Exploitation of UAS imagery with machine learning to derive cow characteristics

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Summary

Within the H2020 project GenTORE we performm a feasibility study of novel technology in beef systems which will show how the use of image information from Unmanned Airborne Systems (UAS or so called drones) and cow sensors can be used complementary to measure cow characteristics and movement patterns as proxies for efficiency and resilience in rangeland beef production systems. Specific cow characteristics in which we are interested are 1) automatic detection of location and animal counting; 2) cow postures like standing or lying; 3) individual cow identification; and 4) individual cow characteristics such as height, size and weight. Animal grazing monitoring may provide useful indicators of animal intake under extensive conditions. Wageningen University and Research (WUR) initiated an Unmanned Airborne Remote Sensing Facility (WUR-UARSF, http://www.wur.eu/uarsf) in 2012 and is ROC certified sind April 2015 and is using a wide array of drone mounted camera systems (e.g. RGB, video, hyperspectral, thermal and LiDAR) amongst others now to locate and estimate individual cow characteristics. At the same time, Noldus Information Technology is developing TrackLab, a tool for livestock research, and testing sensor fusion techniques to combine information from GPS tracking and accelerometer data to create a robust proxy for relevant behaviors of the cattle including grazing and activity. All the work presented here is quite experimental and has been performed at various locations in the Netherlands and Poland. First of all, at CARUS, the research facility of the Department of Animal Sciences, part of Wageningen University, where we have performed two major experiments, one from 1-5 October 2018 with 4 dairy cows and one from 20 – 22 May 2019 with 6 Holstein Frisian dairy cows. In Poland we had an additional campaign on 4th & 5th of June 2019 on a larger area at Juchowo biodynamic farm with nearly 2,000 hectares of land (including amongst others 600 ha of arable land and nearly 400 ha of grasslands) and 600 dairy cows (Schweizer Braun, Local Pommern and Holstein Frisian). In Poland the experiment included 100 dairy cows on approximately 100 ha of land. In total we performed more than 60 flights with RGB cameras, video, thermal camera, and a LiDAR scanning system using different platforms (multirotor as well as fixed wing). For the study presented here we only exploited the RGB imagery from the multirotor platforms Phantom 3 & 4 and a fixed wing EBEE X that we used especially in Poland to cover larger areas. In general fixed wing UAS are more suitable to cover larger areas than multirotor systems due to their aerodynamics, while multirotor systems can easerier handle a wide array of camera systems and can fly from high alltitudes to a few meter above the ground and can hoover at specific locations. So both types of paltforms have their own advantages.

Before performing the image analysis with machine learning we annotated many images with LabelImg (more than 1000 annotations per site). LabelImg is a graphical image annotation tool and uses label object bounding boxes in images. The annotation did concern not only cows in general (Label 'Cow'), but also individal cows with a nickname. After this the images and anotations were uploaded to the machine learning API Nanonets (https://nanonets.com/). The study showed so far that deep learning on UAS imagery is successful to detect, locate and count animals with accuracies over 90%.

Although counting is much dependent on the fight height, flying at lower attitudes can cause double counting of animals, so for counting flying at 80 meters height or mor eis preferred. While for individual cow detection flight heights of 40 to 20 meter height is preferred. In our case, individual cow detection could reach accuracies up to 91% with deep learning algorithms, but only for Holstein-Friesian cows which have very clear unique individual patterns (see Figure 1).

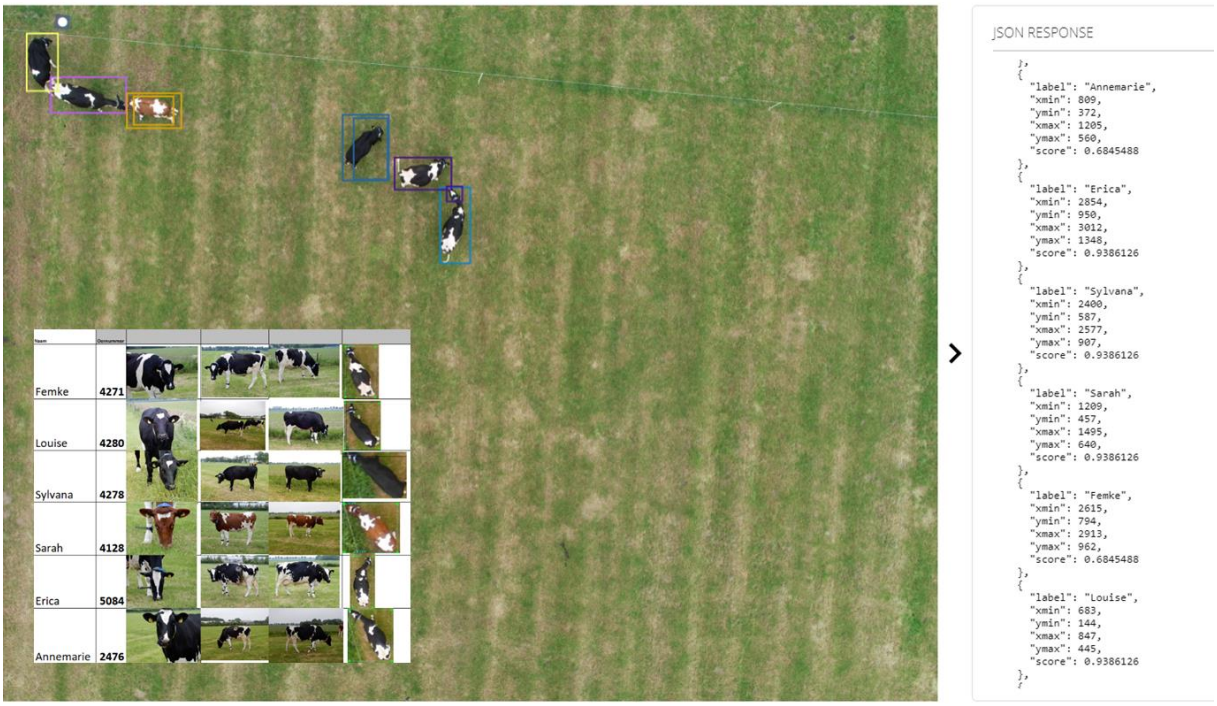

Figure 1 Individual cow identification at CARUS, the research facility of the Department of Animal Sciences, part of Wageningen University, using a Phantom 4 at 40 meter height. The experiment in May 2019 included 6 Holstein Frisian cows with different fur patterns.