SCORPION
VISION SOFTWARE®

Scorpion Vision Software®
Version 9 Product Data

Scorpion Vision Software® is a powerful, flexible and extremely expeditious system software tool for industrial vision.

The most advanced 2D and 3D solutions are made without any programming.

The system is founded on top of a standard Windows XP/XPe/Vista/7 PC platform.

It is cost effective benefitting from the processing power of the multicore cpu, low cost and high quality digital cameras and the possibility of connecting multiple cameras to one PC.

The system gives the user the choice of a small form factor of an embedded PC, the Sony SmartCam or the power of an multicore Industrial Computer.

Scorpion Vision Software® 9 is a complete 3D machine vision platform.
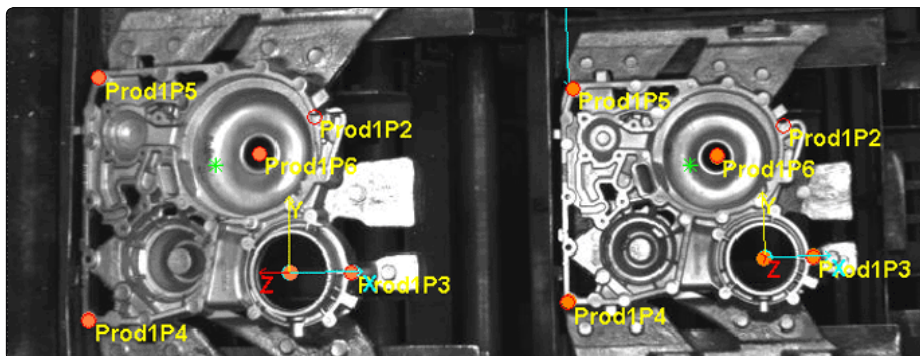
No limitations

There is no restriction on image size, the number of images or camera connections in Scorpion Vision Software®. The software is designed without limitations to enable you to make the most powerful solutions.

One Scorpion Vision Software® system can serve multiple independent production lines or robots simultaneously, supporting on-the-fly reconfiguration to handle different product variants.

Scorpion Vision Software® is the perfect companion to smart cameras, area and linescan cameras with USB, Firewire, Cameralink and GigE interfaces as well as 3D image sensors. Choose between a small form factor with an embedded pc, a smart camera, a standard PC or the power of an industrial PC with Raid and multi-core technology.

Scorpion Vision Software® offers a large reduction in development time and deployment and maintenance cost for machine vision systems. Applications are customised smartly and expeditiously with the flexible user interface, .Net objects and Python scripting.

Scorpion Vision Software® is a family of products

Scorpion Lite - for simple tasks replacing sensors

Scorpion Basic - a complete vision system, typically used for robot vision, colour processing and assembly verification. This version runs on Smart cameras.

Scorpion Premium - for 2D and 3D systems, high precision gauging, multicamera assembly verification, robot vision and label inspection

Scorpion Vision Server™ - running multiple camera systems on multicore server

Scorpion Maintenance - for maintaining and testing profiles on a separate computer

Scorpion Image Logger - automatic image capture, database access and image saving

Scorpion Stinger and Scorpion 3D Stinger™ - families of machine vision components and products providing building blocks for OEM and system integrators.

The combination of Sony SmartCam and Scorpion Vision Software® solves applications within robot vision and high precision gauging.

System & Architecture

Open software architecture

The Scorpion Vision Software architecture is based on Windows standards like tcp/ip, xml, clipboard, Active-X controls, .Net Objects, ODBC, OPC, Python Scripting and html. There is flexible access to Oracle and MS-SQL Server databases by using the Python ODBC interface.

A professional and reliable vision system with standard PCs

Scorpion is designed to run on standard PCs. Depending on the image processing and communication requirements Scorpion runs comfortably with systems equipped with Pentium IIIs. On the latest generation PCs equipped with high speed multicore CPUs processors and GigE cameras Scorpion excels.

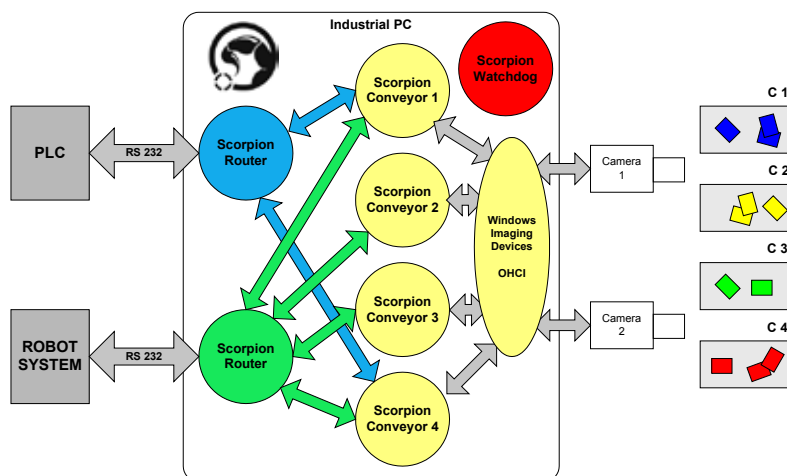Scorpion has support for Windows XP, XP Embedded, MS Vista and Windows 7.

Configurable and event driven communication

A professional and reliable vision system with standard PC running Windows.

Portable vision systems

All Scorpion versions support the latest portable PCs equipped with integrated firewire, gigE and Windows XP / 7.

Flexible and event driven communication

Scorpion supports standards like RS-232, RS-485, TCP/IP, OPC, DeviceNet and PROFIBUS through a common configurable command interface and Python Scripting.
Scorpion commands are simple text and used to control Scorpion from e.g. a PLC, a robot, or from a remote control unit. User defined commands expand the predefined commands and events.

In Scorpion the commands are combined into command sequences and connected to system events and user defined event handlers. All commands and event handlers can be enabled/disabled thus reflecting the actual operating mode. This means that Scorpion quickly is adapted to any external interface requirement without programming. It is just a matter of configuring a simple command set.

No programming robot vision

Using the integrated rs-232 communication modules or the MotomanX Active-X plugin component, Scorpion can be interfaced to any robot system. Custom event handlers and commands build the business logic of the specific problem into solutions. A change in business logic is easily handled at a later stage.
Multiple cameras and images are processed with Scorpion. In complex robot vision applications, these features are used to implement a cost effective and reliable solution.

Open configuration profiles based on xml

The Scorpion configuration profile is stored in a robust, flexible and structured XML-format. This means that all setup including camera configuration and tool configuration can be edited and managed by a simple text editor or the included SPBEditor.

The XML-format and built in backup and restore routines based on zip-files, ensures efficient backup, restore and distribution of Scorpion profiles.

*Powerful profile management with Profile manager. Easy backup and restore using standard zip-format.*

Standard user interface - Integrated web browser - html support

The standard user interface is enhanced by adding custom pages using html, and a set of easy to use Scorpion ActiveX-controls. Documentation prepared in html format is easily integrated in a Scorpion solution. A solution's usability is improved by reducing the man machine interface to the essential minimum.

Configurable man machine interface

Scorpion has a feature rich and configurable Man Machine Interface with image display, data input pages, web pages, ActiveX containment, .Net objects, result panels, image history list, real-time trends, logging, event log and quality alarms.
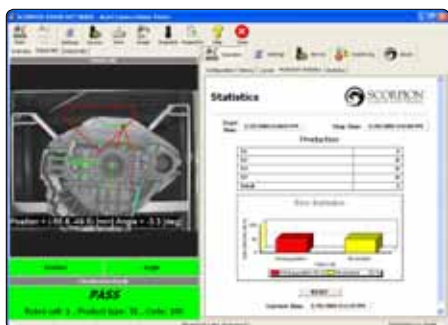
Scorpion Vision Software® user interface

Flexibility with integrated python scripting

The Python script language is integrated in Scorpion. This enhances Scorpion with a large open source library of python modules and a set of Scorpion companion modules. In Scorpion scripts are used to process and validate image processing results, manage profiles, perform robust geometric filtering and to add command extensions.

There is easy scripting access to serial devices, odbc databases, ftp-servers and socket communications from Python.

Any image processing algorithm from Python can be interfaced using Python extension dlls. More information in found in the Python Image Processing section. Python is a complete and extremely powerful development environment embedded into Scorpion.

Integrating vision sensors and IP video servers

Using Python's excellent communication objects one can easily control vision sensors over tcp/ip from Scorpion. In this way Scorpion's system software and networking capabilities is used to combine vision sensors, bar code readers and standard cameras into large vision system.

Simple vision tasks are robustly handled in a compact unit. Axis and Moxa IP Video servers are supported with interface examples.

Expanding Scorpion with standard ActiveX controls and .Net Objects

It is possible to add standard ActiveX controls to the Scorpion graphical interface. In TDVUtilites, a collection of ActiveXs, it is easy to use Curve, Panel, Button, DropDownListBox, WebBrowser, ParetoX and Statistics controls to expand Scorpion's user interface. An ActiveX plugin can also be used to implement an interface to a servo-motor, a PLC or any other device. Combining Python Scripting and ActiveX and .Net Objects, any device can be controlled from the inside of Scorpion. High performance .Net objects runs in separate threads. This can be used to interface high performance 3D Sensors.

Scorpion Vision Server™

The Scorpion Vision Server can run tens of vision sensor tasks or up to four demanding machine vision applications on one Industrial Vision Server. Important features are: Multiple Scorpion applications connected to a specific CPU core and remote debugging of the active system.

The typical hardware platform for a Scorpion Vision Server is GigE cameras, OPC, TCP/IP, Profibus, Quad Core Processors, Hot Swap Redundant Disk and Industrial Ethernet technology.

Security - Password protection

Scorpion has three levels of security: User, Operator and Service. The Operator and Service settings are password protected by separate user configurable passwords.

Configurable logging of images, results and inspection statistics

Scorpion can be configured to log: images, values, states and inspection statistics. Image logging is set up using the built-in logging function. Logging of images and values can be triggered by a user defined criteria thus enabling Scorpion users to limit the amount of data stored and to simplify the offline analysis of the logged data. Images can be stored in monochrome or colour with a user-defined tag added to the image. Bmp or compressed jpg formats are supported. Scorpion provides traceability in a gauging system by offering logging of selected values to

standard csv-files. Combining Python scripts and the Scorpion system events, the user can configure the system to comply with any logging requirement.

Only error images are stored in the image history list. This improves ability to evaluate false rejects offline.
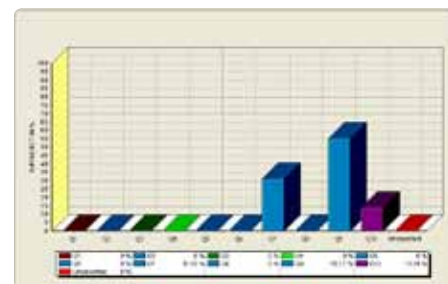

Inspection stastistics

Advanced 3D Modelling - GCPS

3D modelling is available with the new option GCPS. The option enables Scorpion users to create high precision 3D models with a standard video projector and one camera. GCPS - stands for Grey Coding and Phase Shift.

3D measurements are performed on an automotive 'V stay' in the image below. Two cylinder fits are used to establish a high precision reference of the part.
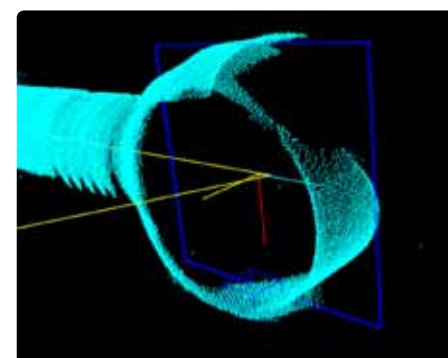
3D model of a V-stay

The new option makes 3D Measurement, 3D Robot Vision, Random Bin Picking and 3D Assembly Verification feasible for everyone.

SCORPION
VISION SOFTWARE®

Tordivel as
Storgata 20, N-0184 Oslo, Norway
www.scorpionvision.com

TORDIVEL

Camera support

Standard camera interface - Supporting multiple ieee-1394, GigE and usb cameras

Scorpion interfaces cameras through a dll making it easy to interface any frame grabber or image source. The main Scorpion image source is standard windows imaging devices.

This gives access to high resolution firewire cameras and low cost usb cameras. Scorpion supports all Sony, Basler, Point Grey, PixeLINK, Imaging Source, Allied Vision and Unibrain's IEEE-1394 cameras. GigE support is provided for Prosilica, Sony and Basler Area and linescan cameras. Scorpion also interfaces Sony's SmartCam.

Linecan cameras are supported through a CameraLink interface based on Matrox Mil 9.0 and their Solios range of framegrabbers.

Depending on camera and driver capabilities, Scorpion can be configured to support colour, direct register access, hardware and software triggering.

Using the ImageProp command, most properties the digital cameras can be dynamically controlled. Only limited by the PC capacity, any number of cameras can be connected and controlled from one Scorpion application.

Supporting GigE Connectivity

GigE has changed the way we use cameras in machine vision systems and opened up new application areas. Scorpion Vision Software and Prosilica is an excellent platform to take advantage of the industry shift based on Ethernet connectivity.

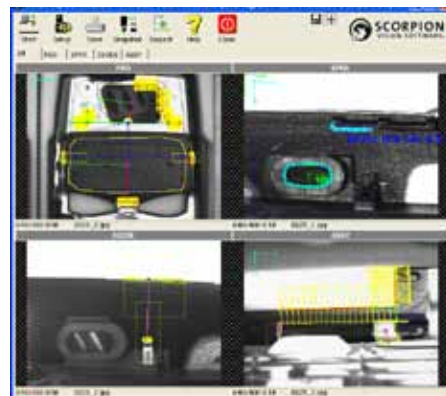*Prosilica GigE camera*

Wireless 3D Robot Vision with GigE

Combining Sony Network cameras and Scorpion Vision Software users can make wireless robot vision systems. Scorpion Vision Software runs multiple 3D robot vision systems on one computer.

Complete support for the Allied Vision range of firewire cameras in Scorpion 8 based on AVT FirePackage.

A four camera Scorpion system doing assembly verification on a mobile phone.

Scorpion supports: Easy image averaging in DirectX camera driver firegrab.dll. Support for raw colour format cameras like Sony XCD-V60CR. Image preprocessing in Python to implement software triggering, eliminating the need for photo cells.

Sony SmartCam running Scorpion Vision Software used in 3D Robot Vision; giving the robot eyes!

EDGE POS2 REJECTED

REJECTED

A two camera and six images solution detecting minor cracks and edge defects on a automotive plastic part.

The Scorpion Tools

Configurable toolbox
Scorpion offers more than 150 tools in the Scorpion Toolbox. The tools are divided into the following groups: Basic, Data, Edge, Geometry, Reference, Advanced and 3D.
All tools have user friendly interfaces and require no programming skills.

Fast configuration with point & click
Enhanced Point and Click for defining ROI, polygon models, reference images and templates, significantly speeds up tool creation.

Toolbox tool
The ToolBox tool is used to define image processing components using a collection of tools.
The tools DataImport and ToolImport are Toolbox companions. These are used to import complete tools or results into the scope of the toolbox tool.
A toolbox tool can contain a toolbox tool that contains another toolbox tool with no level restrictions.

Tool templates
Every tool including the Toolbox tool can be stored as a template. This speeds up toolbox configuration in larger systems.

Flexible and easy to use reference systems - Reference tools
A major feature of the Scorpion toolbox is the reference system concept. Any tool can be a reference. This means that localization and orientation come easy with an unlimited number of references in a profile.
Blobs and edge finders handle translation, rotation and perspective. A reference system can be changed dynamically from script or remotely.
Calibration is supported by a set of reference tools: advanced six-point - for robot or perspectives - Nth order precision grid or manually by entering the linear pixel size.
The Calibrator tool gives high precision with wide-angle lenses, a very important feature in robot vision applications.

Powerful data tools
Scorpion has three very powerful data tools. Below a polygon model defined by the user is used to measure colour coverage. The model is stored in ExternalPolygon.
With ExternalData custom data types and structures are defined – an important feature for scripts and the new Data Input pages.
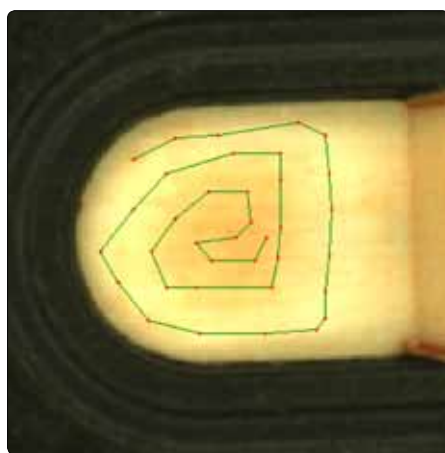
A polygon model defined by the user is used to measure color coverage.
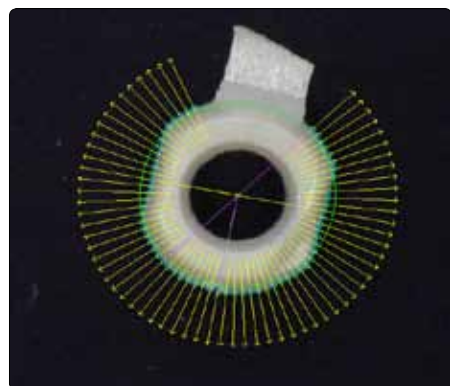
Image processing tools
The following tools are available to do image processing in addition to exhaustive image analysis.

ImageCombiner - image subtraction - running averages - multiple references
ImageResampler - resamples images based on complex references
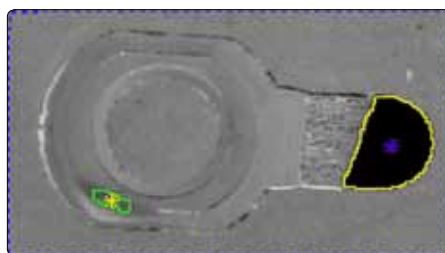*ImageFilter* - image filter and dynamic 2D skew removal

Image Subtraction and a blob analysis detect missing material

The image is processed with Image Filter with the following features: Dynamic skew removal, Median Filtering, Sobel Filter and Contrast adjustment.

Complete set of gauging tools
Making gauging applications is simple with the following geometric and gauging tools:
- *CenterLineFromLines*
- *NormalLine*
- *CircleGauger*
- *WidthGauger*
- *LineReference*

The CircleGauger calculates ovality, the minimum, maximum and mean radius and visualizes the minimum and maximum radius points.

Easy to handle multiple products
ExternalDictionary dramatically reduces the cost of handling multiple products in one system. The tool defines the different product variants by changing the current ExternalData selection. Scorpion automatically selects the tools configured for the different products.

### High precision and robust edge finders

A set of high precision edge finders is suited for gauging. The LineFinder tool's unique constraints make it easy to add geometric knowledge. This makes it very robust even in low contrast problems. The trace combs concept, provides a robust and selective method to find edges with sub-pixel accuracy. The intensity variations are handled using first or second order differentiation. The angle between two lines is easily calculated and visualised using the Angle tool. A Trace line Viewer helps the user to obtain optimal smoothing and filter settings. The LineFinder2 has dynamic thresholds, perpendicular trace lines and custom trace line filters.
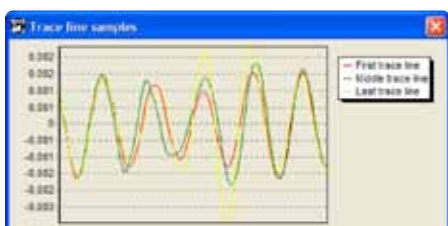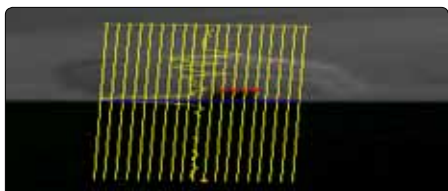
Trace line viewer and edge curves

Optimal object location with PolygonMatch™ technology

The unique PolygonMatch technology has been enhanced with the interactive Polygon Model Builder Wizard. In the example below the model is made using the new wizard. PolygonMatch is available in the following tools: TemplateFinder3, PolygonMatch and PolyLineEdgeFault2
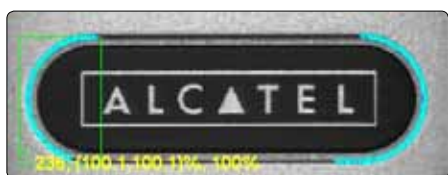
Mobile telephone print located by TemplateFinder 3 and PolygonMatch™ with sub-pixel accuracy.

Tools with polygon region of interest

A set of flexible and useful polygon roi tools make Scorpion very well suited for a large number of advanced tasks. Using the PolygonLineEdgeFault one can easily check the contour of an object.
Blob3 supports form of any shape - ideal for detecting presence of objects and print inspection. PolyLineEdgeFaults2 is used to detect contour errors on a letter in print inspection. All tools handle of course rotation, scaling and perspective when connected to a reference system.
The advanced Blob4 supports polygon roi of any shape – ideal for detecting presence of objects and for print inspection.

PolygonEdgeFaults2 verifies the edge of the print. The model are translated, rotated and scaled using PolygonMatch technology before edge verification.

Edge fault on solar cell wafer

MultiTools - A powerful Scorpion concept

A set of supertools with multiple polygon rois is well suited when a large number of objects are to be verified or inspected. Typical applications for MultiBlob, PolyLineGapFinder and PolyLineEdgeFaults are inspections of printed circuits, counting objects and label inspections. All the tools have flexible constraints and built in classification logic. This means that there is no need for complex logic evaluating the results.
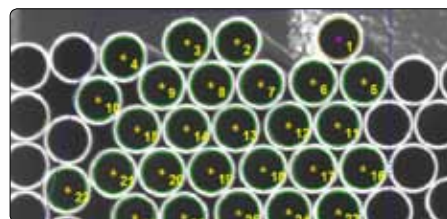
Blob4 sorts results into row and columns. The collection of sorted pipes are shown. A robot will pick the uppermost pipe until the bin is empty.

Blob4 finds contamination on wafer

Robust and reliable pattern matching

With TemplateFinder3 we locate multiple objects based on reference images. The algorithm is standard cross correlation with integrated PolygonMatch™ yields sub-pixel resolution. Advanced resampling and decimation techniques speeds up the object location process. Object variations are handled with multiple templates and template rotation and scaling. The resampling techniques dynamically handle object perspective and size in addition to lens distortion. In Robot Vision the tool can compensate wide angle lenses and size changes due to multiple product object heights still yielding robust and high precision locations to the robot..
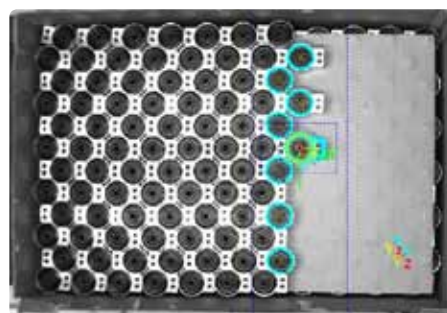
*A box of valves. Scorpion sends the valve positions to the robot.*

Colour identification made easy

ColorMatcher™ identifies colour by colour reference images. Any number of colours can be defined. For each colour one can define any number of references. When an image is captured, the distance to each reference image is computed. The image with the closest match is selected as the actual colour. In the ColorMatcher™ configuration dialog you can see the defined reference colours, the current image and the selected reference with its corresponding name and distance. ColorMatcher™ is a fast and proven easy to use tool proven in Automotive Assembly verification and Fibre sorting. With multiple reference it can reliable distinguish tiny colour variations.
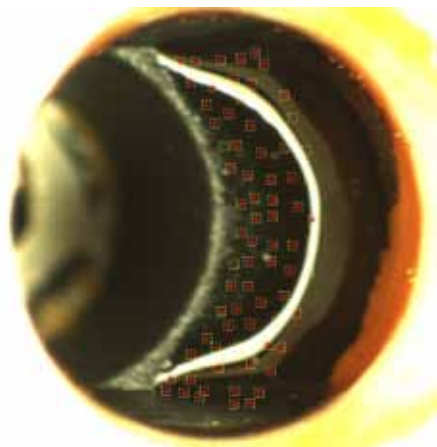
ColorMatcher™ detects glue coverage on a pressure sensor.

Every Scorpion tool can process colour images

When working with colour images – conversion to hue, saturation and intensity images is performed implicit in the Toolbox. This means that edge finders and pattern matchers can process an image using hue, saturation or intensity by selecting the colour plane to work in.

Colour Segmentor

The Color Segmentor is a part of the Advanced toolbox in Scorpion. By configuring the HIS filter, any colour segment is extracted from the image.
The resulting image can be processed using all tools in the Toolbox.

LineFinder finds the edge of a drill pipe based on changes in color.

Texture Matcher

TextureMatcher identifies surfaces by reference images. Any number of textures can be defined. For each texture one can define any number of reference images. When an image is captured the distance to each reference image is computed. The image with the closest match is selected as the actual texture.

The texture algorithms have been successfully used to identify the pattern on automobile wheels, detect microcrystals on solar cell wafers and to sort wallboards.
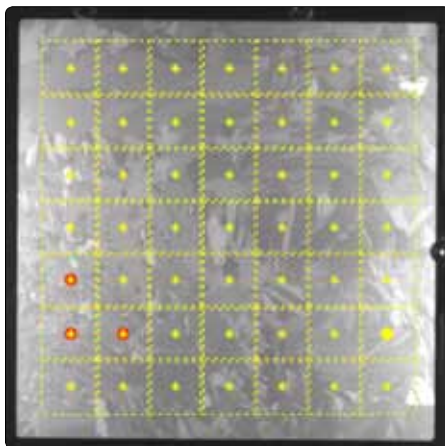
A texture matcher performs a surface analysis of a solar cell wafer. The red dots indicate areas with micro crystals. The analysis is fast and easy to train with the TextureMatcher tool.

Surface Analyzer

Colour and texture matching are combined in the SurfaceAnalyzer, and multiple objects are identified based on colour, size, shape and texture.
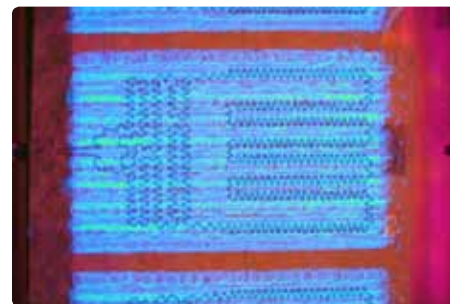
Glue distribution is measured using colour identification.
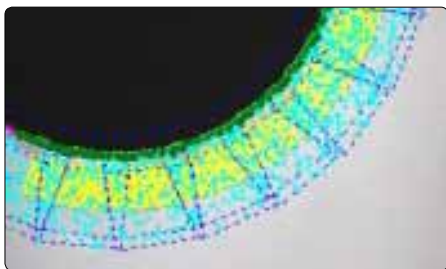
Running tools from python

A powerful feature is the ability to run the Scorpion tools from Python Scripts. From Python you can modify the configuration, execute and read all results thus changing executing sequence based on the processing results.

With easy to use object oriented syntax the following operations are performed in the example below:
Connect to an image; Get the reference c1_ref tool and two line finders: c1_cf and c1_cf1.

The SPB CreateSpb retrieves the configuration of the reference tool. In the loop the reference is moved in a circle from -50 degrees to 60 degrees in 15 degrees steps while the rotated linefinders are executed in every step - see the next page image.

With this feature many tasks are simplified. Inspecting a number of objects is now only to configure the image processing for the first object and then make a python iterator!

```
#Created 17.09.2003 14:44:10
import SPB
img = GetImageMatr('CRACK (CAM1)')
ref = GetTool('c1_ref')
lf  = GetTool('c1_cf')
lf1 = GetTool('c1_cf1')
rspb=SPB.CreateSpb(ref.config)
nf=0
for i in range(-50,60,15):
    rspb.setFloat('Rotation',float(i))
    ref.config=rspb.xml
    ref.execute(img)
    lf.execute(img)
    lf1.execute(img)
    #print lf.result
    n  = int(lf.result['LineCount']>0.0)
    n1 = int(lf1.result['LineCount']>0.0)
    nf+=(n+n1)
print n,'lines found in c1_iterator'
SetValue('c1_mvlf.Value',n)
```

SCORPION
VISION SOFTWARE®

Tordivel as
Storgata 20, N-0184 Oslo, Norway
www.scorpionvision.com

TORDIVEL

Rotating line finders run from Python

Python image processing

With the Image API it is possible to make Python the image source or to generate images from Python. This is a way to interface LineScan cameras not supported by Scorpion. ArrLib is the low level image processing library used to implement the Scorpion Toolbox. All Arrlib image processing functions are available from Python. Having the ability to access the image with GetImageMatr and SetImageMatr methods the following image operations are easily performed:

Intensity Correction, Image Averaging, Image Subtraction, Image Resampling and Image Stitching.

Scorpion's image processing can be extended using Python Extensions. This is described in Example 21 - Custom Scorpion Python extension in the Html-Help file.

Scorpion 3D Tools

Complete 3D Machine Vision platform

Scorpion Vision 8 is a complete 3D framework for Machine Vision. With the release of Scorpion 8, the toolbox contains 50 3D tools. Important features are:

- 3D visualisation
- 3D toolbox containing more than 50 tools
- Complete support for 3D stereo vision including numerous 2D improvements to support stereo vision
- A nice toolset for pointcloud processing including ConnectedComponents, PlaneFit, SphereFit and CylinderFit
- 3DMaMa™ - an extremely powerful tool to find multiple objects in a 3D pointcloud
- GCPS - Gray Code Phase Shift Software Module to create 3D models using stripelight and a standard projector

One of the most challenging tasks in machine vision has been "Random Bin Picking" - RBP. There is not one single solution for this task. Depending on the part shape and more; MonoPose3D, Stereo Vision or 3D imaging can be a solution.

Bin of automotive covers

3D cover location

3D MaMa™

3D Algorithm for Random Bin Picking

Enabling robots to automatically locate and pick up randomly placed and oriented objects from a bin is an important challenge in factory automation, replacing tedious and heavy manual labour.

A system should be able to recognize and locate objects with a predefined shape and estimate the position with the precision necessary for a gripping robot to pick it up.

We have made a system that consists of a structured light instrument for capturing 3D data and a robust approach for object location and pose estimation.

The 3D MaMa algorithm is integrated as a tool in Scorpion Vision Software® and is a result of a three year long research project founded by The Research Council of Norway.
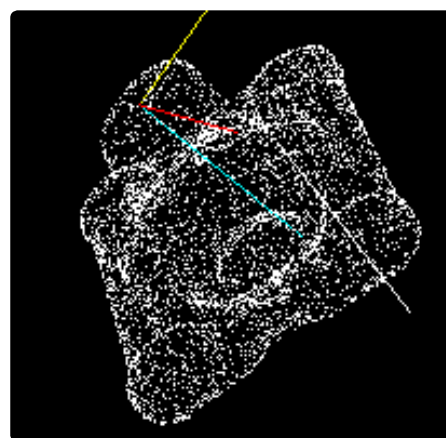

Random bin picking scene
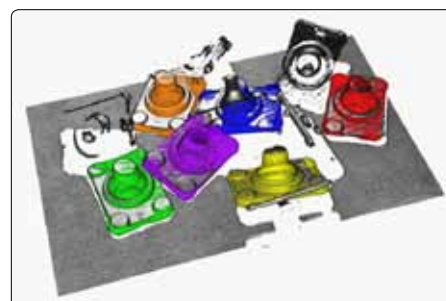
3D object location with 3DMaMa

3DMaMa™ locates the parts based on a 3D Model. The model can be imported from a true 3D Model or be created based on points captured by Scorpion GCPS™.

We believe 3DMaMa™ is a breakthrough in 3D part location!

3D template used by 3D MaMa

SCORPION
VISION SOFTWARE®

Tordivel as
Storgata 20, N-0184 Oslo, Norway
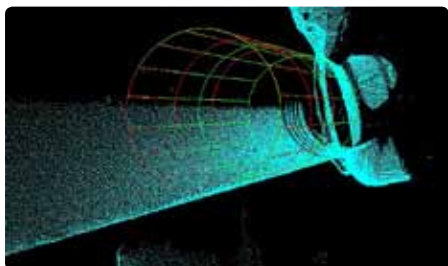www.scorpionvision.com
TORDIVEL

3D visualization

is supported in 2D and 3D images.
- Superimposed on 2D camera images
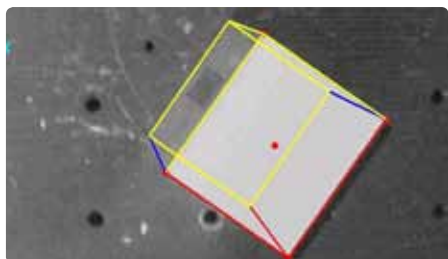- 3D Point Cloud - Scorpion 3D Images based on OpenGL viewer

Additional visualization for both types by a Python API.

Advanced cylinder fit in a point cloud from the Scorpion 3D Modeller.

3D geometry tools

The 3D toolbox consists of a complete set of tools to create lines, planes, intersections and reference systems.

3D geometry tools creating lines and planes

Processing 3D images

In Scorpion 3D images are represented as ordered or unordered sequences of 3D points - called a point cloud.

For more information:

Tordivel AS
Phone +47 2315 8700
Fax +47 2315 8701
office@tordivel.com
www.scorpionvision.com

TORDIVEL

3D reference systems

Following Scorpion 2D standards, 3D reference systems are intuitive, convenient and easy to use.
- Seamless 2D/3D integration means that a coplanar mapping is automatically created from any 3D reference
- Scorpion Result Reference removes complicated coordinate conversions
- Use any 2D tool anywhere in your 3D system. Scorpion moves the virtual camera

3D resampling of 2D images

Any 2D image can be resampled using a 3D reference system using the 3D camera calibration. This enables high precision 3D image processing using the 2D image processing toolbox. The object is located using Stereo Vision. A 3D reference is established as shown in the image below. This is resampled. Note that all 2D image processing tools can use the 3D references without resampling to do 3D processing.


A 3D reference is established

Real time 3D Models with Laser grids

CreatePointCloud is a tool that matches dots from a laser grid using polar geometry and optimal cross correlation.

Below a 19x19 laser grid pointing on a PC mouse. Using three camera stereo vision Scorpion creates a 3D model in 250 ms. The laser grid covers a 3D FOV of 140 x 140 x 80 mm with a resolution of 0.5 mm.
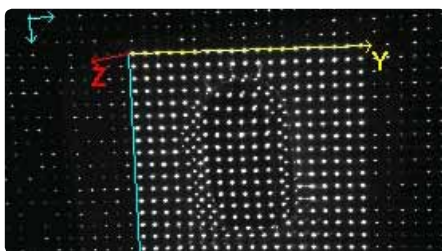

3D Point Clouds

Scorpion 8 support 3D PointClouds. One great feature is to convert profiles from a standard laser triangulation system into 3D Images or pointclouds.

The image below shows the conveyor and two pizza buns being profiled. The laser spans across the 700 mm wide conveyor. The height of the pizza is measured with a resolution 0.1 mm in a dynamic area of 50 mm. The SingleLineFinder tool calculates more than 200 3D coordinates in 4 ms.

With a conveyor speed of 0.3 m/s or 300 mm/s the hw trigged Prosilica Camera GC1350 delivers 60 images per second to Scorpion thus producing a 3D images with the spatial resolution 3 x 5 mm containing 12000 high precision 3D points.

The image contains two pizzas with uniform thickness of 20 mm.
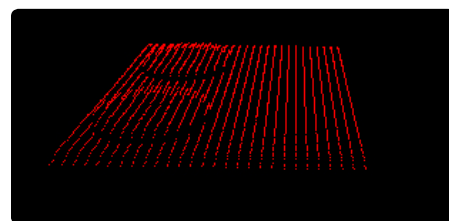
Note: The 3D Imagers runs alone on a dedicated cpu-core. Scorpion can process profiles in realtime up to 200 or 250 profiles pr second.

When working with 3D Images the objects can be located with the ConnectedComponents3D or MaMa3D tool. The image below shows the actual image converted to a heightmap using the ExtractMap3D tool.