The Eleventh International Conference on Sensor Device Technologies and Applications (SENSORDEVICES 2020)
November 21, 2020 to November 25, 2020
Valencia, Spain

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y alimentario

Multi-Sensor Data Fusion and Artificial Neural Network to Estimate the Velocity of Sportive Turfgrass in Putting Green Areas

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Speaker Biography

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Dr. Agricultural Engineer and Bachelor of CC. Economic and Business. Director of IMIDRA's Agro-environmental Research Department since 2010. I coordinate IMIDRA's agro-environmental research work and work on developing protocols for agro-energy crop projects. His specialization in vegetative multiplication of woody crops focuses on the study of possible species for agro-energy crops. He has also participated in herbaceous crop projects and rainfed crop improvement projects. As a result of his participation in these projects, he has various scientific-technical publications, registered varieties, communications to congresses and has taught several courses. Currently, his line of work is focused on the study of agro-energy crops in rainfed systems under sustainable conditions.

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Introduction

In the last decades, the use of sensing devices for environmental monitoring has become more and more popular.

The sensors can be used to monitor the soil, the plants or the water → Some variables are not easy to measure (green velocity in golf course)

Cifferent easy-to-measure parameters to estimate another parameter, which is not possible to measure it directly.

Different options: (i) ***Linear regressions***;

(ii) **Artificial Intelligence- ANN**

Introduction

We need to measure the green velocity to evaluate the recovery process after maintenance action.

Our proposal:

Evaluate if the data gathered from digital sensing devices can be used to estimate the green velocity to monitor its recovery after aeration

Related work

We are going to measure several variables (NDVI, soil temperature, soil moisture, and canopy temperature) to estimate the green velocity. Several works has been done in sportive grass:

- Several indexes can be used NDVI, GA, and GGA to estimate turfgrass resistance to water scarcity (Marin et al.).
- Image processing can be used to identify undesired wild plants in the green and fairway areas of golf course (Parra et al.)
- The correlation of plant and soil measured with surface hardness, a sportive parameter, has been proved (Straw et al.).
- In previous paper, authors demonstrate that a variation of plant specie has no effect on ball rolling behavior (Rana and Askew).
- The data fusion basing on agronomic parameters has been used to estimate the plant biomass (Ouyang et al. and Reddersen et al.).

Material and methods

Description of the studied area:

Two greens of Encin Golf Course (Madrid, Spain)

Greens are composed of Agrostis stolonifera T1 (3-4mm of height).

Irrigated everyday according to the ETP and FAO recommendations.

Maintenance action:

29th of March → half-inch-diameter hollow tines

Normal turfgrass

After maintenance

Measuring period: 24th of February to 31st of July of 2020

Material and methods

Description of the studied area:

Nº of measurement	Day	Label	Description
1	24/02/2020	-1	Before the maintenance action
2	02/04/2020	0	Just after the maintenance action
3	20/04/2020	1	After the maintenance action
4	19/05/2020	2	
5	02/06/2020	3	
6	16/06/2020	4	
7	17/07/2020	5	
8	31/07/2020	6	

Material and methods

Measured parameters :

Soil variables: Soil Moisture (SM) and

Soil Temperature (ST) → TDR 350 FieldScout

Plant variables

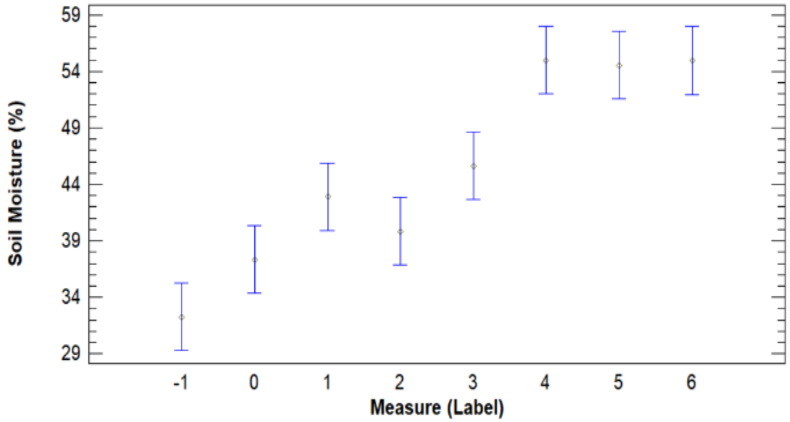
CT → IR thermometer Fluke 561

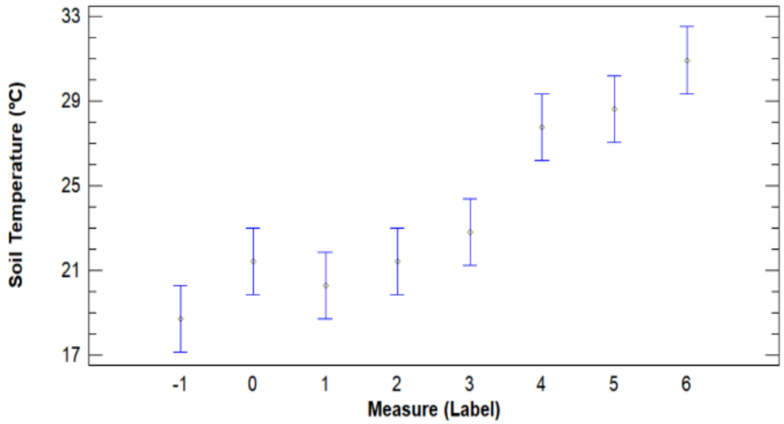
NDVI → GreenSeeker

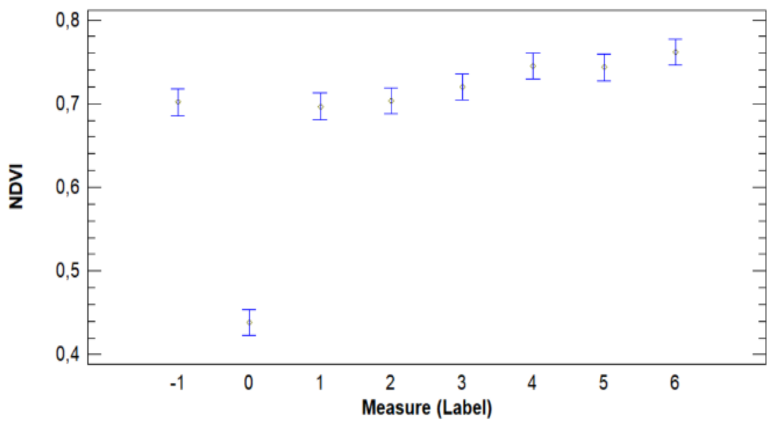
Green Velocity Stimpmeter

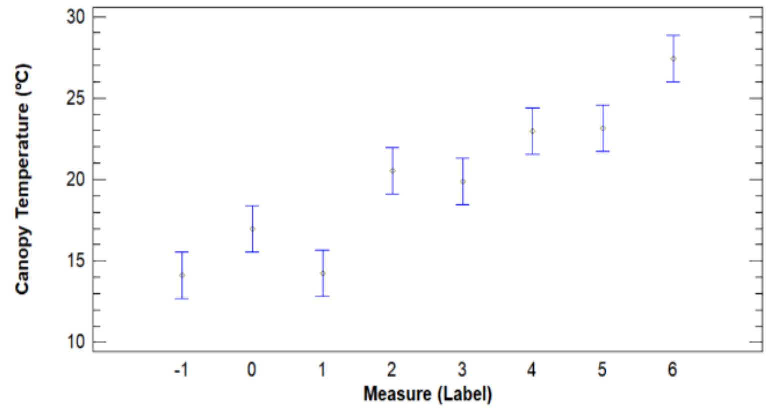
Results

Evolution of sensed variables – Agronomic variables





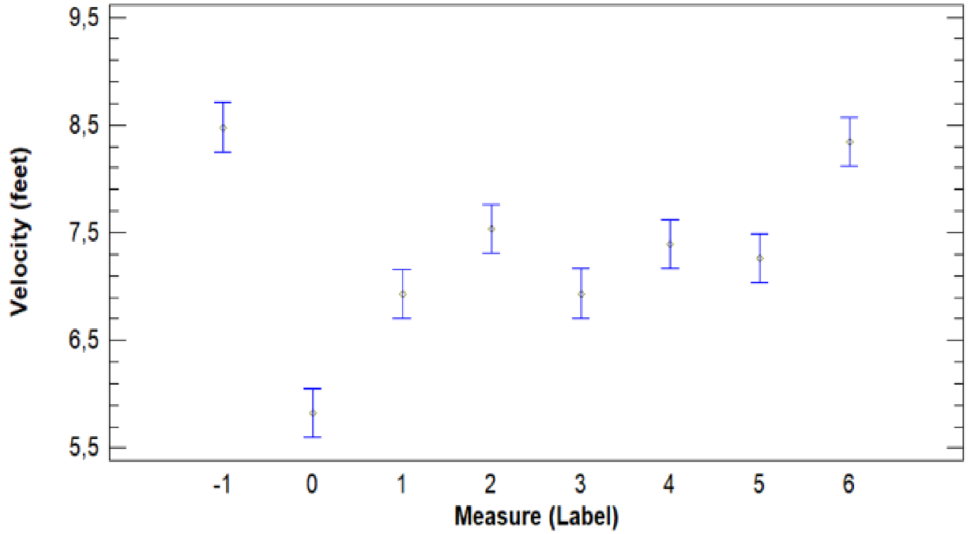




Recovery on Measure 4 (SM), Measure 1 (NDVI).

Results

Evolution of sensed variables – Sportive variable



Recovery in Measure 6.

Thus, we can affirm that the simple measure of agronomic variables cannot inform us about the recovery of the green after maintenance action.

Results

Using agronomic variables to predict the green velocity

-Multiple regression

First model with ST, CT, SM, and NDVI. CT might be extracted to simplify the model. R^2=0,63

Second model:

$$V\ (feet) = 3.296 \times SM\ (\%) + 7.059 \times NDVI + 0.115 \times ST\ (^{\circ}C) \qquad \textbf{(1)}$$

where:

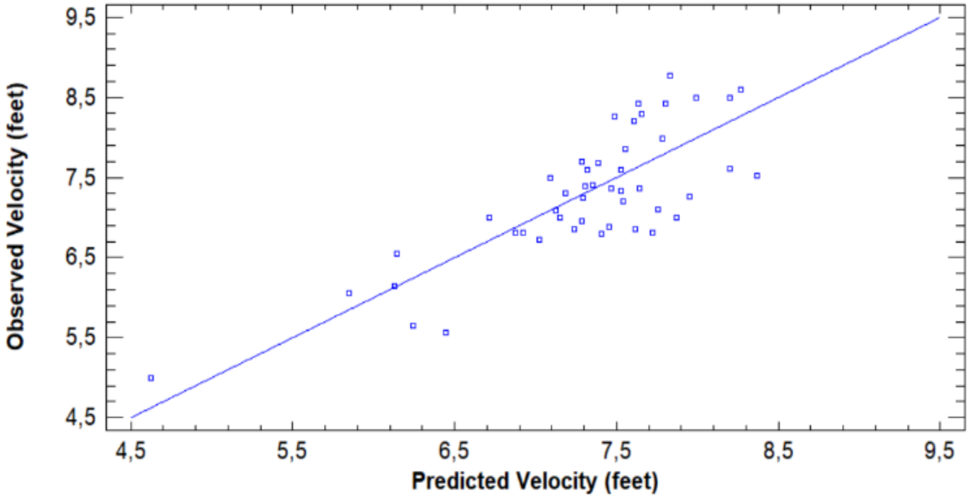
V is the velocity of the green
SM is the soil moisture
ST is the soil temperature

R^2=0,63

Results

Using agronomic variables to predict the green velocity

-Multiple regression



The problem with this model is that greenkeepers need to apply a complex equation to predict the green speed value. We need another option that offers a graphic to be used.

Results

Using agronomic variables to predict the green velocity

-ANN

Three input neurons (soil moisture, soil temperature and NDVI), two hidden layers, and six output neurons (green velocity).

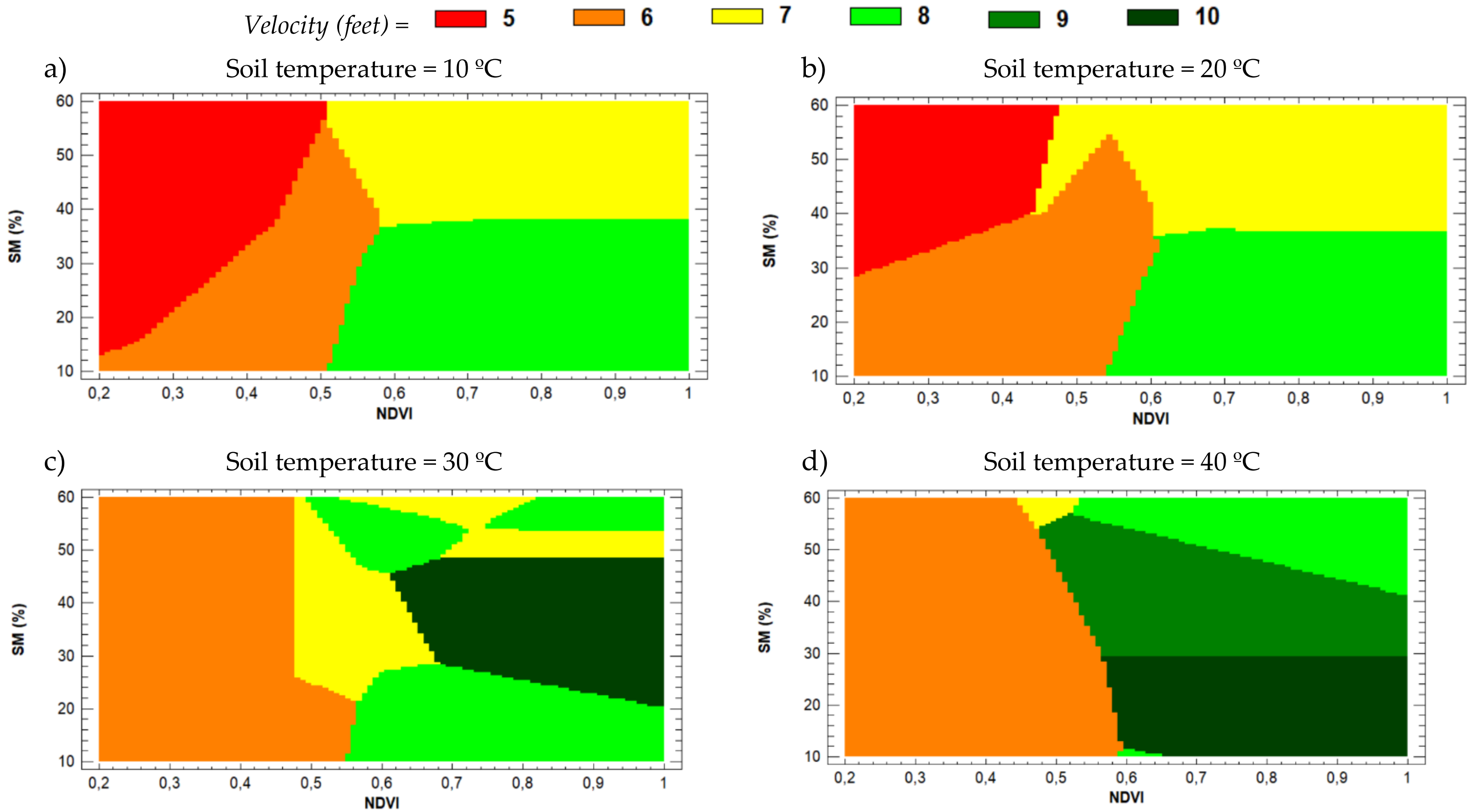
Probability was set as proportional to the observed and the cost of error equal to all groups.

Finally, the sphere of influence was determined by jackknifing.

Results

Using agronomic variables to predict the green velocity

-ANN



Results

Using agronomic variables to predict the green velocity:

- The AAN offered a set of graphics which can be used by greenkeepers as a method to estimate the green velocity.
- 70.83% of cases were classified correctly.
- Main errors of classifications are linked to extreme velocity values.
- Predictions on graphics follows the empirical knowledge of greenkeepers.

Note that obtained results are only based on data from *Agrostis stolonifera T1*

Conclusions

4 agronomic variables and 1 sportive variables have been measured before and after a maintenance action.

The agronomic variables individually are not useful to estimate the recovery time of the green.

ANN is a valuable tool to estimate the green velocity based on agronomic variables in sportive grass.

Conclusions

Further tests are needed in order to obtain more robust results.

1- Analyse this data with other AI techniques

2- Include more variables (RGB images and surface hardness)

3- Gather data in greens with other species and with the presence of *Poa annua* (undesired plant).

Questions

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