3D Cameras
Ruler E

Gigabit 3D for Tough Environments!
Ruler E – 3D camera:
Gigabit 3D for tough environments

Calibrated true shape and surface features for market leading scanning solutions at highest speed

The key component for high speed 3D scanners

Ruler E is a perfect tool for in-line 3D-scanning applications. Our OEM customers and vision integrators use the Ruler E to build 3D scanners with the highest performance and accuracy on the market. It can be used to measure object height, shape and volume, to detect and locate shape defects, to make quality grading, etc. It is designed for the tough environments of wood, steel and automotive industries and with the heating option it can operate at temperatures down to -30 °C.

Ruler E is a camera with in built laser and optics for a predefined field of view, which makes it very easy to install. The data output from the Ruler is calibrated world coordinates (x, y, z) in millimetres which are delivered on a high speed Gigabit Ethernet interface to a hosting PC. Application development is made in a high level VB.Net or C/C++ programming environment.

Benefits with Ruler E:
- High speed 3D-data
- Factory calibrated
- Easy to install and integrate
- Data from several Rulers can be combined
- Free choice of image analysis routines
- Standard interface, Gigabit Ethernet
- Robust housing
- Operates in low temperatures
- Best market price/performance

Applications

Ruler E for production control

3D data from Ruler E can be used to control levels, object presence, and orientation of items in the packaging industry. In the example to the left, the Ruler E data is used to verify that there are no missing or additional chocolate bars in the box. Since the 3D measurements are robust to contrast variations, products with different printing can be measured in the same production line.

Ruler E for grading

In grading applications it is very common that both the shape and the surface properties of objects need to be evaluated. Besides measuring the object shape, the Ruler E can at the same time both deliver a grey scale image and an image that reveals the surface properties (referred to as laser scatter or Tracheid effect in the wood industry). In the board grading example, Ruler E data is used to measure the shape of the board and to detect defects like knots, pitch pockets, etc. The information is then used to sort the boards according to their characteristics. In such applications, the boards are traversed at very high speed and hence high speed measurements are essential.

Ruler E for object location

Detecting location of objects with exact position in a world coordinate system (x, y, z), requires a 3D measurement system. Such coordinate information is required in for instance robot guidance solutions. In the application to the left, the 3D data from the Ruler E is used to locate each parcel on the pallet. The parcel coordinates are then used by the robot arm to off-load each single parcel.

Ruler E for production optimisation

By combining 3D data from several Ruler units the complete shape of objects can be measured. In the log scanner to the left, three Rulers from different sides are used to measure the logs that pass through. In the hosting PC, the data from the Rulers are brought together resulting in a complete shape description of the log. The description is then used to calculate how to saw the log in order to optimise its value.
Ruler E

Ruler E is a high-speed data streamer for true shape measurement of various kinds of objects. The camera delivers calibrated 3D profiles of objects passing through the measurement region. The high quality 3D data can be incorporated into your PC application solving inspection tasks such as volume measurement, shape analysis, object size rejection, 3D positioning, and so forth. In addition to incorporating into your PC application solving inspection problem, Ruler E delivers calibrated 3D profiles of objects passing through the measurement of various kinds of objects. The camera is designed for tough industrial environments. All industrial cables and connectors, providing a more cost efficient complete solution. The Ruler data can easily be incorporated into your image analysis application, using the same programming interface for both camera control and data access.

Features
- Contrast independent 3D measurements
- Delivers calibrated 3D coordinates (mm)
- Ambient light robustness
- Choice of field of view: Ruler E150, Ruler E600 and Ruler E1200
- Several object features measured simultaneously (3D, intensity, scatter by option)
- High flexibility with parameter controlled measurements
- Gigabit Ethernet communication interface
- PC-software for camera configuration and data visualisation
- NET Assembly for easy incorporation into analysis software applications
- C and C++ API for advanced programmers
- Industrial robust IP 65 housing
- Industrial cables and connectors
- Heating option for low temperature operation
- 3B laser option for challenging applications
- 24 V supply voltage

Real measurement in calibrated units
Ruler E is factory calibrated and outputs height and width values in metric units (millimetres). With the use of an external encoder, the camera will automatically compensate for any variations of object speed to ensure accurate length measurements. The encoder input is compatible with RS 422 and includes support for both forward and backward movements.

Field of view
The field of view (FOV) is a trapezoid-shaped region where the Ruler can generate object measurements. In this region, the maximum possible object height and width in a defining rectangle are related. Within specified limits, the FOV used for the inspection task can be controlled via software parameters. The minimal distance between the Ruler and the object is referred to as the stand-off. Ruler E comes in three versions with different FOV and stand-off, the Ruler E150, the Ruler E600 and the Ruler E1200. See table below for details and specification of limits.

Profile rate and accuracy
The maximal profile rate (see table) is dependent on a combination of the measurement accuracy and the height of the used field of view. By decreasing the dynamic range, i.e. the height region used for object inspection, the profile rate can be increased. Note, however, that the maximal usable profile rate also depends on the amount of light reflected from the object. Hence, for very dark objects, it might be necessary to select a longer exposure time which, in turn, limits the profile rate.

<table>
<thead>
<tr>
<th>Field of view</th>
<th>Example field of view</th>
<th>Example field of view</th>
<th>Example field of view</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOV</td>
<td>Ruler E150</td>
<td>Ruler E600</td>
<td>Ruler E1200</td>
</tr>
<tr>
<td>Example FOV</td>
<td>50 x 150 mm</td>
<td>250 x 600 mm</td>
<td>250 x 1200 mm</td>
</tr>
<tr>
<td>Total height range</td>
<td>88 mm</td>
<td>450 mm</td>
<td>1000 mm</td>
</tr>
<tr>
<td>Stand-off</td>
<td>160 mm</td>
<td>415 mm</td>
<td>280 mm</td>
</tr>
<tr>
<td>Max. distance</td>
<td>248 mm</td>
<td>865 mm</td>
<td>1290 mm</td>
</tr>
<tr>
<td>Width at stand-off level</td>
<td>140 mm</td>
<td>450 mm</td>
<td>500 mm</td>
</tr>
<tr>
<td>Total height range</td>
<td>88 mm</td>
<td>450 mm</td>
<td>1000 mm</td>
</tr>
<tr>
<td>Height resolution (½ pixel resolution)</td>
<td>0.05 mm</td>
<td>0.2 mm</td>
<td>0.4 mm</td>
</tr>
<tr>
<td>Max. profile rate</td>
<td>10 000 profiles/s</td>
<td>30 000 profiles/s</td>
<td>10 000 profiles/s</td>
</tr>
</tbody>
</table>

Profiles per second: 10 000 Profiles/s; 30 000 Profiles/s; 10 000 Profiles/s

Best resolution: 0.05 mm (½ pixel resolution)
Getting 3D data

The in-built laser of Ruler E projects a laser line on to the object that is inside the measurement region. The camera, that views the line from a different angle, sees a curve that follows the height profile of the object. By measuring the laser line deviations from a straight imaginary reference line, the height of the object can be computed. As the object passes through the laser beam, contour slices of the object are generated. The collection of such slices, or 3D profiles, is a description of the complete object shape as seen from the upper side of the object. The unique camera technology is capable of finding the position of the laser line by itself and reducing the whole image information into compact laser coordinates. There are only these laser coordinates that are transmitted to the PC. This makes the 3D imaging very fast and reliable.

Intensity and scatter

Along with the 3D profiles, the Ruler can simultaneously measure two other object features: intensity and scatter (by option, see specifications). The intensity reveals how much of the laser light that is reflected by the object and the scatter is a measurement on how much the laser light spreads beneath the object surface. As an example, scatter data is commonly used in the wood industry for a robust knot and defect detection, see figure above. The laser light will scatter less inside a knot than in clear wood. (This effect is also referred to as Tracheid). Hence, the resulting scatter image will be darker at the knot than outside. Thus, by also using scatter data in the application, the defect detection becomes much more reliable. The method is patented by SICK IVP AB.

Having the Ruler measuring 3D shape, intensity, and laser scatter, several aspects of information about the object becomes available. By combining these three object features, very powerful and reliable object analysis applications can be developed, solving challenging inspection tasks.

Movement synchronisation

The data stream of profiles can be synchronised with the object movement or conveyor speed using an external encoder. This functionality will ensure that the length measurement and object scale in the movement direction is correct. Moreover, an external light switch or similar can be connected to the Ruler in order to acquire data only when an object is within the measurement region.

Complete shape analysis

In order to measure the complete object shape, data from several sides of the object need to be collected. In such cases, data from several Rulers mounted around the object (e.g. above and below the object) can be combined. Ruler E comes with a transformation tool for aligning the data from all Rulers into one common coordinate system. For a multiple Ruler system, a Gigabit Ethernet switch can be used to gather the data streams into one single cable for the connection to the hosting PC.

Rough EMC environments

Ruler E fulfils industrial EMC requirements and has moreover been carefully tested in very rough EMC environments (saw mills). The standard cables have been proven to work in these studies. However, in extreme EMC situations, or for very long cable distances, an optical fiber solution is offered.
Ranger Studio

Ranger Studio is not a tool for object analysis and cannot provide high quality data for a specific task. Note, however, that the Ruler offers a graphical user interface for evaluating the data collected. It serves as a valuable tool to understand how to work with Ruler E, to get acquainted with all the possibilities that the Ruler offers, and how to configure the camera to get high quality data for a specific task. Note, however, that Ranger Studio is not a tool for object analysis and cannot be used to solve an image analysis task. For this, the Ruler has to be complemented with other software components. Ranger Studio runs on a PC with Windows XP. In Ranger Studio the user can connect to one of, possibly, several Rulers connected to the dedicated local network. After establishing contact, the user can display both a live 2D image as well as acquire collections of profiles for display as 3D image. Collected data can be visualised in several different ways with tools such as zooming, profile viewing, and interactive 3D rendering. The purpose of the 2D image mode is to setup the measurement region and prepare the system for making 3D measurements.

Ranger Studio also provides access to all camera parameters via the Parameter Editor. Different applications may require different parameter settings in order to get the desired result. Ranger Studio is a very good tool for finding the best camera configuration given a certain application. Moreover, since several parameters can be changed live, i.e. while the camera still is measuring, Ranger Studio serves as a good interactive tool for gaining knowledge about the influence the parameters have on the measurement result. The fine tuned parameter setting can be saved and reused when incorporating the Ruler as a component in a real-time image analysis application.

Application development

Ruler E can easily be incorporated into software applications for Windows XP using one of the three APIs (C++, C, and .NET Assembly). The APIs offer similar possibilities for camera control and data access. Nevertheless, the .NET Assembly is a more convenient and faster solution for high level programmers using, for instance, Visual Basic .NET for application development.

Having the Ruler as the data streaming component in a PC environment, very flexible and powerful solutions can be developed since both the performance of the PC and the choice of image processing algorithms can be precisely adapted to the specific needs of each inspection task. There are several third party software packages available on the market that can be used with Ruler E to develop complete inspection solutions.

Ruler E as an application component

The figure to the right shows a possible scenario where the Ruler is the vision component in an application where faulty parts should be rejected. The Ruler serves as the data source, providing the hosting PC with 3D profiles and object intensity information. An encoder is used to synchronise the data with the the actual movement of the object in order to get correct object length. A light switch is used to limit the amount of data to only send data when the object is present. The light switch data is also used to identify the beginning and end of the object.

As soon as data is being collected, or if preferred, when the whole object has been scanned, the PC application starts to analyse the profiles or the complete 3D image. The application uses its own image processing library to identify object defects and to classify the object as being either correct or faulty. The result is then transmitted to the controlling unit, in this case a PLC, which will use the input to push the faulty object into the waste bin.

Ruler E versions

The base versions of £150, £600 and £1200 are equipped with a 2M-class laser. This laser strength is sufficient for most measurements situations, but in some cases where particularly dark objects are to be inspected, Rulers with a stronger 3B class laser are offered (£600S and £1200S). Combinations of the above different versions are also offered. See table on next page for a complete overview of Ruler E variants. All Rulers are delivered with printed Operating Instructions and example code and documentation, and Ruler E development software CD contains the evaluation tool (Ranger Studio), the APIs required to integrate the Ruler with example code and documentation, and Ruler E manuals. It should be noted that the software CD contains a life time development licence. Future upgrades will be available on our web page.

As a service, power supply and cables required for getting started with the Ruler E have gathered in an accessory kit. See table on page 11 for definition of its content.

For long cabling distances, or in extreme EMC environments, an optical fibre solution with fibre cable and optical adapters are offered. Moreover, for systems with several Ruler units, a Gigabit Ethernet switch is offered. By connecting each Ruler to the switch, there will only be a need for one cable to the hosting PC.

For safety reasons, in installations using a Ruler E with the 3B laser class, it is required to have a key box with a removable key that can be set to block the power to the laser unit. This is to ensure that the laser is not turned on by accident during service or maintenance. Such a box, which is connected with standard cables, is offered as an accessory to Ruler E.
3D cameras: Ruler E

- Easy to integrate
- Data as world coordinates
- Robust housing
- Operates in low temperature
- Best market price/performance

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**Technical data**

- **Performance**: 10,000 3D profiles/second
- **Interface**: Gigabit Ethernet
- **Host platform**: PC, Windows XP
- **Temperature**: Free cooling, light switch enabled
- **Power supply**: 24 VDC
- **Current consumption**: < 3 A
- **Dimensions (L x H x D)**: 295 x 183 x 107 mm
- **Weight**: 5.1 kg
- **Shock load**: 15 g, 58 ... 150 Hz
- **Vibration load**: 5 g, 5 ... 150 Hz
- **Ambient temperature**: Operation: 0 ... +40 ºC
- **Storage**: -30 ... +70 ºC

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**Order information**

- **Version**: 3.0
- **Order no.**: 1014241
- **Power supply**: 1014239
- **Content of Ruler E accessory kit (1014246)**
  - **Order no.**: 1014230

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**Pin configuration according to the Gigabit Ethernet standard defined by IEEE 802.3ab**

- **In_A+**
- **In_B+**
- **TRB**
- **Out1**
- **Out2**
- **GND**
- **Laser Power**

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**Power and I/O cable**

- **Type**: M12 to M12, 2 m
- **Order no.**: 6030121

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**Gigabit Ethernet**

- **Type**: Gigabit Ethernet
- **Order no.**: 6032330

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**Encoder**

- **Type**: Encoder
- **Order no.**: 6020633

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**Dimensions**

- **(L x H x D)**: 295 x 183 x 107 mm
- **Weight**: 5.1 kg

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**Field of view (H x V)**

- **250 x 1200 mm**
- **250 x 600 mm**
- **50 x 150 mm**

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