Vitality of Plants through Coronas of Fruits and Leaves

Igor Kononenko, Aleksander Sadikov

University of Ljubljana,
Faculty of Computer and Information Science, Tržaška 25, 1000 Ljubljana, Slovenia
e-mail: igor.kononenko@fri.uni-lj.si

Abstract: We recorded coronas of apple tree leaves and fruits in order to verify and compare their vitality under different conditions. The results of our study show that coronas of leaves and fruits give useful information about the health status of plants and about the sort, however, we were not able to extract any useful information to differentiate between organically and conventionally grown plants.

Introduction

Recently developed technology, based on the Kirlian effect, for recording the human/plant bioelectromagnetic field using the Gas Discharge Visualization (GDV) technique provides potentially useful information about the biophysical and/or psychical state of the object/person (Korotkov, 1998). The recorded coronas are then processed with GDV-Analysis software and described by the set of numerical parameters.

In a previous study (Skočaj et al., 2000) we recorded coronas of grape berries and have shown that numerical parameters of coronas can be used to successfully classify berries according to infection and sort. In this study we recorded coronas of apple tree leaves and fruits in order to verify and compare their vitality under different conditions. The plants were provided by the Institute for Organic Agriculture FiBL in Frick, Switzerland. Leaves and fruits were recorded in 10 different scenarios with different number of recordings. Each object was recorded several times using different range for Crown-TV. The following table summarizes the available databases of GDV images of leaves and fruits.

Problem	object	#ranges	#instances	#classes	Majority class
variety s41 vs s50	leaf	2	70	2	50
sick vs healthy tree	leaf	2	70	2	50
rootstocks: REM7, REJG, ARM7, ARJG	leaf	3	80	4	25
rootstocks: resi vs arriwa	leaf	3	80	2	50
rootstocks: M7 vs JG	leaf	3	80	2	50
conventional vs organic	apple	4	59	2	51
rootstocks: M7 vs S2	apple	4	30	2	50
rajka vs rosana	apple	4	70	2	57
sick vs healthy fruitlets	apple	4	80	2	50
sick vs healthy leaves	leaf	3	40	2	50

We used machine learning algorithm C4.5 (Quinlan, 1993) in order to interpret the coronas, described with numerical parameters. We used the first 9 numerical parameters, as returned by GDV Analysis: A1. Area of GDV-gram, A2. Noise, deleted from the picture, A3. Form coefficient I, A4. Fractal dimension, A5. Brightness coefficient, A6. Brightness deviation, A7. Number of separated fragments in the image, A8. Average area per fragment, A9.

Deviation of fragments' areas. We used also two parameters, defined by Korotkov and Korotkin (2001): *average streamer width* and *entropy of corona.* Besides we defined also 6 additional parameters: *corona width, normalized skewness of brightness, normalized stability of brightness, entropy of brightness,* and we used also 7 parameters by *Hu (1962).*

Analysis of results

In only four classification problems we have got significantly better results than random classification which probably means that other problems are too hard for Crown-TV. The following table gives results for four positive problems, where Crown-TV provides useful information. We compare the classification accuracy of C4.5 (using leave-one-out testing and average over all different ranges of Crown-TV) with different subsets of parameters: all 22, without 7 Hu's parameters (=15), only 7 Hu's parameters, original 9 parameters plus 2 defined by Korotkov and Korotkin (2001), and only 11 new parameters.

Problem	All 22	22-Hu = 15	Hu = 7	GDV = 9+2	New = 11
variety s41 vs s50	68.4	72.0	**75.5**	72.0	67.7
sick vs healthy tree	83.6	82.2	**84.3**	80.0	**84.3**
rajka vs rosana	**75.4**	70.0	69.3	74.3	72.5
sick vs healthy fruitlets	71.9	73.1	59.0	67.8	**74.0**

The results indicate that no subset of parameters outperforms all the others in all cases. It seem that Hu's parameters are quite robust and together with our 6 additional parameters (altogether 11 new parameters – last column of the table) the robustness even increases, although the results are not stable.

Conclusion

GDV technology can provide useful information for distinguishing healthy and infected plants and, in some cases, it can provide useful information for distinguishing also different sorts of the same family of plants. However, we were not able to find any useful information to distinguish organically from conventionally grown plants.

Our six new parameters together with seven Hu's parameters seems to be useful for describing GDV images and can in certain cases provide better information than standard GDV parameters.

References

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