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Twisted string actuation - history, principle and performance

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String is one of mankind's oldest and most utilitarian forms of material. Several examples from ancient times demonstrate the use of twisted strings for purposes of bearing high forces and transmitting power. Practically every child in modern society is familiar with the principle in the form of one toy or another. Over the past three or four decades, numerous scientists have rediscovered the principle of twisted string actuation and recognised its potential in robotics. It seems as if the principle of twisted string actuation were predestined for use in tendon actuation of robotic hands. A mathematical analysis of twisted strands shows why this principle is so valuable: extremely high tensile forces can be exerted by means of twisting a bundle of strands with a very low torque. This means that a strong and effective linear actuator can be realised utilising a compact, efficient electric motor.

Some constructions will be shown which demonstrate the strength of actuation using the twisted string concept. The behaviour of twisted string actuation and its controllability with force feedback are calculated and validated by experiment. The longevity of the string will be shown in dependence of the mechanical load. Finally, an outlook will be given for implementing the twisted string actuation system in the UB Hand IV, which is under development within the DEXMART project.

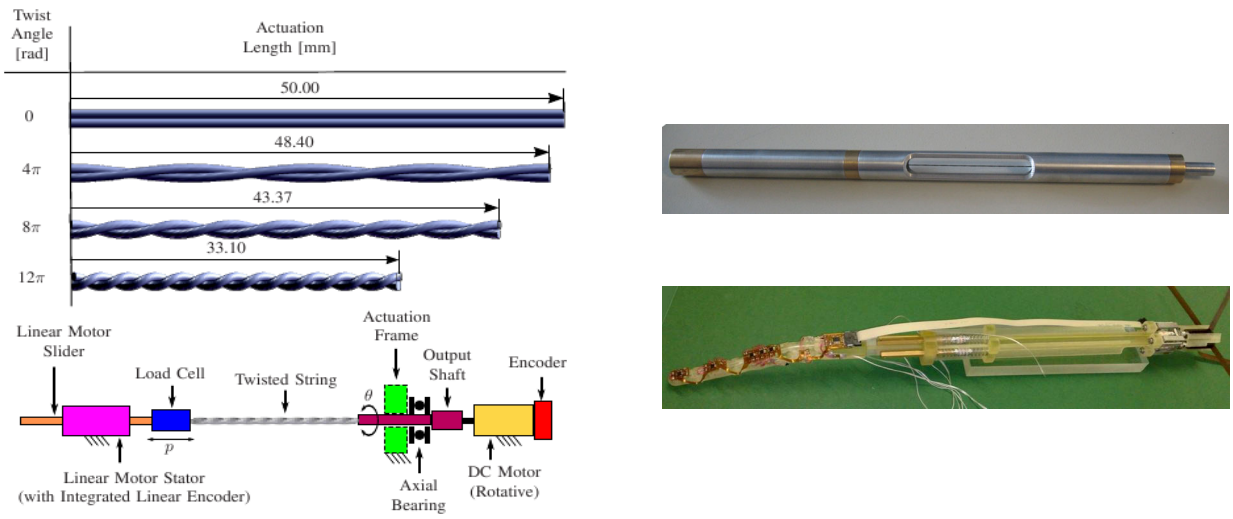

Figure - Twisted string actuation: a) operating principle, b) compact actuation module (above) and finger module with 4 twisted string actuators (below).

[1] Würtz, T.; May, C.; Holz, B.; Natale, C.; Palli, G.; Melchiorri, C.: The twisted string actuation system: modeling and control. In: Proc. 2010 IEEE/ASME Int'l Conf on Advanced Intelligent Mechatronics (Montreal, Canada, 6-9 July 2010), pp. 1215-1220, ISBN 978-1-4244-8030-2