**A surface encoder for MDOF position measurement**

### Principle for 2DOF position measurement

Surface profile of the angle grid:

\[
b(x,y) = -A_x \cos \left( 2\pi \frac{x}{P_x} \right) - A_y \cos \left( 2\pi \frac{y}{P_y} \right)
\]

Output of the angle sensor:

\[
f(x) = \frac{\partial h}{\partial x} = 2\pi A_x \sin \left( 2\pi \frac{x}{P_x} \right),
\]

\[
g(y) = \frac{\partial h}{\partial y} = 2\pi A_y \sin \left( 2\pi \frac{y}{P_y} \right).
\]

### 3DOF measurement by two sensors

**Principle**

Detection of XY position from one sensor

Detection of \( \theta_z \) from difference of two sensors

**Instrument**

**Experiment**

### 5DOF measurement by a scanning sensor

**Principle**

Scanning a laser beam over the angle grid surface

\( \rightarrow \) Sinusoidal output from the sensor

**Instrument**

**Experiment**

**XY-position**

From the phase of output

- \( \theta_x, \theta_y \)
- From the offset of output

- \( \theta_z \)
  - From the number of sine waves.