) to highlight and detect known objects.

- For example, it can help people to spot lost objects or mushrooms when those show up in a scene;

iii) to highlight and alarm about object not fitting spectrally in a scenery.

- For example, this can be used to spot manmade objects in natural environment.



Platinum Sponsors:



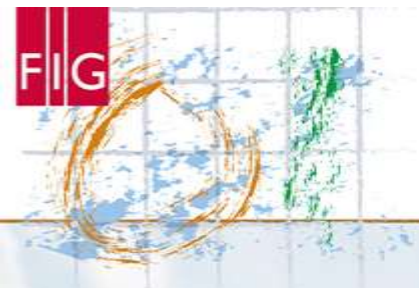


FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Implementation

1. NDVI value acquisition

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

2. Object detection-finding known objects

$$SAM = \arccos \left(\frac{\sum_{i=1}^{N_{bands}} x_i y_i}{\sqrt{\sum_{i=1}^{N_{bands}} x_i^2} \sqrt{\sum_{i=1}^{N_{bands}} y_i^2}} \right)$$

3. PCA component analysis

- to determine the dominant spectral shapes presenting in imagery

4. Image registration: to measure structural similarity (SSIM) for video imagery:

$$SSIM(x, y) = [I_M(x, y)]^{\alpha M} \cdot \prod_{j=1}^M [c_j(x, y)]^{\beta j} [s_j(x, y)]^{\gamma j}$$

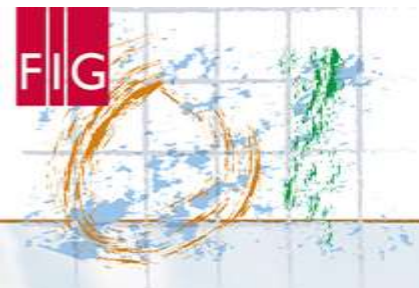


FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Implementation and Results

5. Added information overlapping on video based on Android Smartphone Platform

Results: 1). Figure: A photo and a NDVI visualization of an indoor plant. In this visualization we can see how: (i) the NDVI effectively masks the plant from the background, (ii) greatly reduces the effect of shadows in the plant structure (iii) highlights a dead leaf in the middle of the plant, and (iv) reveals the veins in the leaves on high detail.



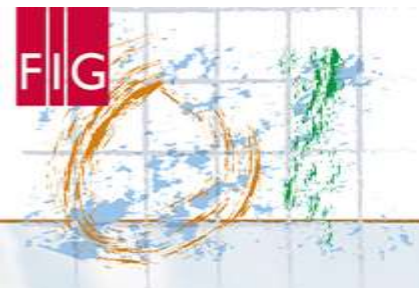


FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Results

2) .Figure: A photo and highlighted NIR image of the SAM detection experiment. Some green plastic pins were stuck to the leaves of the plant. For human eye, detecting all pins would have been a challenging task. From hyperspectral image, the spectrum of one pin was picked. This reference spectrum was compared to all pixels in the image using SAM algorithm.





FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Results

3). Figure: A photo and image of anomalous objects produced with unsupervised PCA filtering. a) Plant with green pins; b) Plant with plastic buckets; c) PCA without any component removal;





FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Results

d) Investigate 12 top most dominant component contributions. The fifth component clearly shows the green pins; e) The seventh component shows the rubbers.



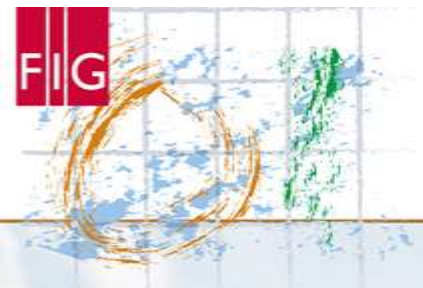


FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Results: Image library and Video image registration by a smart phone

4) Figure: (a) A plant image; (b) NDVI image of the plant; (c) NDVI image mask;

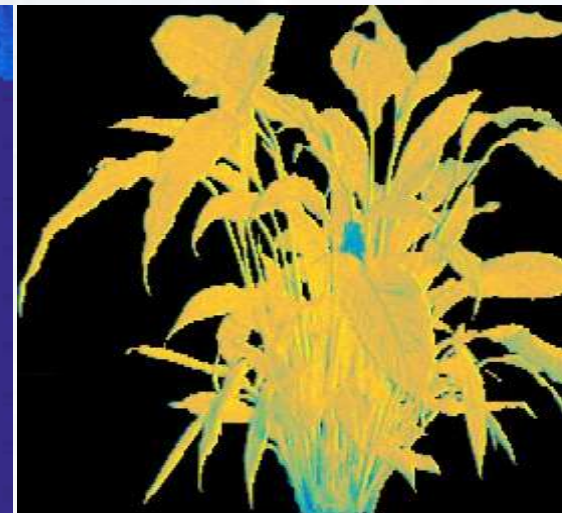
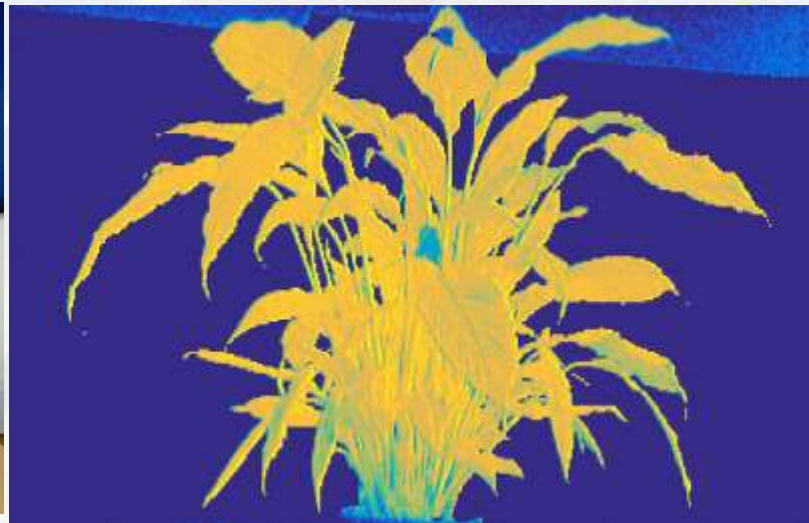




FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Results: Image library and Video image registration by a smart phone

(d) A video image; (e) NDVI image matching to video image; (f) Overlapped images when matching condition meets.

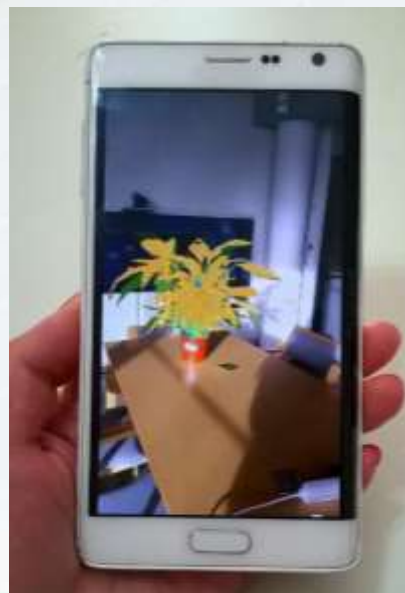
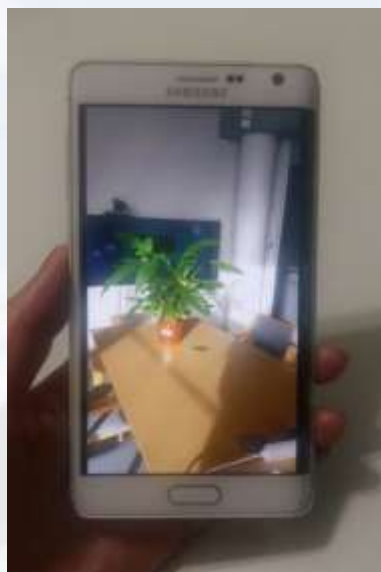




FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Summary

- We proposed an AR technology to enhance video images by superposing the added information from multispectral camera.
- Explored and analyzed images for the NDVI value of the vegetation, object detection from known spectrum, and the PCA components of a scene;
- Video images were registered to image library files and obtain the images;
- Overlap the image from the library on the video image and display on the smart phone.
- The development was based on two platforms: Matlab and Android smart phone.



Platinum Sponsors:



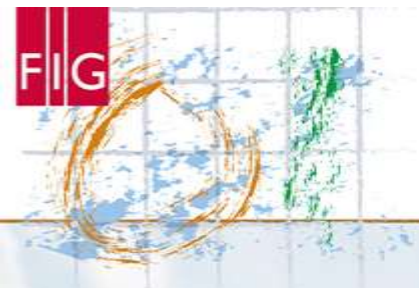


FIG WORKING WEEK 2017

Surveying the world of tomorrow -

Helsinki Finland 29 May - 2 June 2017

From digitalisation to augmented reality

Thanks for your attention!

More discussion by email:
lingli.zhu@nls.fi



Platinum Sponsors:

