

Technology Opportunity, Ref. No. UA-19/269

ASTRAS Angular Sensor for TRacking System

ASTRAS is an ultra-miniaturized optical angular sensor delivering absolute, high-resolution angle measurements in spaces where conventional encoders cannot fit. Operating independently of external optical tracking systems with their required line-of-sight, while avoiding the EMI-induced performance degradation typical of magnetic encoders, ASTRAS enables highly precise motion tracking in the tightest robotic and mechatronic environments.

Keywords	Miniaturized rotary encoder, Angular position sensing, Absolute angle measurement, Optical sensor, Surgical robotics, Endoscope tracking, High-precision motion tracking
Inventors	Prof. Philippe C Cattin, Dr. Lorenzo lafolla, and Dr. Lilian Witthauer, Department of Biomedical Engineering, University of Basel
Reference	M. Filipozzi et.al., 2024 IEEE SENSORS, pages 1–4. IEEE, 2024.
Background	Precise tracking of joint angles is critical in applications such as minimally invasive surgical robotics, where the tool tip position directly determines safety and effectiveness. Existing tracking solutions suffer from major limitations: optical systems require an unobstructed line of sight, magnetic sensors are disturbed by nearby metals and electronics, and fluoroscopy exposes patients to harmful radiation. Conventional rotary encoders additionally lose accuracy when miniaturized and often require bulky encoded disks or magnets. These constraints make accurate angle sensing in ultra-compact, articulated systems extremely challenging. ASTRAS was developed to overcome these limitations by enabling precise angular measurements in very small form-factor and without requiring external tracking infrastructure.
Invention	ASTRAS is a miniaturized optical angular sensor inspired by the operating principle of sun sensors. An LED illuminates a small mirror attached to the rotating element. The reflected light passes through a slit in a shadow mask and is captured by a lens-free CMOS image sensor. The resulting light pattern shifts proportionally with the mirror's rotation, allowing the angle to be calculated with high precision. Unlike conventional encoders, ASTRAS maintains excellent performance when scaled down and requires only a flat reflective surface, no magnets or encoded disks. In a 2 x 1.5 x 1 mm prototype, ASTRAS delivers absolute angle measurement with up to 16-bit (noise-free) resolution, ready for integration into miniature joints or shafts.
Fields of Use	Medical and surgical robotics, articulated endoscopes, miniature robotic joints, precision mechatronics, industrial micro-automation, and compact absolute position sensing.
Patent Status	Granted US and EP patents (US 10914578 B2, EP 3555560 B1)
Contact	<i>Unitecra, Technology Transfer University Basel, Dr. W. Henggeler, Steinengraben 5, CH-4001 Basel, +41 61 267 30 14, mail@unitecra.ch</i>