EVALUATING THE ACCURACY OF WEED MAPS GENERATED USING AIRBORNE MULTISPECTRAL IMAGING

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Abstract

Accurate, spatially registered maps of weed patches in young crops or fallow fields are an important agronomic tool for scientists and farm managers. Global positioning systems (GPS)-equipped variable-rate weed sprayers also require detailed weed maps to control the herbicide application. Airborne multispectral imaging of young crops and fallow fields is potentially one means of generating metre-resolution weed maps in a timely and cost-effective manner. An airborne multispectral image of a fallow crop (canola stubble), interspersed with patches of hairy panic (*Panicum effusum*), was converted into a weed map using a standard supervised classification procedure. A comparison of the weed map with detailed ground-truth data demonstrated a mapping accuracy of better than80% is possible.

Key words: Airborne multispectral imaging, remote sensing, weed mapping, classification

On average, Australian dryland cereal farmers will spend between $A15 and $A25 per hectare per herbicide application, on weed control. In most cases they will apply herbicide uniformly over entire paddocks regardless of the distribution and density of weed infestation. Patch spraying increases the efficiency of herbicide application, and can provide significant financial savings to the user (4). However, automated GPS-equipped mobile patch spraying units require geo-referenced weed maps to control the variable-rate herbicide application (3; 4). The aim of this present work was to estimate the accuracy of mapping weeds in fallow fields using a 4-band airborne video system tuned to wavelengths of 440 nm, 550 nm, 650 nm and 770 nm (2).

Use of remote sensing to detect and map weeds in young crops or fallow fields requires a spectral or "colour" difference to exist between the weed patches and the background field. Typical reflectance spectra of common weeds and stubble or soil show them to have significantly different spectral signatures (5).

This particular evaluation was completed using a field of canola stubble interspersed with patches of hairy panic (*Panicum effusum)*. A 1 m^2-resolution image covering 27.2 ha of the target field was acquired at noon (AEST) on 14th January 1997. Two weed/non-weed maps were generated from a maximum likelihood supervised classification of the image using all four wavebands, and two wavebands (near infrared and red) respectively. The accuracy of each weed map was calculated by comparing them directly to a detailed ground-truth map. The ground-truth map was generated using a data logger (Trimble TDC1) and an all terrain vehicle equipped with a Trimble ProXL 12 channel differential global positioning system. The accuracy of each map was quantified by counting the number of correctly and incorrectly classified pixels (both weed and non-weed classes), as discussed by Congalton (1).

Results

Error matrices of the four-band and two-band supervised classifications are given in Table 1.

The elements of each matrix represent the number of non-weed pixels correctly classified as "non-weed" (upper left), non-weed pixels incorrectly classified as "weed" (lower left), weed pixels incorrectly classified as "non-weed" (upper right), and weed pixels correctly classified as "weed" (lower right). Pixel numbers were converted into hectares using a simple relationship given sensor characteristics (lens size, size of pixel array) and height above ground.

(a)

?	Ground truth? non-weed (ha)	Ground truth weed (ha)
Classified? non-weed	18.1	2.6
Classified? weed	1.3	5.2

Overall accuracy = 85.8 %

(b)

?	Ground truth? non-weed (ha)	Ground truth? weed (ha)
Classified non-weed	18.2	2.9
Classified weed	1.2	4.9

Overall accuracy = 84.7 %

Table 1. Error matrices for the (a) four-band and (b) two-band supervised classification of weed and non-weed pixels.

Discussion

The overall classification accuracy of the supervised classification procedure was reduced by only 1.1% in going from a procedure involving four-bands to one utilising only the near infrared and red wavebands. This has important implications when selecting a low-cost imaging system for this kind of application as a two-waveband system may be as good as a four-waveband system.

Effective use of a supervised classification procedure requires the user to know the location of representative weed and non-weed sites in every target in order to train the computer to discriminate "weed" from "non-weed" classes. In practice it is a reasonable expectation that crop managers will be familiar enough with the weed problem in any given field to provide this information. Nevertheless, an investigation of automated classification processes is in progress.

The major source of incorrectly classified pixels in each classified image was the pixels along the weed patch boundaries. Incorrect classification could have arisen from pixels containing both weed and non-weed classes, from misalignment of the 4 imaging cameras, from spatial distortion in the image introduced by rectification errors and from errors in the location of class boundaries in the ground-truth map due to limitations in DGPS accuracy. These are the subject of ongoing investigations.

It is accepted that the accuracy requirements of spraying weeds in an actual management situation varies from 100% hit (no misses) to significantly less, and this depends on the weed type and crop situation. In a fallow field where a farmer may be dissuaded from spraying at all because of the cost of inputs, a hit accuracy of 80% may be acceptable in return for reducing potential seed banks and conserving soil moisture for the following cropping season. In a situation where thresholds are less forgiving, then the blanket application of a reduced spray rate onto a field, could be supplemented by the additional variable application of more spray on the more significant patches mapped using this approach.

Conclusion

A preliminary evaluation of using metre-resolution airborne digital imaging for mapping weeds in crops, has demonstrated a mapping accuracy of better than 80% is possible. While this evaluation was applied to mapping weeds in a fallow crop, the image processing requirements are also similar to mapping weeds in a seedling crop.

References

1. Congalton, R.G. 1991. *Rem. Sens. Environ.* **37**, 35-46.

2. Louis, J.P., Lamb, D.W., McKenzie G *et al*. 1995. *Proc. 15th Biennial Workshop on Colour Photography and Videography in Resource Assessment* (ed. PW Mausel),Terre Haute USA, 326-333.

3. Paice, M.E.R., Miller, P.C.H. and Bodle, J.D. 1995. *J. Ag. Eng. Res.* **60**, 107-116.

4. Stafford, J.V. and Miller, P.C.H. 1996. *Proc. 3rd Int. Conf. Precision Agriculture* (eds. PC Robert, RH Rust & WE Larsen), Minneapolis USA, 465-474.

5. Van der Rijt, V., Louis, J.P., Cregan, P., Dare-Edwards, A.J., Pratley, J.E. and McKenzie, G. 1992. In: *Data Report, Charles Sturt University Centres for Conservation Farming & Image Analysis*.