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Cotton yield estimation using very high-resolution digital images acquired with a low-cost small unmanned aerial vehicle

Title	Cotton yield estimation using very high-resolution digital images acquired with a low-cost small unmanned aerial vehicle
Title (native language)	
Category	• Recording or mapping technology
Short summary for practitioners (Practice abstract) in English)	Yield estimation is a critical task in crop management. Traditional methods are costly, time-consuming, and difficult to expand to a relatively large field. Remote sensing can provide quick coverage over a field at any scale. Satellite remote sensing is used for large-scale earth observation. Remote sensing with manned airplanes at relatively high altitudes (>500 m) has difficulty achieving the spatial resolution required for field-scale precision farming. Ground-based systems are typically used for point measurements and are restricted to field conditions. Unmanned aerial vehicles (UAVs) provide a unique platform for high-resolution remote sensing, and UAV-based remote sensing systems can be used to estimate crop yield in a cost-effective manner. The objective of this study was to develop and evaluate new methods for estimation of cotton yield for precision cotton farming. Experimental plots were laid out in a cotton field near Stoneville, Mississippi, in 2014. Nitrogen fertilizer was applied to the plots at five different rates to generate cotton yield variation. Two methods were employed to estimate cotton yield using very high-resolution digital images (2.7 cm pixel-1) acquired from an inexpensive small multirotor UAV: (1) using three-dimensional point cloud data derived from multiple digital images of the cotton field to estimate cotton plant height and hence estimate yield, and (2) segmenting cotton boll signatures from the background of the digital images of the defoliated cotton field just prior to harvest and then estimating yield with the estimated cotton plot unit coverage. The results indicated that low-altitude remote sensing with an inexpensive small UAV can be used to estimate cotton yield accurately through estimation of plant height (R2 = 0.43, compared with R2 = 0.42 for yield estimation through manually measured plant height). The results further indicated that the method can offer reliable cotton yield estimation through estimation of cotton boll coverage in each plot with Laplacian image processing while considering a few plots with poor light condition as outliers (R2 = 0.83). This study could benefit yield estimation of cotton, with similar methods used for other crops, in agricultural research and crop production. © 2016 American Society of Agricultural and Biological Engineers.
Short summary for practitioners	
Website	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85007404922&doi=10.13031%2ftrans.59.11831&partnerID=40&md5=1061d3ac3d88ca15a5232bc081dc382e
Audiovisual material	
Links to other websites	

Additional comments	
Keywords	Farming practice
Additional keywords	COTTON; Digital image; Unmanned aerial vehicle; Yield estimation
Geographical location (NUTS)	EU
Other geographical location	The field is located on a research farm of the USDA-ARS Crop Production Systems Research Unit at Stoneville, Mississippi
Cropping systems	Arable crops
Field operations	Harvesting
SFT users	Farmer | Contractor
Education level of users	Secondary education | Apprenticeship or technical school education
Farm size (ha)	10-50 | 50-100

Scientific article

Title	Cotton yield estimation using very high-resolution digital images acquired with a low-cost small unmanned aerial vehicle
Full citation	Huang, Y.; Brand, H.J.; Sui, R.; Thomson, S.J.; Furukawa, T.; Ebelhar, M.W. (2016). Transactions of the ASABE, Volume 59, Issue 6, pp 1563-1574, DOI:10.13031/trans.59.11831

Effects of this SFT

Productivity (crop yield per ha)	No effect
Quality of product	No effect
Revenue profit farm income	No effect
Soil biodiversity	No effect
Biodiversity (other than soil)	No effect
Input costs	No effect
Variable costs	No effect
Post-harvest crop wastage	No effect
Energy use	No effect
CH4 (methane) emission	No effect
CO2 (carbon dioxide) emission	No effect
N2O (nitrous oxide) emission	No effect
NH3 (ammonia) emission	No effect
NO3 (nitrate) leaching	No effect
Fertilizer use	No effect
Pesticide use	No effect
Irrigation water use	No effect
Labor time	No effect
Stress or fatigue for farmer	No effect
Amount of heavy physical labour	No effect
Number and/or severity of personal injury accidents	No effect
Number and/or severity of accidents resulting in spills property damage incorrect application of fertiliser/pesticides etc.	No effect
Pesticide residue on product	No effect
Weed pressure	No effect
Pest pressure (insects etc.)	No effect
Disease pressure (bacterial fungal viral etc.)	No effect

Information related to how easy it is to start using the SFT

This SFT replaces a tool or technology that is currently used. The SFT is better than the current tool	no opinion

The SFT can be used without making major changes to the existing system	no opinion
The SFT does not require significant learning before the farmer can use it	no opinion
The SFT can be used in other useful ways than intended by the inventor	no opinion
The SFT has effects that can be directly observed by the farmer	disagree
Using the SFT requires a large time investment by farmer	no opinion
The SFT produces information that can be interpreted directly	disagree

View this technology on the Smart-AKIS platform.

SMART AKIS PARTNERS:

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