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Measurements and Modeling of Compliance Using Novel Multi-Sensor Endoscopic Grasper

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In this study, we report on the development of a new multi-sensor endoscopic grasper which is capable of measuring the sensed object's compliance and has potential applications in minimally invasive surgeries. The designed prototype has 8 cylindrical friction-enhancing projections which are supported by Plexiglas bases. The tactile sensor consists of two elements, a rigid central part and a peripheral annular-shaped compliant cylinder. Two separately located polyvinylidene fluoride (PVDF) films in the form of a circle and a ring constitute the part of the sensor that measures the applied forces. Upon contact with an object, the rigid cylinder and the compliant cylinder convey different forces to the underlying PVDF films. The relative contributions of these forces lead to the measurement of the sensed object's compliance. On the basis of the experimental data, we clarified that as the compliance of the sensed object increases, the value of the force contribution for the rigid part of the sensor decreases accordingly. Both experimental work and theoretical analysis have been carried out. The results of three-dimensional finite element modeling correspond well with experimental findings.

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