Object based image analysis of high resolution multi-spectral imagery for classifying and quantifying weeds in turfgrass areas

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Vorbemerkung

An der Universität Wageningen läuft ein umfangreiches Forschungsprojekt zur Frage der Herbizid-freien Unkrautbekämpfung auf Golf-Fairways. Im Rahmen einer Dissertation, bei Prof. Dr. Bernd Leinauer, bearbeitet Daniel Hahn dieses innovative Forschungsvorhaben unter dem Titel: „Non-herbicidal Weed Control for Turf Areas“.

Das gesamte Entwicklungskonzept ist vor dem Hintergrund entstanden, dass in den Niederlanden im Rahmen des „Green Deal 2020“ seitens der Regierung ein umfangreicher Verzicht auf die Anwendung von Pflanzenschutzmittel im Rasensektor zu erwarten sein wird, um eine grüne, nachhaltige Zukunft zu gewährleisten.

Sofern Herbizide im Rasenbereich verboten werden, sind also ökologische Alternativen für ein nachhaltiges Rasenmanagement zu entwickeln. Bei den derzeitigen Untersuchungen stehen zwei Schwerpunkte im Fokus. Zunächst sollen Gräserarten und selektierte Sorten mit überdurchschnittlichen allelopatischen Eigenschaften herausgefunden werden, um dann in einem zweiten Schritt geeignete Management-Strategien für diese Gräser zu entwickeln, so dass eine möglichst erfolgreiche Unkrautunterdrückung gewährleistet werden kann.

Ein wichtiger Teil-Aspekt dieser Forschungsarbeit steht unter dem Leitthema: „Image analysis for classifying and quantifying weeds in turfgrass areas.“ Hierüber wird in diesem Beitrag berichtet.

Background

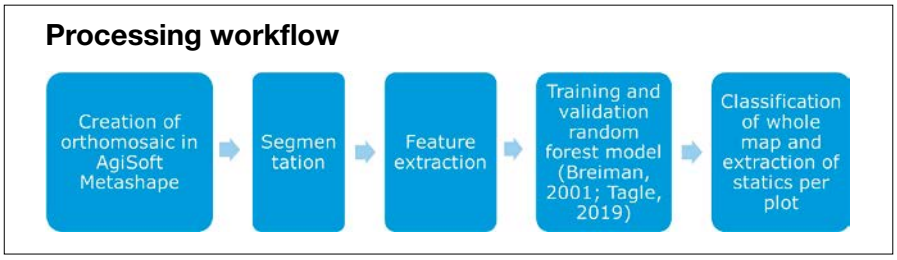
Weeds in turf areas can reduce its playing quality and aesthetic value (BUSEY, 2003; McELROY & MARTINS, 2013). Measuring and quantifying vegetation composition can be challenging in turfgrass research. We conducted a study at Wageningen University, the Netherlands, to classify and quantify vegetation cover of field plots seeded with different fescues species (*Festuca spp.*), clover (*Trifolium repens* L.), daisy (*Bellis perennis* L.) and yarrow (*Achillea millefolium* L.).

Objectives

- Using multispectral imagery to separate weeds from grass and soil in a seeded field trial with *Festuca spp.* and three types of weeds.
- Phenotyping of clover, daisy and yarrow by object based image analysis.

Methods

- Individual plot size 1,5 x 1,5 m.
- Six *Festuca spp.* cultivars from five *Festuca spp.*
- Species: Melyane (*F. arundinacea*), Musica (*F. r. commutata*), Barisse (*F. r. rubra*), Mentor *(F. r. trachyphylla*), Samanta & Barpearl (*F. r. trichophylla*).
- Four weed treatments (clover, daisy, yarrow and a mixture of all three).
- Seeded as a pure Festuca spp. stand (control), pure weed stand (control) or as a mixture of Festuca spp. cultivars with one of each weed treatment.
- Randomised block design with 34 entries per block, replicated 4 times (136 plots in total).
- Images taken from a height of 3 m, 53 days after sowing.
- Camera: Parrot Sequoia, 1280 x 960 pixels, green (530-570nm), red (640-680 nm), red-edge (730-740 nm) and NIR (770-810 nm).



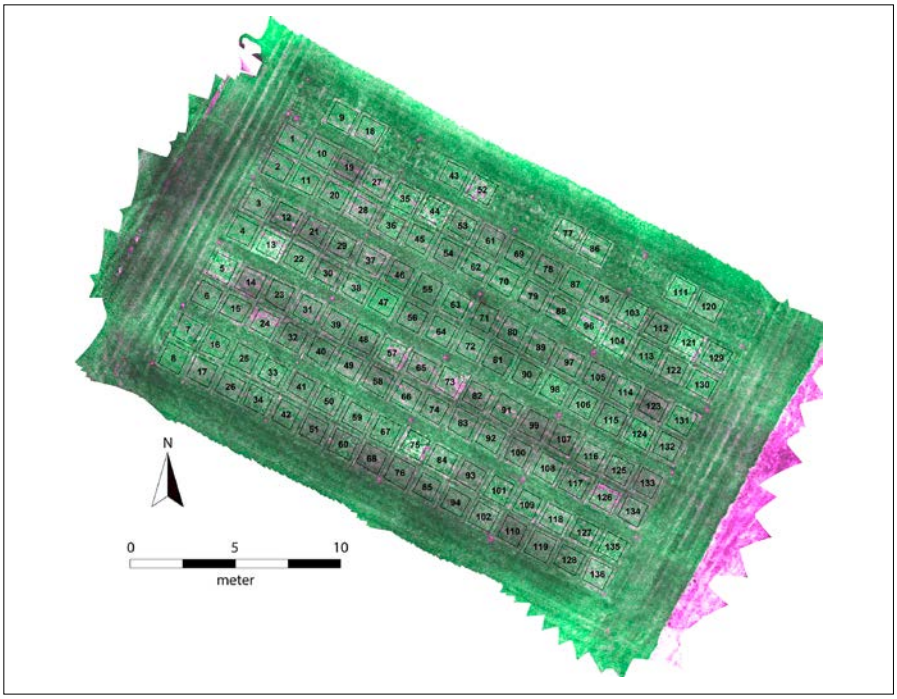


Fig. 1: False color representation of the multispectral orthomosaic (RGR) of the field trial. Ground pixel size is 3 mm.

		Validation Class			Sum	User accuracy (%)
		Grass	Soil	Weed		
Mapped Class	Grass	79	4	14	97	**81**
	Soil	2	74	1	77	**96**
	Weed	9	1	196	206	**95**
Sum		90	79	211	349	
Overall accuracy		180	158	422	729	**92**
Producer accuracy (%)		**88**	**94**	**93**		

Tab. 1: Confusion matrix and classification accuracies caluclated based on validation dataset of 349 entities.

		Validation Class					Sum	User accuracy (%)
		Clover	Daisy	Grass	Soil	Yarrow		
Mapped Class	Clover	77	20	5	0	18	120	**64**
	Daisy	9	38	0	1	3	51	**75**
	Grass	9	1	80	1	5	96	**83**
	Soil	0	0	3	77	1	81	**95**
	Yarrow	4	7	2	0	18	31	**58**
Sum		99	66	90	79	45		
Overall accuracy		**78**	**58**	**89**	**97**	**40**		**76**
Producer accuracy (%)								

Tab. 2: Confusion matrix and classification accuracies caluclated based on validation dataset of 375 entities.

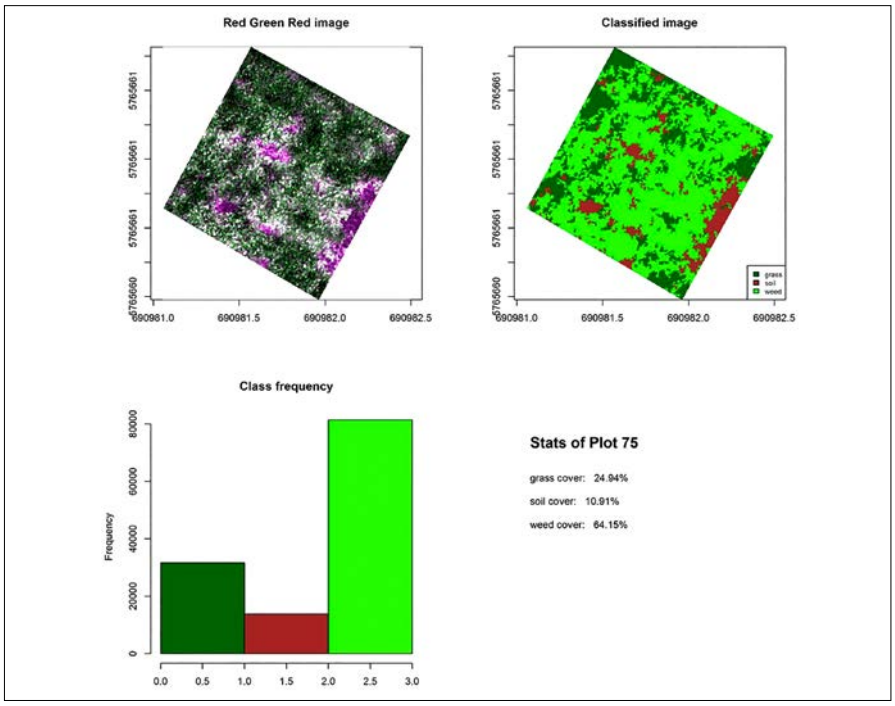


Fig. 2: Visualisation of plot 75 (daisy control), classified by a rondom forest model into 3 classes (grass, weeds and soil).

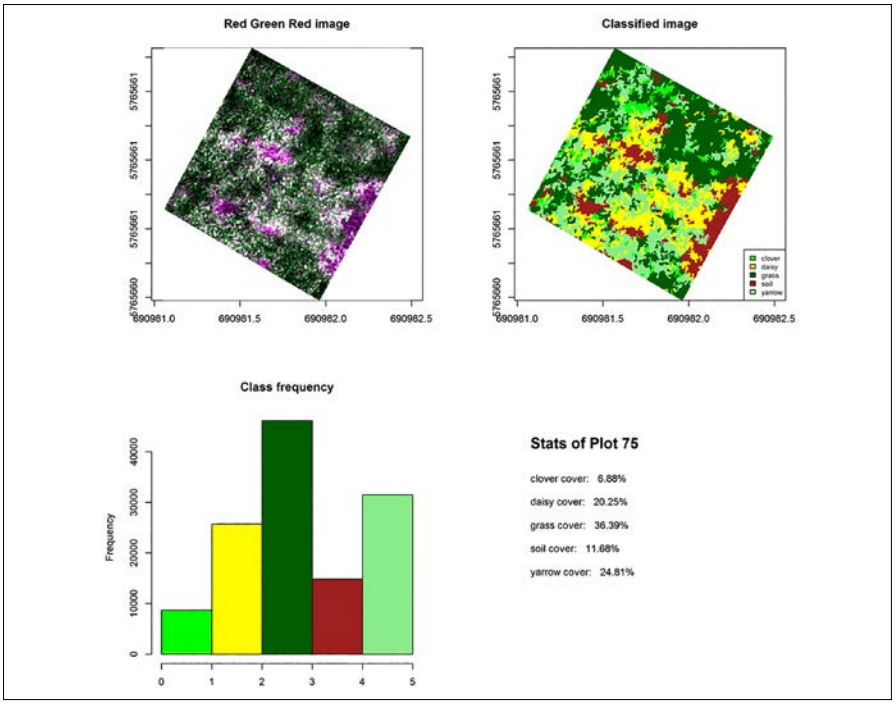


Fig. 3. Visualisation of plot 75 (daisy control), classified by a rondom forest model into 5 classes (clover, daisy, grass, soil and yarrow).

Results

Classification results of a random forest model trained on three classes: grass, weeds and soil. Clover, daisy and yarrow were grouped together as 'weed'-class. The overall classification accuracy is 92 %.

Classification results of five classes: clover, daisy, grasses, soil and yarrow. Phenotyping weeds (clover, daisy, and yarrow) and classifying grasses and soil of a random forest model resulted in an overall classification accuracy of 76 %.

Conclusions

- Grass, soil and weed classification was achieved with an overall accuracy of 92 %.
- Phenotyping weeds with multispectral imagery remains challenging.
- In future research, we will investigate the use of high resolution RGB images to optimize the object based algorithm for phenotyping purposes.

References

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