# Fiber Optic Distal Sensor Controlled Surgical Blade

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## Technology description

INVENTION NOVELTY
We describe a micro-surgical blade integrated with a common–path swept source optical coherence tomography (CP-SSOCT) based fiber distal sensor for high-precision cutting control. The blade is connected to a linear motion motor that can accurately and precisely control up and down cutting motion with accuracy on the order of 10 μm during freehand use. In our study, the cutting motion was controlled by a CP-SSOCT sensor driven PZT motor with a step resolution of <5 μm, that concurrently reduces the hand tremor transmitted to the tip of the instrument by the surgeon. The present embodiment uses a closed-loop proportional-integral-derivative (PID) control algorithm based on graphics processing unit (GPU) processing and an analysis rate of up to 500 Hz.
VALUE PROPOSITION
Motion-compensated high-precision surgical blade using a fiber optic distal sensor to monitor, in real time, the relative position between the blade tip and the tissue surface. The linear motion motor controls the blade tip position based on the OCT sensor input to then rapidly compensate for unwanted tissue and hand motions providing precise control of the blade cutting depth and motion. The sensor-servo loop in the present system is capable of 500 Hz monitoring and blade position adjustments. Future embodiments may be capable of more rapid processing and instrument response.
TECHNICAL DETAILS
The invention explores a matrix factorization technique suitable for large datasets that captures additional structure in the factors by using a projective tensor norm, which includes classical image regularizes such as total variation and the nuclear norm as particular cases. Although the resulting optimization problem is not convex, the invention shows any local minimizer for the factors yields a global minimizer for the product.

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