UAS IN CROP RESEARCH MONITORING

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Abstract

Crop research traditionally required technicians to take many measurements across field experiments; typically an experiment can have hundreds or even thousands of plots, each requiring assessment. These assessments may be subjective and inconsistent between technicians. Digital imaging is increasingly being developed to undertake the measurements, giving quantitative and consistent data. Unmanned Aerial Systems equipped with RGB off-the-shelf inexpensive digital cameras (with or without IR filters) can be used for monitoring of experimental plots. This poster shows the author's experience of such research at Rothamsted Research in the United Kingdom.

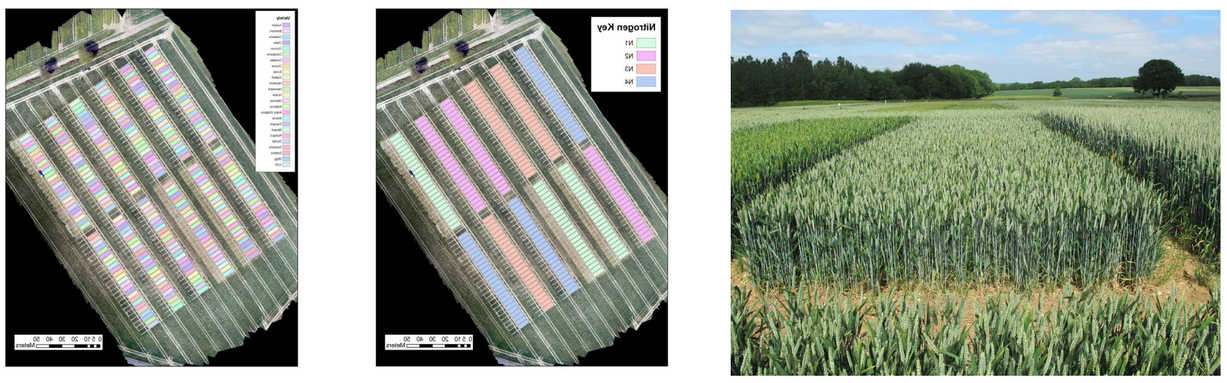

Fig. 1 The Diversity Field Experiment in 2014. Wheat varieties (left), nitrogen levels (centre), and an example plot ground level view.

Introduction

Agricultural research institutes around the world are working on increasing crop yields to satisfy growing food demand. Rothamsted Research is a leading international agricultural research institute in the UK. A key area of research is crop genetics and improvement, both of yield and quality; much of the work is on wheat, but also other cereals and crop species. In agricultural field experiments there is a need to measure various plant traits, a process known as phenotyping.

Objective

One of the phenotyping traits is plant height. Traditionally, it was measured with a ruler in the field, which was slow and subject to slight inconsistancies due to slightly different techniques of different personnel. However, for several years, attempts have been made to apply photogrammetric measurements, using UAS, to determine heights.

Study area: the field experiments are situated at Rothamsted Experimental Farm, south east England. The Diversity Field Experiment consists of 300 plots with 25 varieties of wheat and four nitrogen level treatments. Each plot is 3 x 9 m. The experiment conducted in 2015 is illustrated in Fig. 1.

Methods

The height of each plot in the experiment was measured on the ground at the end of vegetation growth (about second half of June) with a ruler. The same week as the ground measurements were done, a UAS flight was also carried out. Almost six hundreds RGB photos with greater than 80% overlap in both directions were taken with the UAS. The data was processed in AgiSoft ® (photogrammetric part) and ArcGIS ® (the height calculation using point cloud). Each plot height is calculated as a vertical difference between top of the canopy and the surrounding bare earth.

Results

The results are illustrated in the centre of Fig.2. A linear regression line was fitted to the data. The regression coefficient was calculated ($R^2 = 0.95$).

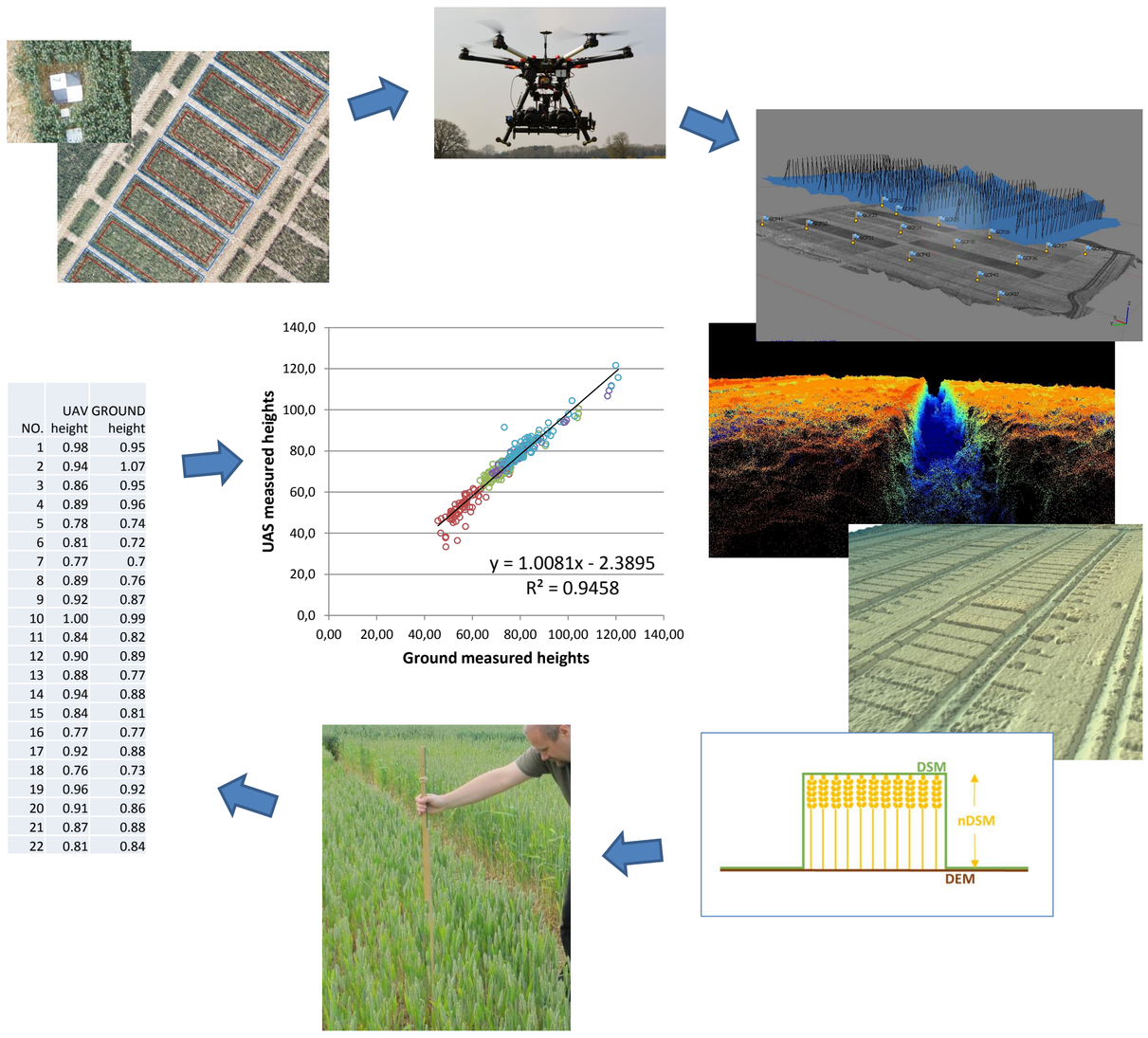

Fig. 2 The plots heights extraction workflow

Other traits

There are also other traits can be measured and processed. The RGB camera with removed infrared filter is a usefull tool for high resolution NDVI estimation. (Fig.3). A thermal camera can give information about canopy temperatures (Fig. 4), useful for water stress estimation.

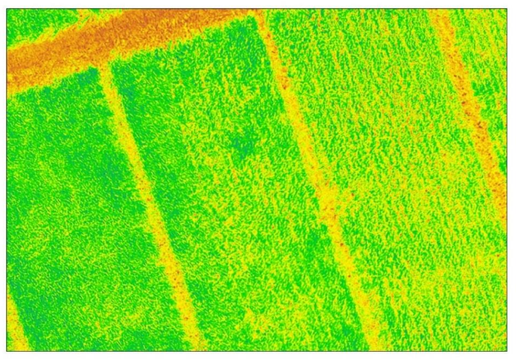

Fig. 3 NDVI orthoimage (approx. 1 cm resolution)

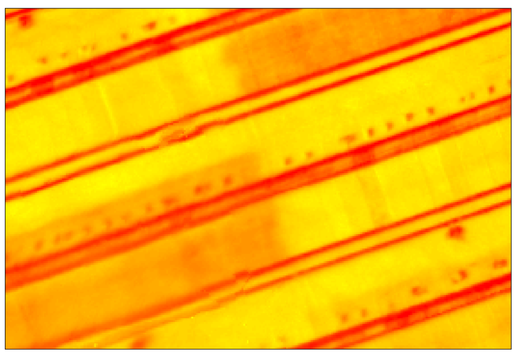

Fig. 4 Canopy temperatures

Conclusions

Unmanned Aerial Systems are useful tools for extracting crop heights and other traits in agricultural research. The Diversity Field Experiment used here provided a useful test of estimating crop height in large plots. A much more detail analysis for this experiment has been published [1]. There is still a space for further research in this area, especially for experiments with small and lodging damadged plots [2].

References:
[1] Holman F.H., Riche A.B., Michalski A., Castle M., Wooster M.J., Hawkesford M.J.; High Throughput Field Phenotyping of Wheat Plant Height and Growth Rate in Field Plot Trials Using UAV Based Remote Sensing; Remote Sensing 2016, 8(12),
[2] Michalski A., Riche A., Castle M., Holman F., Hawkesford M., Wooster M., UAS in 3D crop modelling for agriculture research, Proceedings, 7th International Conference on Cartography and GIS, 18-23 June 2018, Sozopol, Bulgaria ISSN: 1314-0604, Eds: Bandrova T., Konečný M.

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