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Sensing Systems for Agricultural Management (SeSAM)

Comparison of Performance in Weed Detection with Aerial RGB and Thermal Images Gathered at Different Height

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Introduction

Importance of green areas in cities and their potential benefits for society.

To stop the proliferation of weed plants, periodic mowing + phytosanitary products.

To reduce the amount of used product → develop tools for early detection.

Existing techniques are not optimal…

Introduction

Problems of existing techniques:

- Tools developed for agriculture are based on linear scheme → Not useful for grass.
- or based on the recognition through artificial intelligence (AI) of the wild plants → data cannot be processed in real-time in most cases.

In this paper we test the performance of specific methodology (drone-based) using band combination (no AI) at different height in grass surfaces.

Related Work

Hassanein and El-Sheimy: Inspire 1 drone from DJI with an X3 RGB (good results at 80 and 120m but no data about thresholds or equations are detailed)

Barrero and Perdomo: RGB camera with 12.1 megapixels + multispectral camera with 1.2 megapixels + neural networks (good results at 60-70 m but expensive (camera + gimbal) and use of AI)

Tamouridou et al. professional drone + machine learning (good results 0.1 to 1.5 m/pixel but use of AI and expensive)

Zou et al. DJI MAVIC 2 + combined AI techniques (good results with images of 5mm/pixel but use of AI)

Materials and Methods

Drone: Bebop 2 Pro →1080x1440 pixels and 24-bit

Images: Golf course in green areas of *Agrostis stolonifera* L. T1, which was suffering from an infection of *Daucus carota* L. In 3 areas.

Flying height: 4 to 16m.

4 Golf balls delimited the studied area

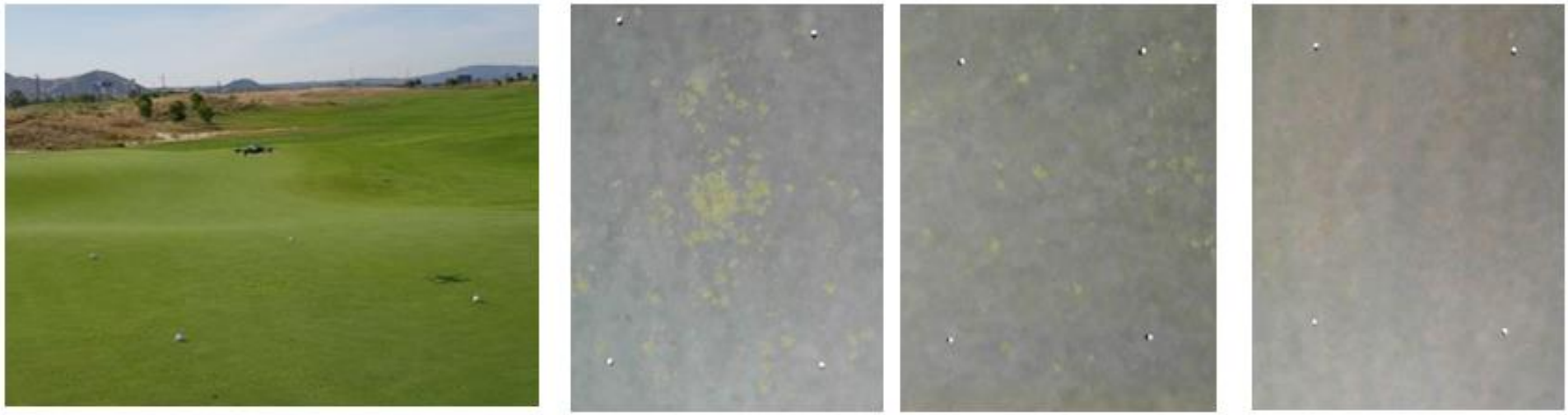


Figure 1. Images of the data gathering process, (a) picture taken during the data gathering, (b) to (d) data gathered for each studied area.

Materials and Methods

Analysed by:

ArcGIS software:

- 1: Vegetation index based on RGB. In past papers, we have developed vegetation indexes. Nonetheless, indexes were used for mixed lawns. As we have a single grass species, we will try to simplify the existing indexes.
- 2: Threshold to differentiate the type of cover is determined. The image is reclassified, pixels without wild plant are = “0”, pixels with wild plant are = “1”.
- 3: Generate a vectorial layer formed by a polygon that delimits the studied area To define the polygon, the inner extreme of each one of the balls is used.
- 4: Tool Zonal Statistic as a Table is used to obtain the summary of data in each studied area. The statistics summary of each polygon is exported to Excel. Finally, in Excel, some other parameters are calculated. The % of affection is calculated using the total number of pixels in the studied area and the number of pixels with values = 1 (obtained through the summation).
- 5: We consider that data at 4m has no error in their results. This is 100% of detection. The percentages of detection obtained at other height are compared.

Results

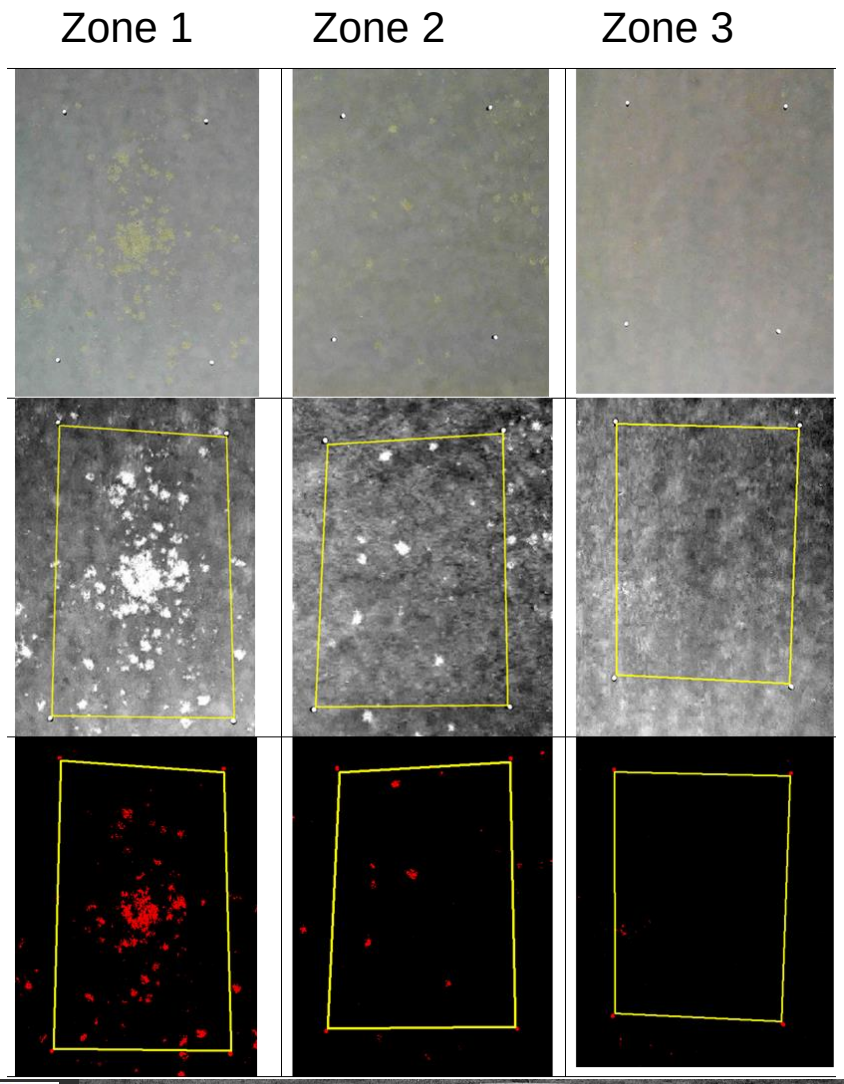
Classification results:

Vegetation Index= B1+B2-B3

Theshold:

-29 to 189 = grass

190 to 260 = wild plant



Results

Performance at different height:

1- Statistic summary

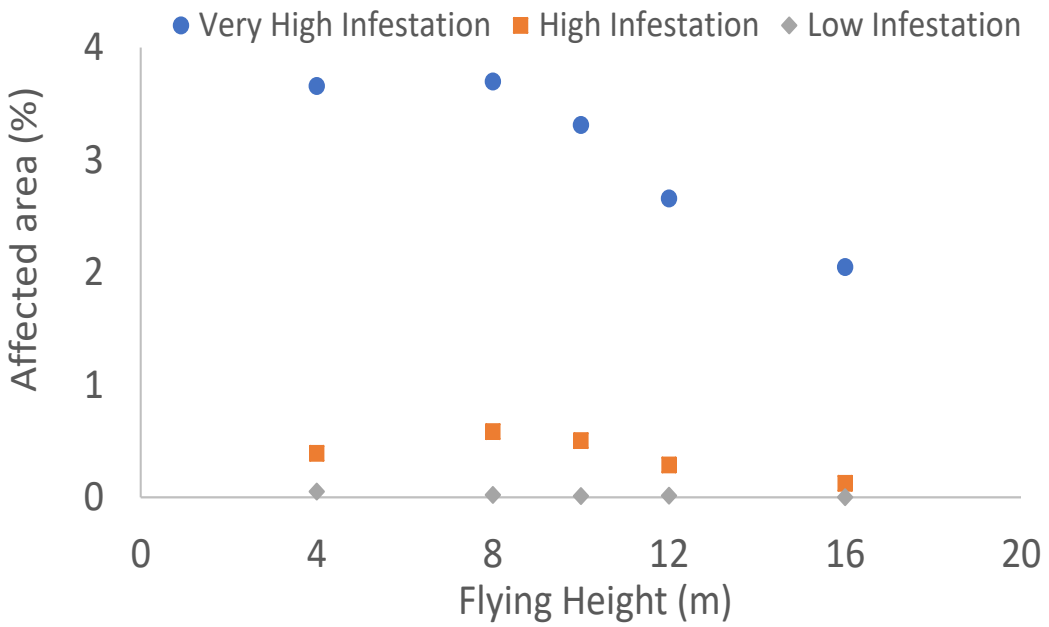
TABLE II. SUMMARY OF OBTAINED INFORMATION OF EACH AREA

Zone (Id)	Height (m)	Area (number of pixels)	Wild plant (number of pixels)	Mean (pixel value)	STD (pixel value)
1	4	326956	11953	0.036558	0.187675
1	8	178129	6585	0.036968	0.188682
1	10	124936	4135	0.033097	0.17889
1	12	47070	1251	0.026577	0.160845
1	16	29356	601	0.020473	0.141611
2	4	245417	958	0.003904	0.062356
2	8	127101	740	0.005822	0.076081
2	10	67318	339	0.005036	0.070784
2	12	35319	101	0.00286	0.053399
2	16	19955	25	0.001253	0.035373
3	4	266248	137	0.000515	0.022678
3	8	147082	31	0.000211	0.014516
3	10	89412	9	0.000101	0.010032
3	12	35570	5	0.000141	0.011855
3	16	20203	0	0	0

Results

Performance at different height:

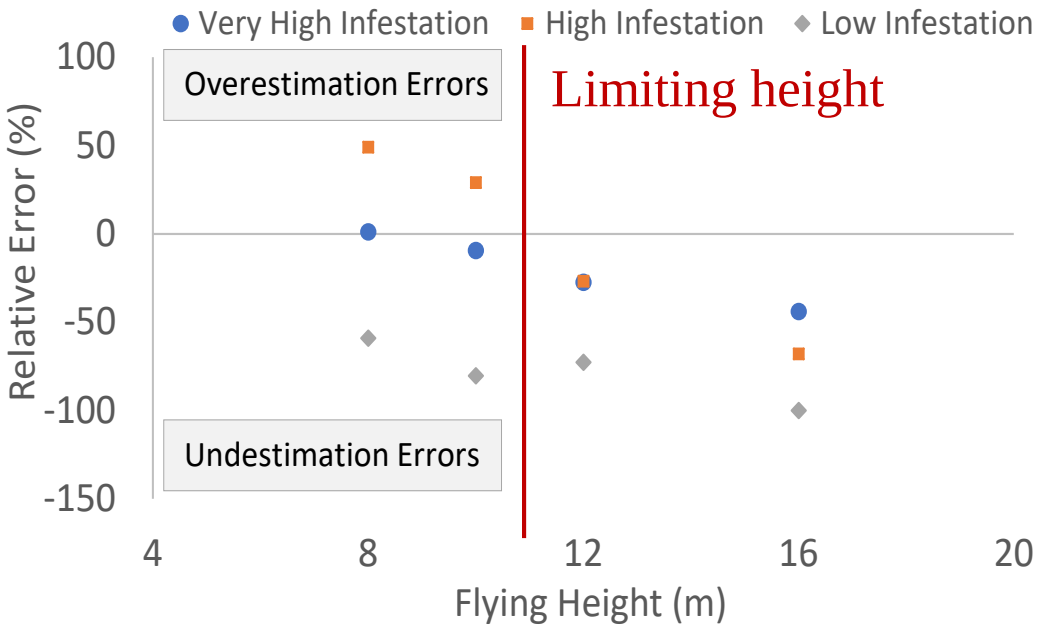
2- Comparison of estimated affected area



Results

Performance at different height:

3- Relative Error of estimated affected area



Results

Performance at different height:

4- Time required for different surfaces (12, 10 and 8 m)

Regulation Course with turfgrass areas from 350,000 m^2: 24.30, 21.26, and 18.23 hours.

For golf course type Par 35 or 36 Standard combination (surface of 120,000 m^2): 8.33, 7.29, and 6.25 hours.

Polo (surface of 40,134 m^2): 2.7, 2.4, and 2 hours.

Soccer or rugby fields (surface of 10,800 m^2): 45, 39.37, 33.75 minutes.

Hockey field, (surface of 5,027 m^2): 21, 18.3, 15.7 minutes.

Tennis court (surface of 195 m^2): less than 1 minute regardless of the flying height.

Conclusion

We need to find a balance between:

- spatial resolution (low flying height had high resolutions) and
- flying time vs. covered area (high flying height had better relation).

We have evaluated the error in determining the % of infestation for different flying heights.

Our results indicate that 10 m should be the maximum height given the characteristics of our camera.

Conclusion

In future work we will:

-include thermal images to evaluate if having a combination of four bands allows having a better index and have a higher flying height.

-work on the standardization of indexes for different undesired species to simplify the process.

-compare the recommended threshold for wild species with a threshold for disease.

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THANK YOU FOR YOUR ATTENTION

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