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Optical Force Sensors

– Introduction To The Technology

White Paper

January 2015

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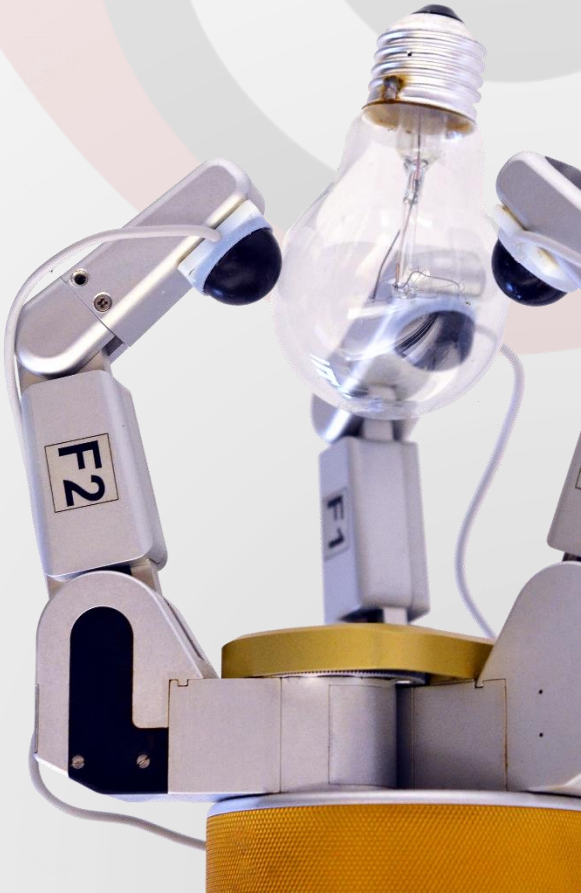
Optical force sensing

Force sensing in essence is measuring deformation and deducting the applied load. **Strain gauge** technology has been the most prominent on the market since it's inception in 1938. The principles hasn't changed much since that and so the main **limitations, such as brittle structure, expensive manufacturing and heavy weight** has been constraining wide-spread application.

Optical, silicone based force sensors, first commercially available from OptoForce promise to open up new possibilities in automation.



In this White Paper you will learn about

- The principles
- Silicones – compliance, abrasion, hysteresis
- Shapes and sensing surfaces
- Measurement ranges and overload
- Non-linearity and cross-talk
- Applications

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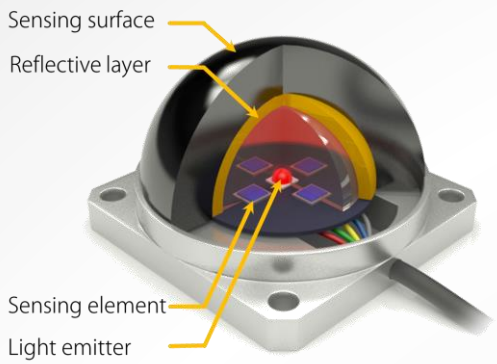
3-axis force sensing



Unlike in other technologies, OptoForce sensors have only one structure for measuring deformation along the 3-axes (X, Y, Z).

In optical force sensors photodiodes are measuring the amount of reflected light, originally emitted by the LED. By comparing the measured values on the photodiodes, the acting forces can be precisely reconstructed – and not just the magnitude, but also the direction.

6-axis force/torque sensing

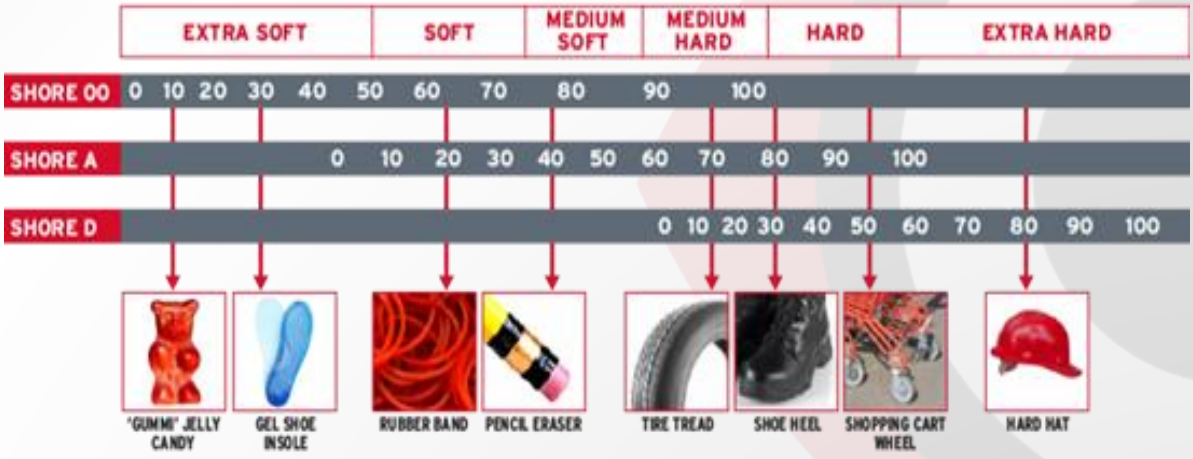
6-axis sensors can not only measure the lateral forces, but also the **torques** around the X, Y and Z vectors.

An array of 3-axis sensors can be used to construct a 6-axis force/torque sensor as well.

Silicones

Compliance

When people hear the word “silicone”, many people imagine a gel like material and so they get worried about the negative effects of compliance on positioning precision. In reality, some of the silicones are as hard as a hard hat. In OptoForce sensors, the smallest deflection we measure is around a few hundred nanometers, while the maximum deformation of the sensors are between 1-3mm.



Abrasion

Our standard materials have a Shore A hardness between 50 to 87. So they are as abrasion resistant as a shoe heel – but we also supply our sensors with metal plates so that it can be increased.

Temperature and aging

Our optical grade silicones can withstand temperatures between -40°C - +200°C. Due to the high quality material properties, these silicones don’t suffer from the regular aging effects that can be seen on plastic and rubber parts.

Hysteresis, deformation

Compression set values were the most important, when we selected our new additional type silicones, so that hysteresis and plastic deformation became negligible.

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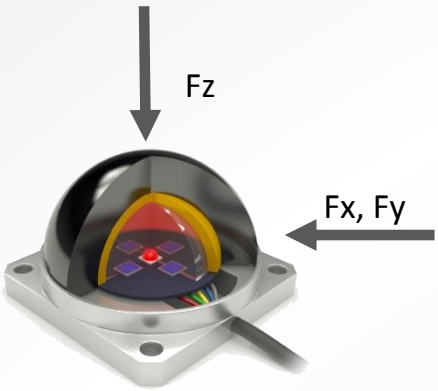
Measurement ranges and overload



The nominal capacities of our sensors range from 10N to a few thousand newtons.

When you are compressing the sensors in Fz, the silicone is protecting the sensors – our sensors are almost indestructible.

In Fx, Fy the silicone is being sheared off the base, so here the overload is limited to 200% - which is still more than what an average strain gauge sensor offers.
In all cases, building a mechanical hard stop is cheap and easy.

Shapes and sensing surfaces

While the internal structure is always hemispherical, the outside can be customized.

An important feature of OptoForce sensors is that they are sensitive on their entire surface.

In one example, we even programmed 4 individual buttons and a 3D joystick on one single sensor – see in red on the left.

Non-linearity and crosstalk

Non-linearity

Non-linearity is defined as the maximum error from an ideal linear output on the total measurement range. Non-linearity values of OptoForce sensors range from 1% - 5% depending on the model – upon request integrated software compensation in the DAQ can improve it to 0.1% - 1.5%.

Crosstalk

Crosstalk is measuring how measurements along one axis create an error along other axes. Our cross-talk values are normally below 1-3% and depend on the shape and material. With integrated software compensation in the DAQ it can be improved to be below 1%.

Typical applications

Typical applications include:

- Grinding, polishing, finishing with force control
- Robotic assembly
- Guiding and teach-in of robots
- Collaborative robots
- Safety features: collision detection from various angles

Any further question?

If you have any question left, our trained product specialists will be glad to answer them.

Please send us an e-mail to info@optoforce.com or visit our website at http://www.optoforce.com!