3D Image Sensing Using Smart Pixel Technology

Shape, Size and Volume
3D Image Sensor using Time-of-Flight Distance Measurement

The 3D image sensor is designed to evaluate size, shape and volume in industrial automation applications. The compact, easy-to-use sensor uses time-of-flight distance measurement and photonic mixing device technology to identify an object in its field of view. The integrated 64 x 48 smart pixel array projects 3072 points of reference onto an object, capturing the entire object in three dimensions.

Active Lighting
Active lighting combined with ifm’s patented Suppression of Background Illumination (SBi) technology allow the 3D sensor to be applied in all lighting conditions, both indoors and outdoors.

Time of flight principal
This principle measures a distance based on the time it takes light to travel to an object and back to the receiver.

Consistent measurement
Variations in color cause challenges with traditional photoelectric sensors. White objects reflect more than dark gray objects. ifm’s 3D sensor has minimized this impact creating a more consistent measurement throughout the color spectrum.

PMD Technology
An integrated 64 x 48 pixel array captures the light. Each pixel within the array is able to compute the phase difference directly on-board the sensor chip. This built-in functionality allows the sensor to pre-process the signal, removing the need for expensive high-speed electronics.

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Smart pixel
Each pixel has two gates that are controlled by an oscillator. Here, the electrons are converted into photons. The light information is sent from the PMD chip as the representative distance for that pixel, carrying the desired 3D information.
Determine the overall Field of View

The 3D image sensor’s Field of View consists of 64 x 48 pixels. The size of each pixel is directly related to the distance of the sensor to the object. For example, in the chart below, at 1 meter range, the average pixel size is 11 mm x 11 mm square. This creates a Field of View that is 840 mm x 580 mm in dimension.

Increasing the sensor-to-object distance will create a larger Field of View; conversely, decreasing the sensor-to-object distance will create a smaller Field of View.

Determine the minimum object size

As the distance between the sensor and object increases so does the size of each pixel. The pixel size will determine the minimum size of the object that can be evaluated.

For best results, ifm recommends that the minimum object size is at least two times the size of an individual pixel. These values can be found in the chart below.

For example, at 0.5 meter the pixel size is 6 x 6 mm.

At 1 meter the pixel size is 11 x 11 mm.
Three-dimensional vision.

Efector pm3d is the first industrial 3D sensor that can detect objects in three dimensions at a glance. The time of flight measurement principle enables an unimagined variety of application solutions. In conventional systems, either the object or the sensors must be in motion in order to obtain several measurement points of an object.

The innovation: the measurement and the evaluation of the time of flight are integrated on one sensor chip. The sensor chip has 64 x 48 pixels. In addition to the reflectivity, each pixel of this chip matrix evaluates its distance to the object.

This results in 3072 distance values at the same time. The image of the object on the chip matrix and the respective distance values correspond to a 3D image. These measurement points of the 3D image enable distance-independent assessment of the characteristics of the object or the scene. They form the basis for the three evaluation modes volume, distance and level, serving as solutions for different applications.

Volume: irrespective of the distance between sensor and object, efector pm3d determines the volume of any object.

Areas of application: control of the loading and filling condition of outer packaging or trays.

Example bread baking pan: dynamic processes in conveyor lines can be detected as well. The different pans are monitored for underfill or overfill.

Example crate: the sensor moreover enables subdivision of the field of view into separate windows. Areas of no interest can be ignored and relevant areas can be inspected in detail.

Up to 64 windows can be monitored for the same adjustable threshold. The missing bottle in this case triggers a switching signal.
Example
Euro pallet: if the 3D sensor is installed about 1.5 m above the maximum stack height, overlapping parts can be detected in addition to overfill and underfill.

Example conveying technology: navigation support or collision avoidance on AGVs; use in parcel sorting systems.

**Distance:** With the 3D sensor, the measurement of distances from irregular surfaces is no longer a challenge. 3072 precise distance values replace a multitude of standard photoelectric sensors. efector pmd 3d also is a clever alternative to ultrasonic sensors, photoelectric distance sensors or laser scanners.

**Application examples:** Filling status of shelves, pallets or stacks. Navigation support or collision avoidance on AGVs.
**Level assessment.**

- **Level:** the sensor determines the level above the previously defined background in the search zone. The shape of the bulk material does not matter.
- **Areas of application:** level measurement of bulk material such as grains or granulates in silos. Control of the correct filling of packaging in the food industry.

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**Technical data efector pmd 3d**

<table>
<thead>
<tr>
<th>Application area</th>
<th>Visual assessment of distance, level or volume</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical design</strong></td>
<td>PhotonICs® PMD, resolution: 64 x 48 pixels</td>
</tr>
<tr>
<td>Order no.</td>
<td>O3D200</td>
</tr>
</tbody>
</table>

| Sampling rate / switching frequency [Hz] | max. 25, adjustable |
| Unambiguous ranges [m] | 6.5 (single frequency mode) / 48 (dual frequency mode) |
| Illumination | infrared (850 nm) |
| Operating voltage [V] | 24 DC (± 10 %) |
| Current consumption [mA] | < 1000 (max. 2500) |
| Short-circuit protection, pulsed | • |
| Overload protection | • |
| Operating temperature [°C] | -10...50 |
| Protection | IP 67, III |
| Dimensions [mm] | 122 x 75 x 95 |
| Materials | Housing: aluminium; lens window: polycarbonate; LED window: polycarbonate |
| Connections | external trigger; max. 2 switching inputs / outputs; analogue output (configurable) |
| Parameter setting options | via PC / notebook or 10-segment display and two pushbuttons |
| Parameter setting interface | Ethernet 10Base-T / 100Base-TX |

**Accessories (selection)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switched-mode power supply 24 V DC / 2.5 A</td>
<td>DN2011</td>
</tr>
<tr>
<td>Operating software for O3D</td>
<td>E3D200</td>
</tr>
<tr>
<td>Mounting set for rod mounting Ø 14 mm</td>
<td>E3D103</td>
</tr>
<tr>
<td>Mounting rod, 100 mm, Ø 14 mm, M12 thread, stainless steel</td>
<td>E20939</td>
</tr>
</tbody>
</table>

**Sockets**

<table>
<thead>
<tr>
<th>Description</th>
<th>Order no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 m PUR, M12 straight, 8 poles</td>
<td>E11950</td>
</tr>
<tr>
<td>5 m PUR, M12 straight, 8 poles</td>
<td>E11807</td>
</tr>
<tr>
<td>10 m PUR, M12 straight, 8 poles</td>
<td>E11311</td>
</tr>
<tr>
<td>Parameter setting cable, 2 m, M12 D-coded / RJ45, cross-link</td>
<td>E11898</td>
</tr>
</tbody>
</table>
Overview ifm main catalogues:

- Position sensors and object recognition
  Inductive sensors
  Capacitive sensors
  Magnetic sensors, cylinder sensors
  Safety technology
  Valve sensors
  Photoelectric sensors
  Object recognition
  Encoders
  Evaluation systems, power supplies
  Connection technology

- Fluid sensors and diagnostic systems
  Level sensors
  Flow sensors
  Pressure sensors
  Temperature sensors
  Diagnostic systems
  Evaluation systems, power supplies
  Connection technology

- Bus systems
  Bus system AS-Interface
  Power supplies
  Connection technology

- Identification systems
  Multicode reading systems
  RF-identification systems
  Power supplies
  Connection technology

- Control systems
  Control systems for mobile vehicles
  Connection technology

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