WinDIAS 3
Image Analysis System

Image analysis system for leaves

WinDIAS provides high speed measurement and analysis of leaf area and leaf features, making it the ideal tool for plant pathology applications

- **Advanced leaf area meter plus perimeter, length, width, object count and more**

- **Automated measurement of diseased, healthy and pest-damaged leaf areas**

- **Point and click colour selection**

- **Choice of camera or scanner systems**

- **Conveyor accessory for rapid processing of leaves**

Introduction

The WinDIAS system offers specialised image analysis features suitable for a wide range of applications in the plant sciences. It is especially suited to applications that need high colour *discrimination, for example in plant pathology and phenotyping.* It provides a full set of measurement statistics, and can process up to 800 leaves per hour using the conveyor belt option.

The WinDIAS components include a choice of high resolution colour USB video cameras with a lightbox and overhead lighting rig to ensure good contrast and colour rendition, or alternatively an A4 scanner with excellent depth of field.

For reporting and further analysis, all results and images from WinDIAS are easily exchanged with other Windows applications.
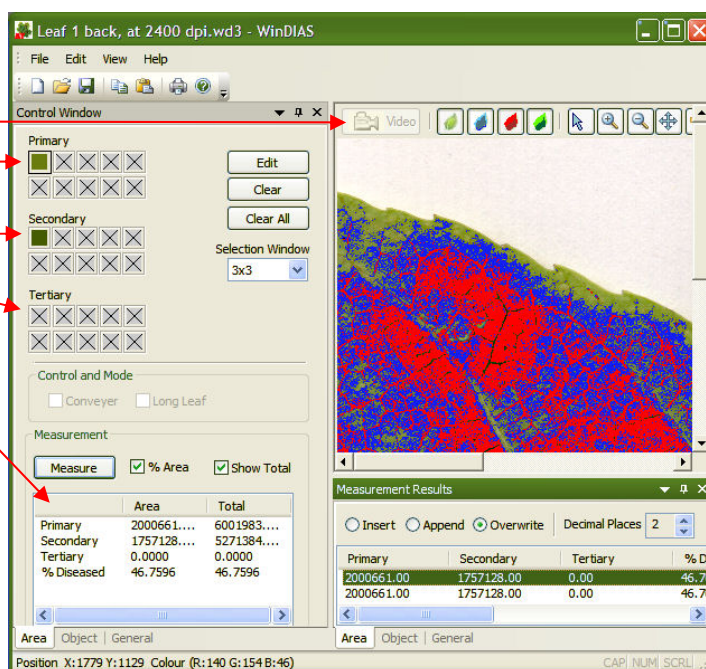
Applications

- Plant pathology
- Phenotyping
- Agronomy and plant physiology
- Crop protection
- Forestry
- Object counting

Point and click colour selection

- Quick function tool bar
- Colours picked to set primary threshold colour range
- Colours picked to set secondary and tertiary threshold colour range
- Results box showing healthy and diseased areas
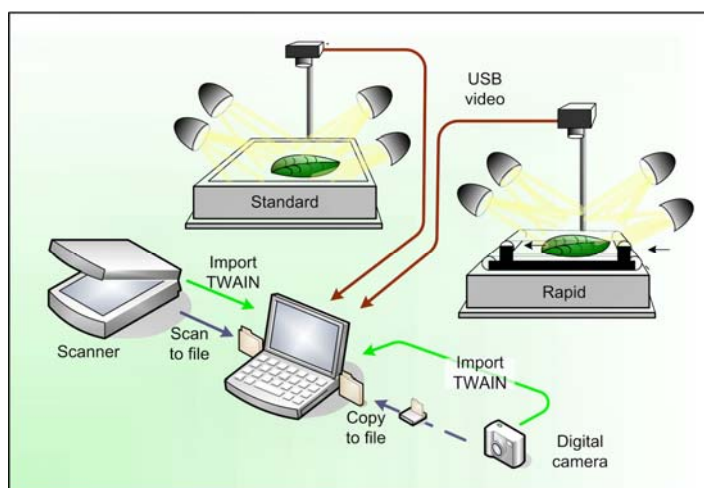
WinDIAS Features

Rapid thresholding: Three thresholds can be set, each based on a different user-defined range of colours. The primary threshold is used for the main zones of interest in the image, e.g. healthy areas. The secondary and tertiary thresholds are used for other zones, e.g. diseased areas. Thresholds are set by a simple point and click with the mouse in a region of interest. The areas included are immediately visible as overlays on the image.

Editing: Images can be edited on-screen to retouch boundaries, separate objects that overlap, remove undesirable "noise" and holes, add or erase lines or rectangles, and fill bounded areas in any colour.

Measurement: WinDIAS analyses the thresholded regions to measure area, perimeter, length, width, circularity, elongation and shape factor. A correction factor can be applied to estimate the surface area (of pine needles for example) from the projected area. Calibration is carried out against a ruler.

Object count: Seeds, needles, or other small objects can be quickly counted by WinDIAS. Colour thresholding enables easy discrimination of different types of object, or disease spots. Dust and debris can be excluded by defining a minimum object area.

Exchange of data and images: WinDIAS imports images in .bmp, .jpg and .tif formats, and results can be saved as .txt files for easy import into Excel.

WinDIAS systems and interface options

WinDIAS System Choices

WinDIAS is modular and expandable - researchers can specify a system that suits their particular requirements:

System type	Features and advantages
WinDIAS 3 Entry Level System *The Entry Level System includes the scanner and WinDIAS software only*	The Entry Level System enables the full set of analysis features and can be used at very high resolution up to A4 size, but is slow – it may take ~1 minute to scan and analyse each image at higher resolutions.
WinDIAS 3 Standard System *Includes USB colour video camera, camera stand, lightbox, overhead lighting rig and WinDIAS software*	The standard system enables full analysis of static images illuminated by lightbox or overhead lights, typically 2 or 3 images per minute. The Standard System camera has excellent resolution at 2048 x 1536 pixels but cannot be used for moving images.
WinDIAS 3 Rapid System *This complete system includes a camera capable of accurately imaging moving objects, all the other Standard System components plus the conveyor belt*	A powerful and complete system capable of very rapid area measurement of ~800 leaves/hr on the conveyor belt, analysing long leaves, and full colour analysis of static objects. The Rapid System camera has good resolution at 1280 x 1024 pixels.

Applications

Agronomy and plant physiology
WinDIAS provides a flexible resource with countless laboratory applications - from simple leaf area measurement to the analysis of complex distributions of colour. The addition of the Conveyor Belt accessory opens up further applications:

- Rapid throughput of large numbers of leaves
- Measurement of intact long leaves e.g. maize, sorghum, sugar cane and miscanthus

Crop protection
WinDIAS is optimised for the rapid analysis of area by colour difference, creating many applications in plant pathology and plant protection. Examples include:

- Necrosis caused by fungi and bacteria
- Leaf tip burn and leaf spotting
- Nutrient deficiency symptoms
- Viral infection and leaf senescence

Forestry
All of the applications described above are relevant to the study of broadleaf tree species. It is also possible to use WinDIAS with conifers; the surface area of pine needles can be estimated by multiplying the projected area by a conversion factor.
Factors for Corsican Pine (*Pinus nigra var maritima*) and Scots Pine (*Pinus sylvestris*) are included in the User Manual. General conversion factors and other references are also included.

Plant pathology
Rapid measurement of a wide variety of leaf types is a key requirement in plant pathology. WinDIAS automates these measurements after a simple set-up procedure.

By pointing and clicking with the mouse on the image, up to 10 examples of colours from healthy leaf regions can be tagged, plus up to 10 examples from two different type of diseased regions (e.g. diseased and necrotic). These defined bands allow for the natural colour variation among samples of healthy leaves, permitting WinDIAS to distinguish them from the colours present in the diseased areas - as, for example, in a mosaic virus infection.

Regions whose colours are within the primary secondary and tertiary colour ranges show immediately as overlays on the video image, quickly indicating whether the required areas have been detected. WinDIAS can then calculate areas, make other measurements, and count the number of spots, within these regions.

Conveyor Belt

The Conveyor Belt Unit works with WinDIAS to provide a rapid and convenient method of handling large batches of leaves. Twin transparent belts carry the leaves past the camera. A lightbox provides background illumination, and top lighting is also recommended for optimal colour discrimination.
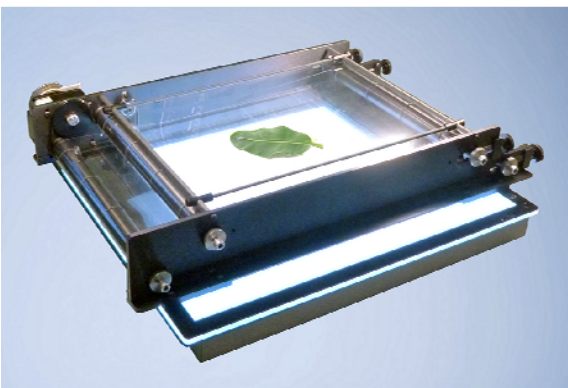
Conveyor Belt Unit and Lightbox

Long Leaves

With the addition of the Conveyor Belt Unit, WinDIAS can measure leaves which are too long to fit in the field of view of the video camera. WinDIAS software repeatedly samples the leaf image as it moves past the camera at constant speed. Stored data sets include total area and the percentages of healthy and diseased leaf area. Typically, a leaf 30cm long by 2cm wide can be measured in 4 seconds.
Calibration is straightforward, using a reference target of known area. In Long Leaf Mode, accuracy is typically better than ± 5% (see specifications).

Virtual Conveyor Mode

WinDIAS can be set to automatically process batches of leaf images. This mode is particularly useful when working with photos taken in the field with a digital camera or a scanner.

WinDIAS Specifications

	Entry Level System	Standard System	Rapid System
Throughput (leaves/hour)	~50 (typical, depends on leaf size)	~150	~800
Resolution	1200 dpi max	2048 x 1536 pixels	1280 x 1024 pixels
Minimum object size	~ 0.02 mm	1 pixel	1 pixel
Maximum sample area	297 x 210 mm (A4)	300 x 295 mm	250 x 290 mm (conveyor) 250 x >1000 mm (long leaf mode)
Accuracy ■ area measurement ■ diseased/healthy area ■ long leaf mode	■ ± 1% typical ■ contrast dependent ■ not applicable	■ ± 4% typical ■ contrast dependent ■ not applicable	■ ± 4% typical ■ contrast dependent ■ ± 5% typical
Colour depth	WinDIAS works in 24bit colour space (16 million colours)		
Image file formats	.jpg, .bmp and .tif		
Operating system and drivers	Windows		
Calibration ■ static measurements ■ conveyor measurements	■ against an object of known length, e.g. a ruler ■ not applicable		■ against a ruler ■ against a target of known area
Conveyor belt speeds	not applicable	not applicable	60/100/140/190 mm/s (20% faster for 60 Hz model)

Specifications apply to a WinDIAS system using standard components supplied by Delta-T Devices. Use of other cameras, lighting systems or camera stands may reduce accuracy due to reflections, poor contrast or image distortion.

Ordering Information

WinDIAS Systems

WinDIAS 3 Entry Level Image Analysis System type WD-E3 includes WD-SW3 Software and WD-FBS-1 Flatbed Scanner.

WinDIAS 3 Standard Image Analysis System type WD-S3-230 (230V/50Hz) includes WD-SW3 Software, WD-CS1 Camera Stand, WD-CAM-S1 USB Colour Camera, WD-LEN-1 Precision Lens, WD-LB1-230 Lightbox, WD-OL1-230 Overhead Lights (with spare bulbs) and acrylic sheets. *Requires correct IEC mains lead – please see below "Mains Lead types"*

WinDIAS 3 Rapid Image Analysis System type WD-R3-230 (230V/50Hz) contents as listed for Standard System, except camera type supplied is WD-CAM–R1 USB Colour Camera, and includes CB-230/50 Conveyor Belt Unit and WD-RTS-1 Reference Target Set. *Requires correct IEC mains lead – please see below: "Mains Lead types"*

*Mains Lead types PC-UK, PC-EU, PC-US, PC-IN, PC-CN connects national plug to WInDIAS IEC connector. Required for WinDIAS systems type WD-S3-230, WD-S3-110 and WD-R3-230.

110V/60Hz Systems: For Standard System order **WD-S3-110**. *Requires correct IEC mains lead – please see above: "Mains Lead types"* *We are unable to supply 110 V versions of Conveyor Belt Unit and therefore cannot supply 110 V versions of the WinDIAS Rapid System. We can, however, supply **220 V 60 Hz systems that include Conveyor Belt Units** - please enquire for further details.*

Individual Items

WinDIAS Software type WD-SW3 Software, Quick Start Guide and USB copy protection dongle

Camera Stand type WD-CS1

Camera type WD-CAM-S1 USB Colour Camera for use with the Standard System

Camera type WD-CAM-R1 USB Colour Camera for use with the Conveyor Belt Unit

Precision Lens type WD-LEN-1 for use with either WD-CAM-S1 or WD-CAM-R1 cameras

Lightbox type WD-LB1-2

Overhead Lights type WD-LB2

Conveyor Belt Unit type CB-230/50 (230 V/50 Hz)

Flatbed Scanner type WD-FBS-1

Reference Target Set type WD-RTS-1

Spares

Spare Bulbs type WD-SP1-230 for Overhead Lights (230 V/50 Hz)

Spare Conveyor Belt Material type CBSP1 enough to make 10 pairs of belts

Pack of 10 Acrylic Sheets type WD-AS1

LAI - Leaf Area Index

There are more ways of getting to LAI than just measuring individual leaves. We also offer SunScan and HemiView - two innovative techniques for estimating LAI non-destructively in crop and forest canopies.

WinDIAS 3 slide show presentation
Downloadable at www.delta-t.co.uk