Leaf area and leaf orientation measurement by using stereo-vision

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This paper presents a 3D stereo-vision system aiming at the measurement of plant characteristics. The method is intended to be used in an Ecotron where the availability of plant material is limited and where crop should be characterised non destructively. The plants were not considered as individuals, it was the crop as a whole that was characterised. The leaf area index (LAI) was measured. It is an important property of vegetation, since it determines the photosynthetic primary production, the plant evaporation and characterises the plant growth. The average leaf angle (ALA) was also measured. For the computation, leaf pixels were differentiated from soil pixels by using linear discriminant analysis. The stereo vision system computed the distance to the camera of each pixel in the image in the region where the pixels are present in both images. The observed area was computed on the basis of the average distance of the leaf pixels in the region. The leaf area was evaluated for each triplet of adjacent pixels by computing the cross product of the vectors defined by those three points. The sum gave the leaf area for the same region. The area of these triangles was summed for all the pixels in the region and the ratio to the observed area gave the LAI. The ALA was the mean orientation of the pixel triplets. After calibration, the method was found to present a coefficient of correlation of 0.93 with destructive reference measurements and a precision of 0.12 for the LAI. It was possible to measure the LAI and the ALA from the germination up to the ripening stage with a minimum of work load. The figure below shows the resulting software with the left and right image above, the disparity below left and the result of the leaf/soil segmentation below right.