

MAD-Transformation Plugin for Definiens Developer 7.0

User Manual

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Introduction

The concept of object-based image analysis has been established for some years. With the software Definiens Developer a powerful and extensible commercial software product for object-based image analysis is available.

The *MAD-Transformation Plugin* for Definiens Developer 7.0 implements the Iteratively Reweighted Multivariate Alteration Detection (IR-MAD) transformation based on object features.

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Methodology

The Multivariate Alteration Detection (MAD) transformation [Nielsen et al., 1998] is based on a classical statistical transformation referred to as canonical correlation analysis to enhance the change information in the difference images.

The procedure is briefly described as follows:

If multispectral images of a scene acquired at times t_1 and t_2 are represented by random vectors \mathbf{X} and \mathbf{Y} , which are assumed to be multivariate normally distributed, the difference D between the two images is calculated by $D = \mathbf{a}^T \mathbf{X} - \mathbf{b}^T \mathbf{Y}$. Analogously to a principal component transformation, the vectors \mathbf{a} and \mathbf{b} are sought subject to the condition that the variance of D is maximized and subject to the constraints that $\text{var}(\mathbf{a}^T \mathbf{X}) = \text{var}(\mathbf{b}^T \mathbf{Y}) = 1$. Determining the vectors \mathbf{a} and \mathbf{b} in this way is a standard statistical procedure which considers a generalized eigenvalue problem. For a given number of bands N , the procedure returns N eigenvalues, N pairs of eigenvectors and N orthogonal (uncorrelated) difference images, referred to as to the MAD components.

The Iteratively Reweighted Multivariate Alteration Detection (IR-MAD) method [Nielsen et al., 2007] for detecting the change represents a further development of previously presented MAD transformation. The idea is quite simple, the IR-MAD method first calculates the ordinary canonical and original MAD variates and in the following iteration steps we assign different weights to the observations. Small changes get a higher weight than bigger changes. This allows delimiting regions in which changes occur from regions without changes. Iterations are performed until a defined termination criterion is reached.

The MAD components represent different categories of changes. Since relevant changes of manmade structures will generally be uncorrelated with seasonal vegetation changes or statistic image noise, they expectedly concentrate in different MAD components. The components are sorted according to the increasing variance, so higher order MAD components represent the small scale changes whereas lower order components contain the overall or wide-area changes.

The MAD transformation was originally developed for pixel-based change detection and was now applied using the object features.

Installation

At first you have to close the Definiens Developer application. Then you can copy the *DIAPropAlgrMAD.dll* into the Definiens Developer installation folder */bin/plugins/*. Now you can run Definiens Developer and append a new algorithm in the process tree. You will find the new algorithm *MAD Transformation* under *Variables operations*.

Attention, the plugin algorithms are initially hidden under the available algorithms, these can be found, if you select 'more' in the algorithm selection.

Usage

After a common segmentation of the initial image data, you can append a new algorithm "*MAD-Transformation*" in the process tree.

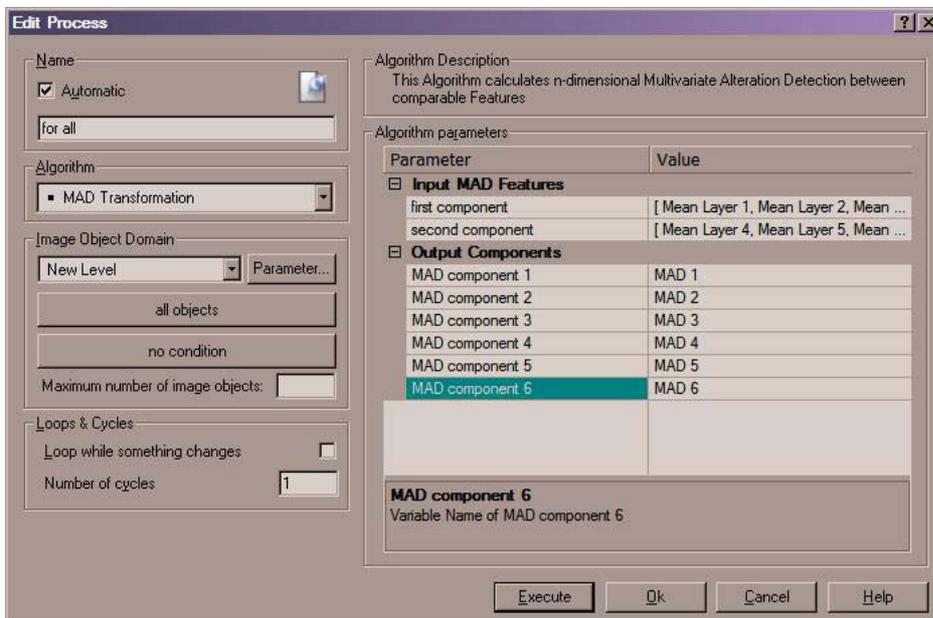


Fig.1 - Edit Process / MAD Transformation

You have to choose the input MAD features for both times and create the object variables to store the MAD components. Then you can push the *Execute* button.

For a given number of object features N , the procedure returns N orthogonal (uncorrelated) MAD components, representing different categories of changes.

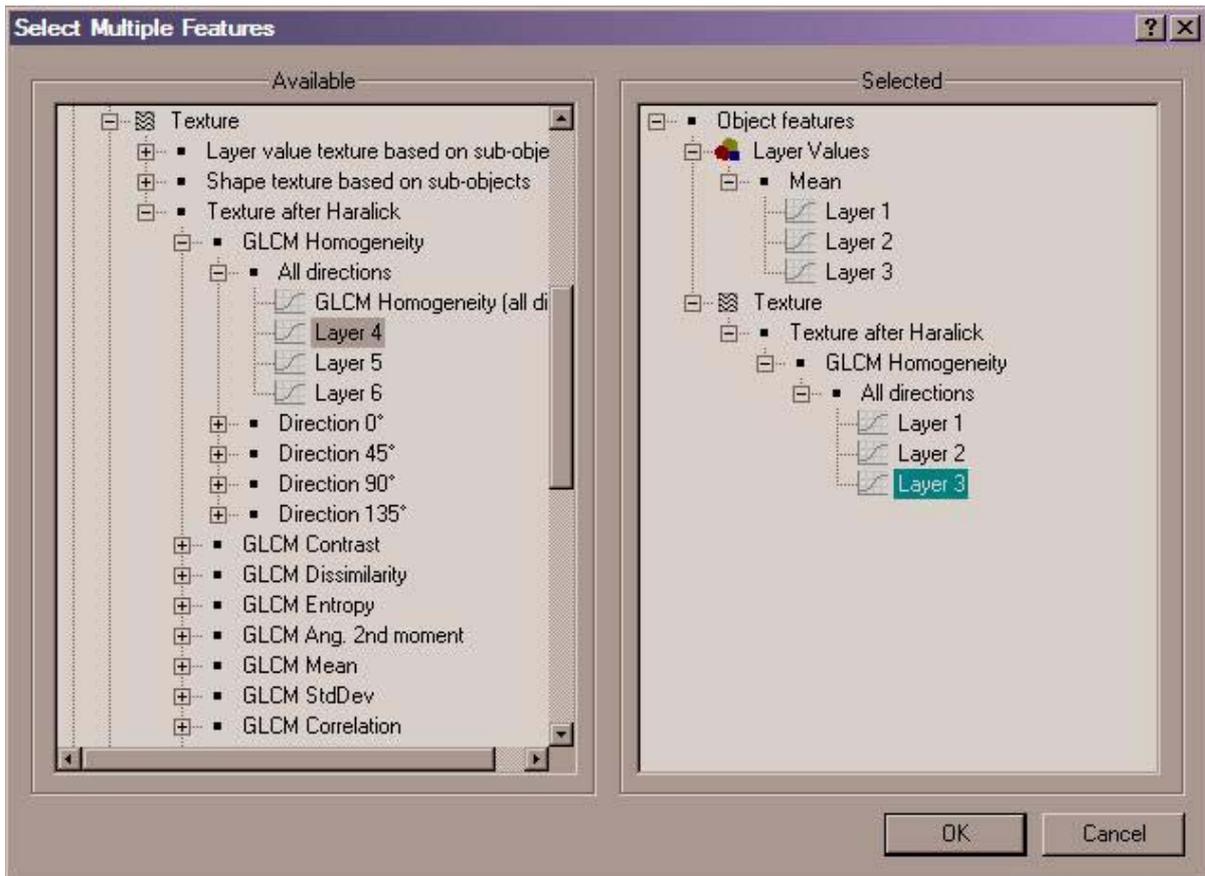


Fig.2 - Input MAD Features / first component

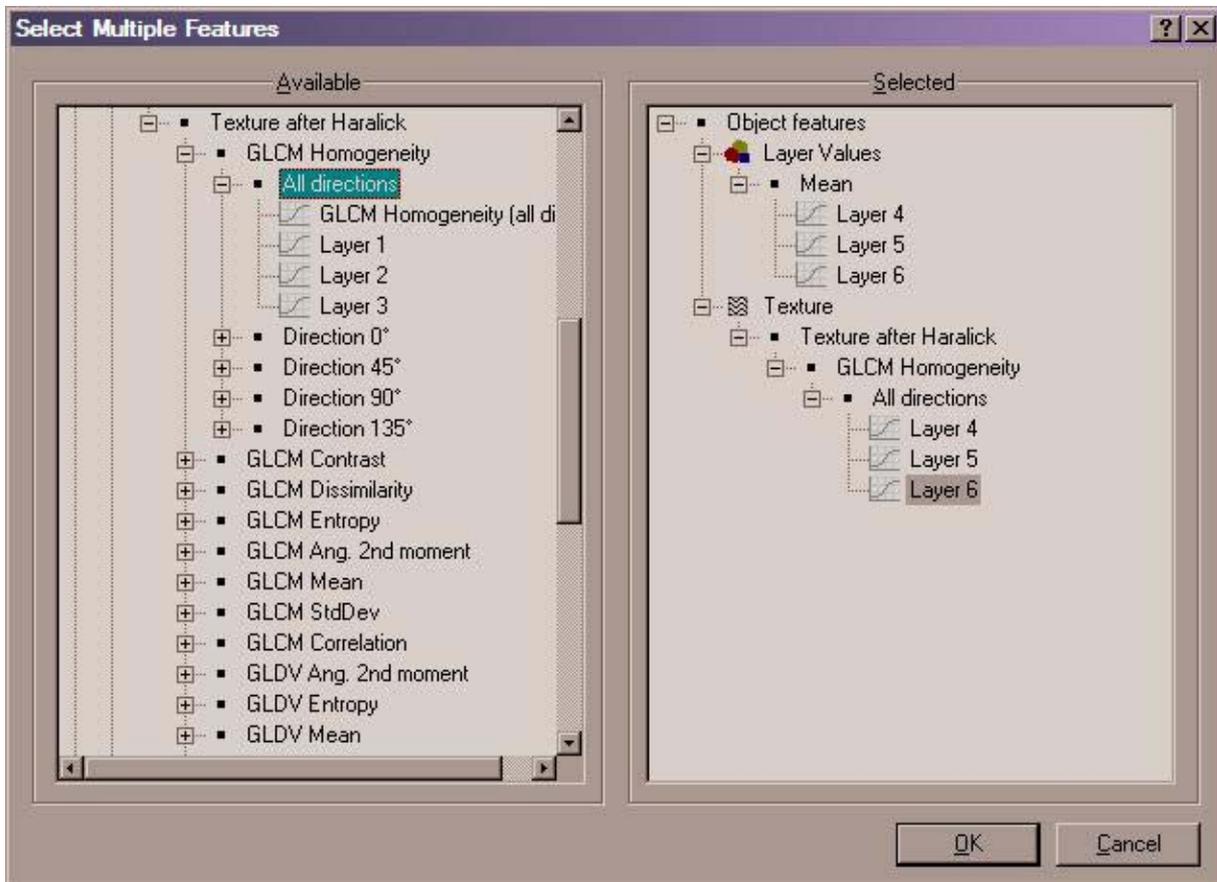


Fig.3 - Input MAD Features / second component

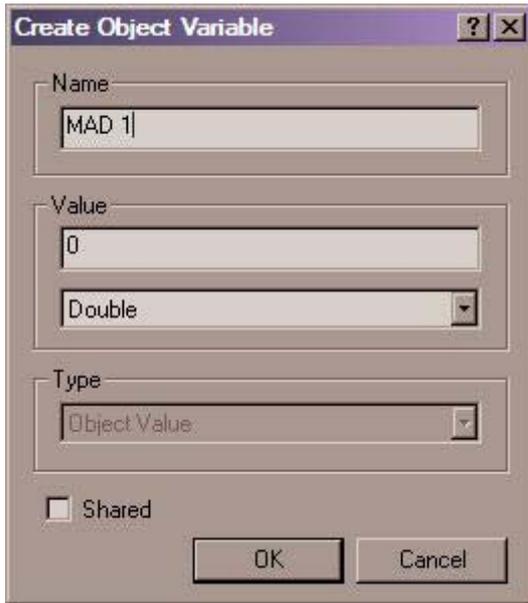


Fig.4 – Create Object Variables for the Output Components

Fig.5 – Result of the MAD Transformation

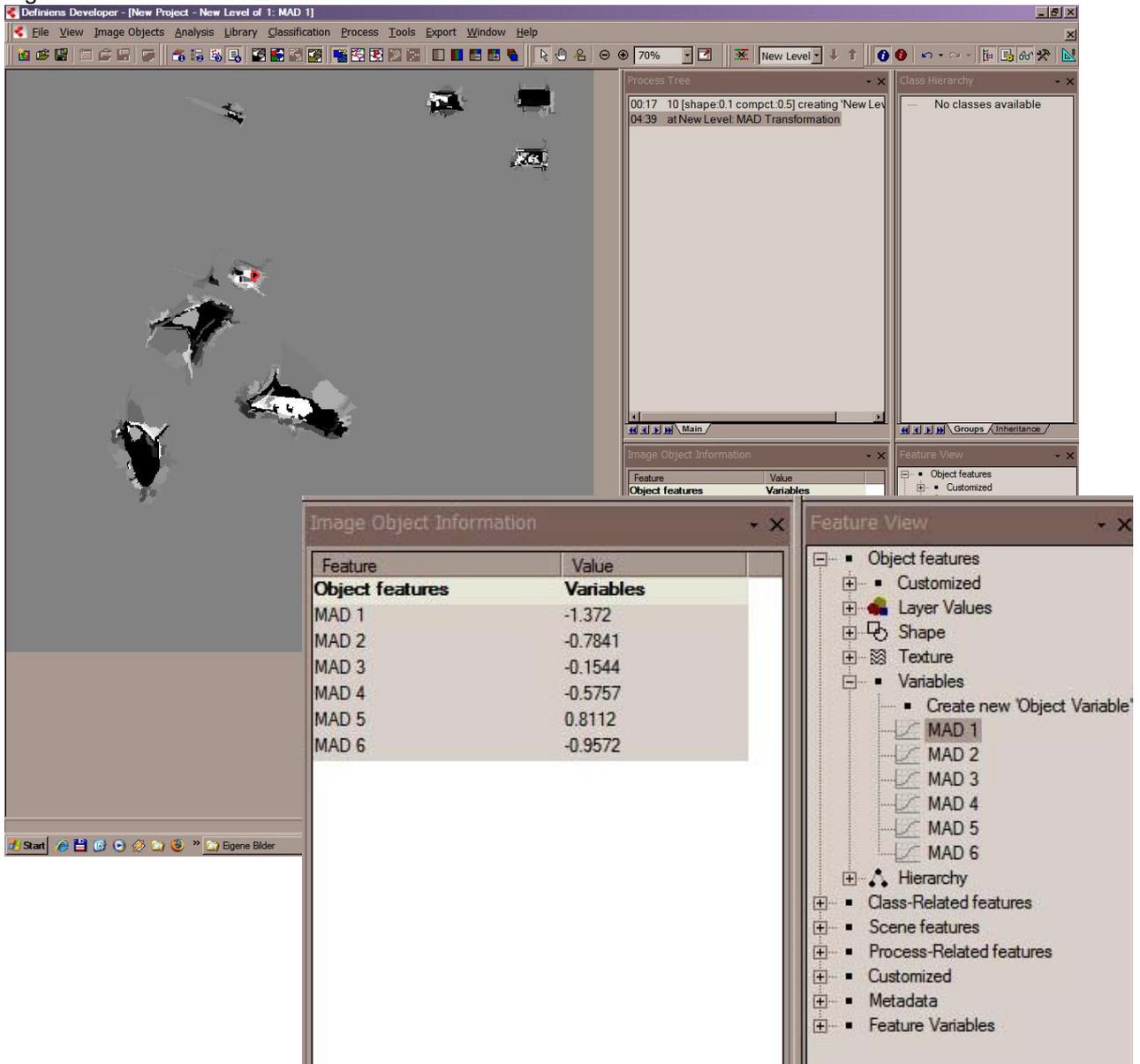
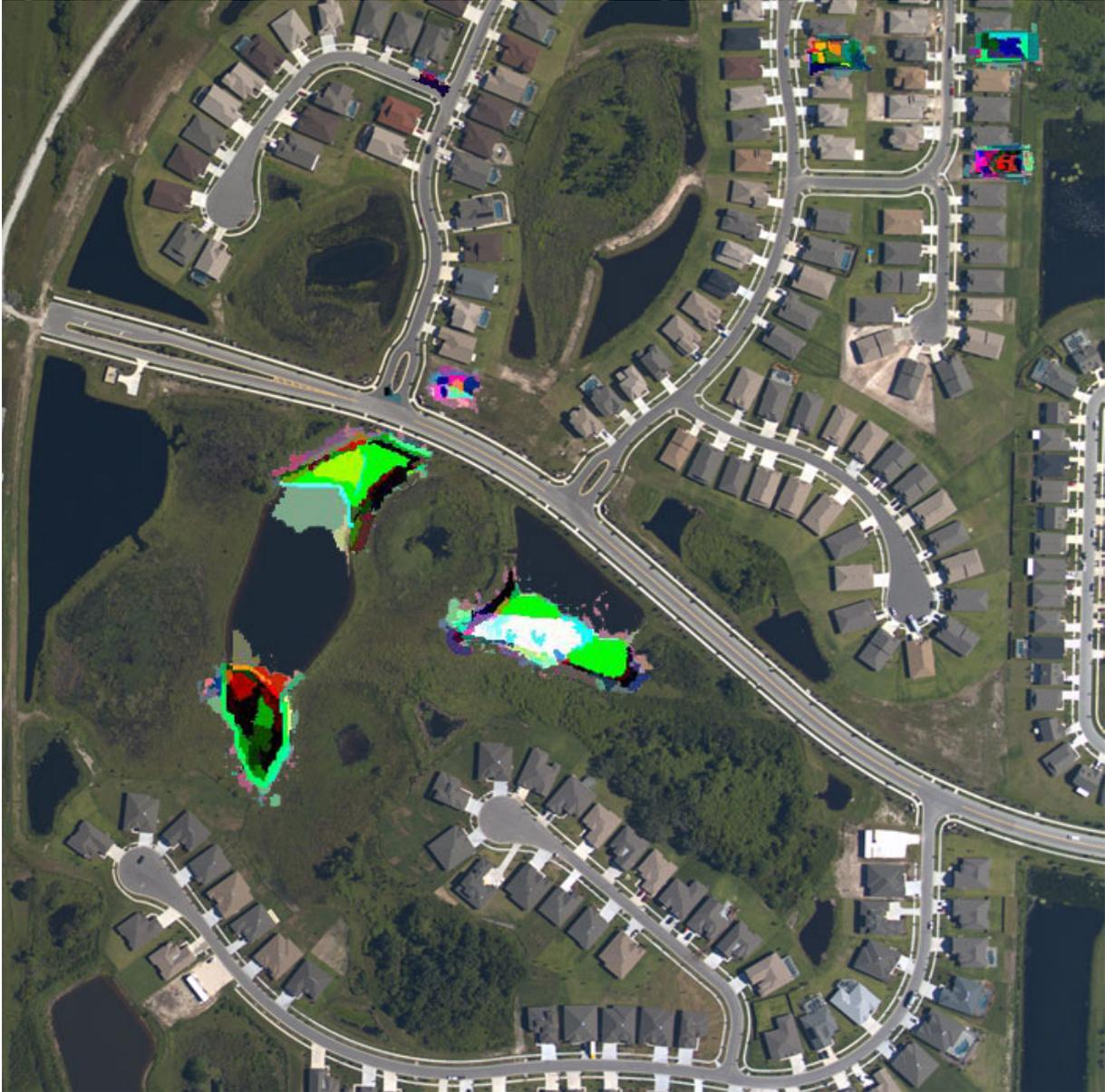


Fig.6 - Original data + MAD components 1-3 (as an RGB image)



Known problems

If you use texture features or other computation-intensive features it can lead to long calculation times and in some rare cases also to program crashes.

We are currently working on improvements of the algorithm to increase performance and to make software more stable.

References

A. A. Nielsen, K. Conradsen, J. J. Simpson, *Multivariate alteration detection (MAD) and MAF processing in multispectral, bitemporal image data: New approaches to change detection studies*, Remote Sensing of Environment 64: 1-19, 1998

A. A. Nielsen, *The Regularized Iteratively Reweighted MAD Method for Change Detection in Multi- and Hyperspectral Data*, IEEE Transactions on Image Processing Vol. 16, No. 2, 463-478, 2007

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