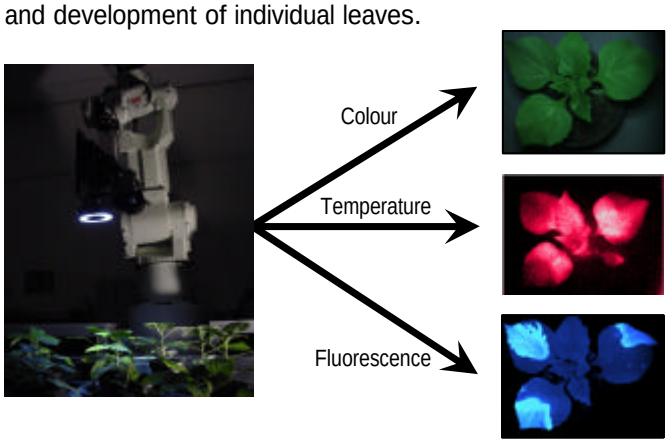
WAGENINGEN UR
For quality of life

Plants in Control

GreenVision

Introduction

The aim of the project is to register plant leaves within an image in a time sequence, hence allowing automatic local tracking of stress symptoms of a leaf in time. This way, patterns in time can be analysed, leading to early detection and identification of stress. A recording system, MIPS[(1)], captures time-series of two fluorescence images, a thermal image and a colour (RGB) image. A time-sequence of an image of a plant exhibits rotation, translation, scaling as well as other deformations related to the circadian rhythm and to growth and development of individual leaves.



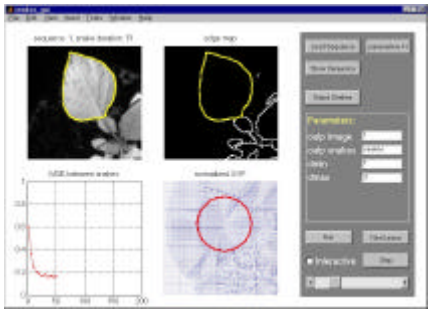
The Multiple Imaging Plant Stress (MIPS) robot system captures time-sequences of colour, temperature and fluorescence images of plants.

Plants in control - Goal

- **Data fusion:** Pixel to pixel correspondence between images of different sensors and images in time.
- **Pattern recognition:** Search for features linked with plant-growth and development
- **Stress quantification, visualization, identification:** Search for stress indicators at an early stage.

Extracting the contour using snakes

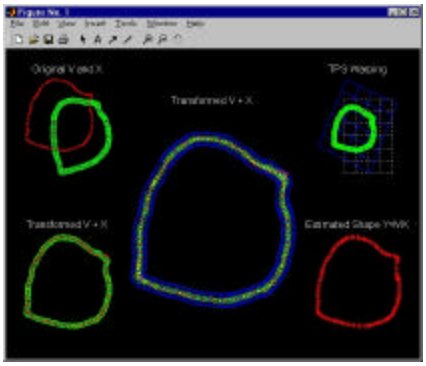
A snake, or active contour, is a curve in an image that can move under the influence of internal (like rigidity and elasticity of the curve itself) and external forces (like a gradient vector field from the image data) to a position that minimizes some energy functional, combining these forces. This technique is used to extract the contour of the leaves in each time-step.



The snakes graphical user interface: top left is the grey value image, with the final snake. To the right is the edge (contour) map. Bottom left is the difference between two successive iterations of the snake as function of the iteration. To the right is the initial snake (a circle) and the Gradient Vector Flow field.

Robust Point Matching

Once having obtained the snakes for a series of images of the same leaf, the correspondence between the points of the successive snakes is still not one-to-one. In fact, the number of points and the spacing is often not fixed for a snake.
To overcome this problem, we have used the TPS-RPM (Thin Plate Splines - Robust Point Matching) algorithm. It uses a fuzzy assignment least squares energy function for the correspondence between two point sets.



Top left are the two snakes of the same leaf at a different time. In the middle one snake is warped to the other snake. In the top right, the corresponding transformation grid (TPS) is shown.

The thin plate spline function, which was obtained in the previous step is used for mapping every pixel within the image.

(1) The contribution of GreenScreen, Plant Dynamics and Growlab with the use of their MIPS recording system is greatly acknowledged.

GreenVision
P.O. Box 17, NL-6700 AA Wageningen, The Netherlands
Telephone: +31 317 478558 Fax: +31 317 475347
E-mail: GreenVision@wur.nl
Internet: greenvision.wur.nl