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Geoscientific Instrumentation Methods and Data Systems Discussions
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Interactive comment on "Semi-automated roadside image data collection" *by* Neal Pilger et al.

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RC: This paper describes the development of a mobile agricultural practice inspection system using images taken from the side of a motor vehicle. Such a system seems to be of some applicative interest for agricultural administration and statistics. However, there are many on-board shooting vehicles and the development of a new one, in itself, is not a very original contribution.

AC: I agree there are a host of mobile mapping vehicles commercially available for hire - many with 3D mapping (LiDAR). This project, however, was based around minimizing costs (labour, time, resources) for the capture of ground verification data of post-

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harvest tillage practices only over large geographical regions. Key issues included the timeliness of acquisitions to match satellite coverage and the period of time when land management assessments are necessary. It was envisioned as a surrogate, or direct replacement for traditional methods which employ upwards of 30 people, require six or more vehicles, and gather information on tillage residue, and tillage operations over rather broad classes. The results of which (40 - 60 fields) are then extrapolated across a county-wide region to determine the percentage of agriculture operations which are shifting from conventional (full soil overturning and grooming post harvest) to conservation (residue left behind) and/or cover crop operations (note that No-till operations are another form of conservation tillage). Such traditional methods employed in securing such ground reference data may also involve access onto priviate property which requires significant resources prior to the campaign to gain the necessary permissions, potential safety risks (crossing culverts and so forth), and limited samples which may prove not to be actually representative of the larger region. This project - a precursor to follow-up studies which will be using our data in validating satellite classifications, was not designed to sample, but to provide a cost effective census of field conditions on a particular day following the majority of harvest operations.

RC: Moreover, the paper, although pleasantly styled and easy to read, is actually quite poorly written and ultimately unclear. For example, reading the abstract and the introduction, one might think that the method produces data useful for the calibration or verification of remote sensing methods, but this is not the case. In reality, the proposed system is more of an alternative to remote sensing and high-altitude aerial imagery.

AC: The paper has been re-written sections to improve clarity. In certain cases we do see this as an opportunity to either form a calibration/validation data set for remote sensing imagery, but as noted during the small time windows when this data is necessary, techniques that are accurate enough to provide a census and therefore a replacement of optical remote sensing data may be necessary. Notably, a random sample of the census data from this project is being utilized as ground verification training data (calibration data) for classification of both optical and radar orbital imagery with the remaining data being used for post-classification verification. The argument presented in this paper is that the census data may be employed for classification on its own merits - for a rather broad 4-5 category classification. Both of these are follow-up studies, however, which explains why there was not significant discussion on the utility of this data collection method. The subsequent draft of this manuscript will address such issues in a clearer manner.

RC: One might have expected to see a comparison between the results of the system and those of the alternative methods, but this is not the case. Later in the paper, it is understood that the system is supposed to replace a traditional surveying method, by operators on board of vehicles. One might therefore expect to see a comparison, in terms of efficiency (acquisition & processing time) and quality of the result, but again, this is not the case.

AC: I feel that perhaps a table specifying the comparison between the roadside survey method and those traditionally employed would serve to clear this up. The issues you refer to are present in the paper, but should be more concisely arranged. For example 5000 fields versus 50; one operator versus 30; one vehicle versus six; 5-6 hours of data collection versus 12; etc. Also imagery not used (duplicates, non-agricultural imagery, etc.) should also be included. The benefits is gaining census rather than sample data, yet that is also the detriment, as there is a lot of data produced.

RC: The only experiment shown compares interpretations (apparently purely visual) made on images taken in the fields (in vertical view) with images in oblique view obtained with the help of the proposed mobile system. Finally, the effect of the angle of view in this experiment is largely evaluated, rather than the system itself.

AC: More detail is provided in this respect, and less on the issues related to oblique versus nadir view. Post sorting and deletion of non-agricultural field imagery, all subsequent images were visually classified by 4 individuals and recorded on spreadsheets.

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Contrary classifications were allocated their final classification based on simple majority. For the 4 classes, confusion was primarily between Conservation (CS), and No-Till (NT) classes where quantification of residue was close to 60% (the division between the two classes. Cover crop was green, and Conventional tillage was lacking any significant residue, therefore mis-classification of these categories was virtually non-existent. The confusion between Conservation and No-Till, was also slight, and considered acceptable, as both are actually conservation tillage methods. Further clarification on this matter are addressed in the subsequent draft.

RC: The experimental protocol is not well described. Someone unfamiliar with the classification methods used by the operators (especially for oblique views) has difficulty understanding them and there is no bibliographic reference on this point.

AC: The classification methodology was expanded upon as described above.

RC: One of the practical interests of the system would be to automate the analysis task, but this is not discussed at all, which is a pity.

AC: A follow-up study performs exactly what is proposed. We are using Semantic segmentation and Deep Learning (DL) to automatically classify such roadside imagery. Much in the same fashion as autonomous vehicles classify in near-real-time objects and entities around them, this DL segmentation protocol classifies fields based on tone and texture into 4 classes (conventional tillage, conservation tillage, no-tillage, and cover crop) all other scene entities are discounted as ‘other’ and effectively removed (blacked out) from the image scene. We hope in time to have a system that will auto-classify, so at the end of a survey a final classified product is ready for dissemination. This paper, however was meant to describe how the camera system is developed as cost effective efficient data collection technique, which captures 100% of the fields in a given county area. Perhaps a note to this effect could be included at the end of the manuscript in discussion to follow-up studies.

RC: The only equation in the paper is wrong or, at the very least, poorly commented on. A speed being the ratio of a distance to a time, SA, defined as the ratio of a speed to a distance, cannot be a time, but rather a frequency. In addition, it is disturbing to talk about shutter actuation because one would tend to associate this term with the speed at which the shutter closes. This one, with the speed of the vehicle and the aperture of the diaphragm, condition the motion blur present in the images: vibrations are not the only possible sources of image quality loss.

AC: The equation listed relates to programming the camera shutter interval to ensure a minimum of 2 usable images captured for every field in the county study area. The roadside survey vehicle described in this paper was used over three different counties (two mentioned in this paper). To ensure that every single field is adequately imaged, the roadside width (average frontage) of the fields in the county area is required, and an upper limit driving speed. This equation then indicates the time (in seconds) it takes to drive between the two outer boundaries of the average field in the area. With a desire to capture 2-3 images for each field, the mean field width is divided by 3. This does not mean that the vehicle will maintain a steady velocity, as there are always exceptions where a field may be split, or other features (e.g. streams, hedgerows, etc.) may result in narrower plated plots. It is, however a guideline for setting the camera intervalometers, as they are external to the vehicle and not readily accessible while in motion. In event of narrow fields, or fields slightly obscured by trees, the operator can slow down, stop, and/or double back to ensure adequate coverage. As to your second point about the camera itself, such details can be included in the subsequent draft of the manuscript. The cameras used are Garmin VIRB XE units that shoot 12 MP images - exposure time is not static, as it is digitally based on incident light saturation, however, in most instances it is operating between 1/1000 and 1/2500 of a second. The cameras are mirrorless and do not have physical shutters or diaphragms but are electronically stabilized to minimize blur. Regardless the equation was omitted from the final draft.

RC: By the way, what is the type of camera shutter (global or rolling shutter)? It is not

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clear how the field of view is estimated. Are the cameras geometrically calibrated?

AC: Camera specifications have been addressed in response to the previous comment. The cameras have internal GPS which is auto-calibrated prior to each field operation, and again following battery changes. location error is consistent with any other hand-held Garmin GPS unit operating at 10Hz - generally accurate to within 20cm at variable speeds. More than accurate enough for agricultural field identification.

RC: It would still be interesting to argue a little more about the justification for the choice of carrier. Rather than a land vehicle, with the drawbacks that this entails (oblique viewing, vibrations, etc.), one could have considered imagery by drone, Ultra-Light plane or helicopter. This also makes it possible to pass under the clouds, and that would especially offer very interesting efficiency, while remaining in vertical sight.

AC: While an ultralight aircraft or helicopter would be prohibitively expensive for this type of study, a UAV would be more versatile with the ability capture both oblique and Nadir image data, in RGB or False Colour format. The vehicle used in this project actually carries two UAVs in the back. The main issue with running them as opposed to the roadside survey as performed lies in the limited range, and time requirements to operate drones within the legal requirements put forth by Transport Canada. Excepting extreme circumstances (e.g. search and rescue operations) Drones in Canada must be down line-of-sight (LOS) only. Additionally there are restrictions barring operation without Special Flight Operations Certification (SFOC) within 100 metres of any person, vehicle, occupied structure, and livestock. Barring such legal restrictions, a stop-and-go survey of every field at a county-level scale would be no more efficient than physical trespass into the fields as is the current method for generating a sample of tillage practices. This study was designed not to sample, but to provide a large area census with minimal costs, and personal. The reason why the vehicle does carry UAVs, was to address the obstruction of clear lines of sight from hedges/fences which, while not numerous are still prevalent in the study areas we were looking at. However, to facilitate maximum coverage in minimal time, such obscured field images were removed during

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the preliminary sorting/classification phase

RC: From a paper structuring point of view, it is annoying that the purpose of the work only appears at the bottom of page 3. It would be better to state them at the beginning of the introduction, before giving details of the application, making a critical inventory of the existing means of inspection and positioning the choices made.

AC: The purpose of the manuscript was moved as suggested.

RC: In addition, it is usual to end the introduction by describing the structuring of the paper (announcement of the plan). For all these reasons, I cannot support the publication of this paper, at least in its present state.

AC: Yes, this is traditionally standard, and the response to your previous comment would include such.

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