Sensitive Active Surfaces (SASs) on the Velvet II Dexterous Gripper

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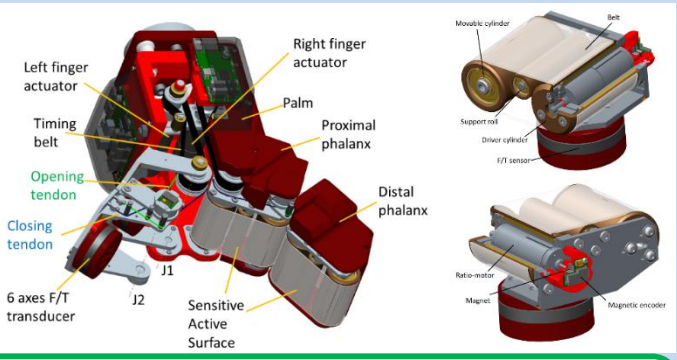
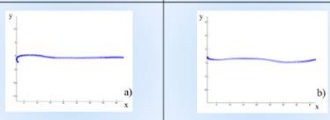
In this work we discuss the implementation of Sensitive Active Surfaces (SASs) on the phalanges of a gripper (Velvet-II). The SASs comprise an intrinsic F/T sensor mounted between the frame of the phalanges and a controlled conveyor belt. The SASs form the interface between the gripper and the grasped object. We implemented and tested an algorithm to detect the **contact point location** and a **variable friction** control algorithm. In a preliminary set of experiments we utilized the SAS to investigate the contact forces occurring in incipient **slippage conditions.**



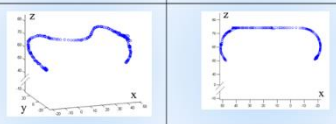
Contact point location [1]

Capability to track the trajectory of the CP. The greeting HI was written off-line on the upper plane of the belt with the aid of a ruler. Later the text was followed manually with a sharped object.

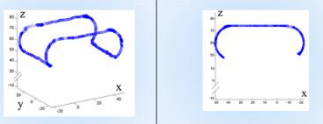
Trajectory estimation with belt still or moving. A straight line was traced on the upper plane with a guide over the belt. On the left the motor is off, on the right the line was traced as the belt moves.



Random trajectory. A random and continuous trajectory was tracked with a sharped object over the belt, from the left cylinder to the right cylinder through the upper plane, and traced by the algorithm.



Perimeter of the SAS. The perimeter of the SAS potentially involved in a contact with objects, was followed with a pen and traced by the contact point algorithm.



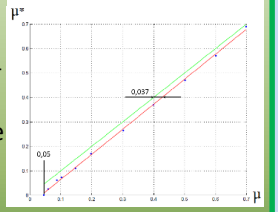
Variable friction [2]

V → voltage to the motor which corresponds to a resistant force limited by an adjustable friction force.

V* → compensation of the internal friction by putting the conveyor belt system in incipient movement. By applying V*, even a little tangential external force moves the system in retrograde motion.

$V_H(\mu^*)$ → voltage which corresponds to a force limited by $\mu^* F_N$. In the graph the desired friction coefficient μ* is compared to the actual friction coefficient μ (red line). The horizontal offset is due to the difficulty of compensating internal friction precisely.

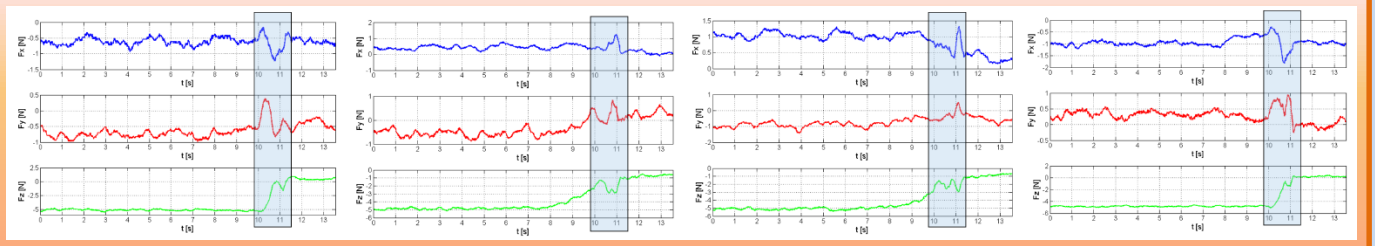
$$V = V^* - V_H(\mu^*)$$



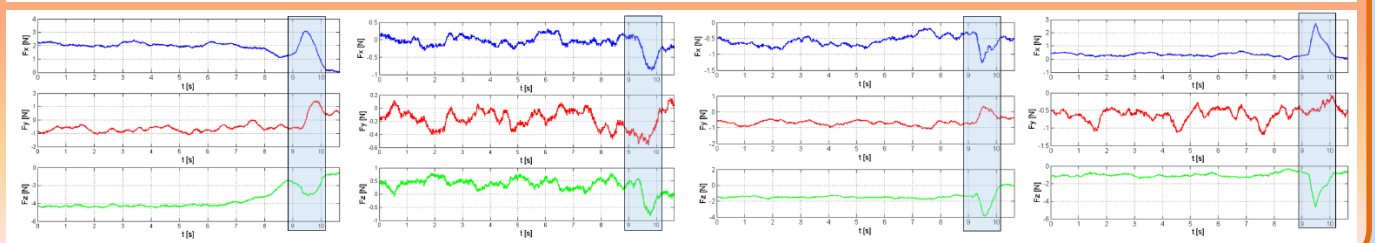
Low friction experiment: μ*=0,05

Slippage detection: the experiments have been conducted in power grasp configurations by slowly decreasing the internal grasp force until the grasped object slipped. Dropping the object is predated by a rapid redistribution of the components of the total grasping forces on each phalanx of the gripper, highlighted in the graphs with rectangles.

Hammer



Battery



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[1] Bicchi, Antonio, J. Kenneth Salisbury, and David L. Brock. "Contact sensing from force measurements." The International Journal of Robotics Research 12.3 (1993): 249-262.
[2] Hayward, Vincent, and Brian Armstrong. "A new computational model of friction applied to haptic rendering. Experimental Robotics VI. Springer London, 2000. 403-412.