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A new softness display based on bi-elastic fabric

M. Bianchi, A. Serio, E. P. Scilingo, A. Bicchi

Haptic perception allows to explore and recognize an object by conveying several physical information to mechano-receptors and thermo-receptors lying into our skin throughout the body. The term ”haptic” is usually referred to eliciting both kinaesthetic and cutaneous channels.

EQUIPMENT DESCRIPTION

The ***F.Y.D.*** (**F**abric **Y**ielding **D**isplay) is a new display which conveys to subjects both cutaneous and kinaesthetic information. It is based on a layer of bi-elastic fabric which can be touched by subjects with their forefinger. The fabric elasticity is changed according to the desired softness to be felt by subjects.
The system is composed of:

- A hollow plastic cylinder containing a DC motor, controlled using a Sabertooth Syren 10 dual motor driver (bidirectional movement);
- A thin layer of bi-elastic rectangular shaped fabric (Superbiflex HN by Mectex),which is placed on the top of the hollow cylinder and it is tied to a circular crown which can run outside along the cylinder.
- A screw, which is jointly connected to the axis of the motor while a female screw is attached to the crown by means of four supports.
- The rotational movement of the motor is converted by the female screw into a translational movement of the crown.
- The position of the crown can be acquired (National DAQ system PCI6036E) by an external potentiometer, and, consequently, set the input voltage for the motor in order to reach the desired position, i.e. the desired stretching of the fabric.

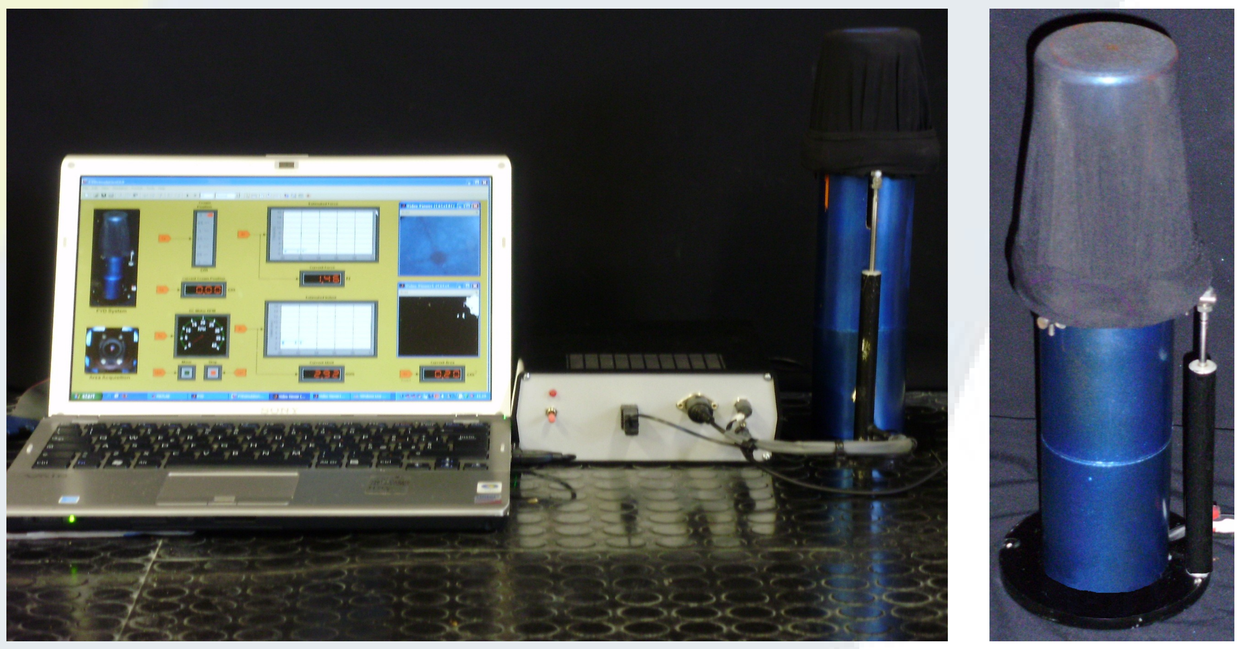

Figure 1: Complete equipment (on the left side) and a particular of F.Y.D. (on the right side).

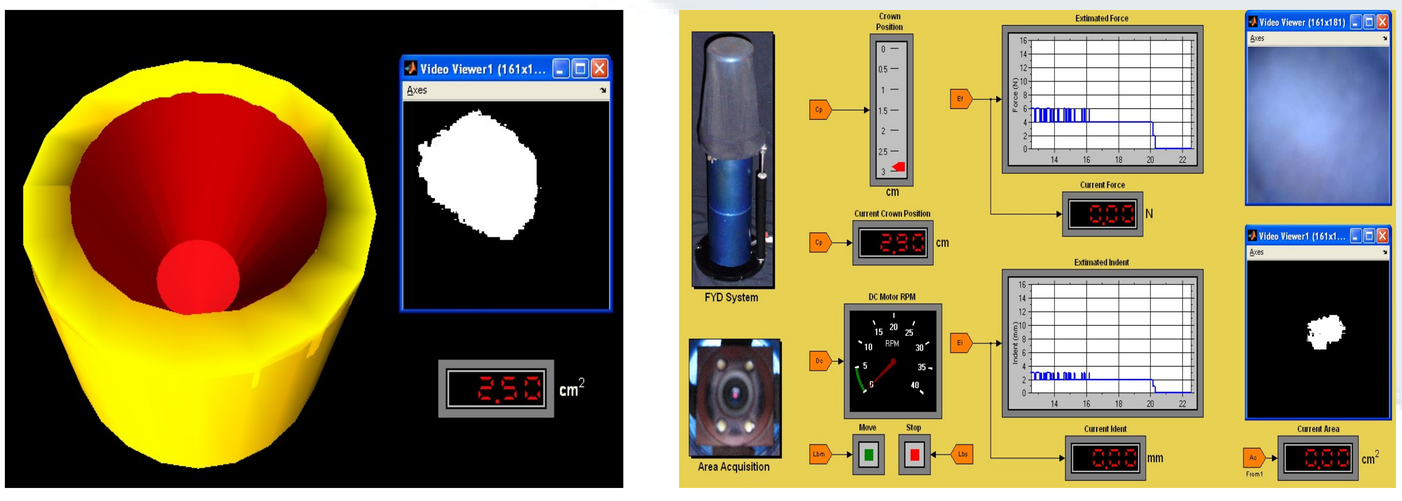

Figure 2: Virtual reality G.U.I. (on the left side) and Simulation G.U.I. with real time area acquisition (on the right side).

AREA ACQUISITION: GRAPHICAL USER INTERFACE AND VIRTUAL REALITY

- A 3 Megapixel camera endowed with leds is mounted inside the cylinder, just beneath the fabric.

During the tactual indentation, the fabric is strained and the fabric area which comes into contact with the finger changes according to the level of stretching and the applied force.
The camera allows to acquire the image of the strained fabric and by means of suitable processing algorithms, the contact area can be estimated (real-time measurement).
A graphical user interface was created, to control the F.Y.D. system.
A virtual reality system enables the user to see the object on the pc screen, during the indentation.

CHARACTERIZATION

The system was characterized in terms of force-displacement and force-area provided by the fabric under different levels of stretching (i.e. position of the crown: range 0 - 30 mm, step of 3 mm). Starting from these results, it is possible to interpolate the position of the crown which allows to render a fixed value of stiffness.

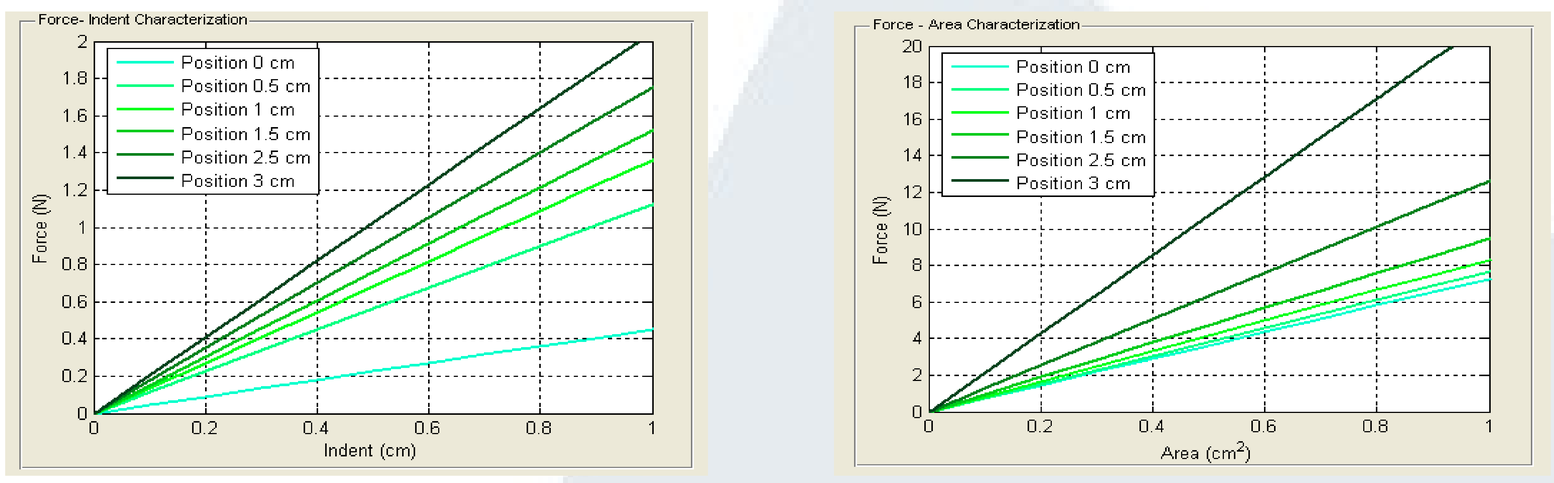

Figure 3: Force – Indentation characterization (on the left side) and Force – Area characterization (on the right side).

RESULTS

- A more realistic way of rendering softness;
- No edge effects;
- A real-time measurement of the contact area spread.

FUTURE WORK

- A direct real-time measurement of the forces and of the indentations;
- A statistically significant number of tests, to compare the tactual discrimination
- using F.Y.D. with the results obtained with other tactile display (C.A.S.R.).

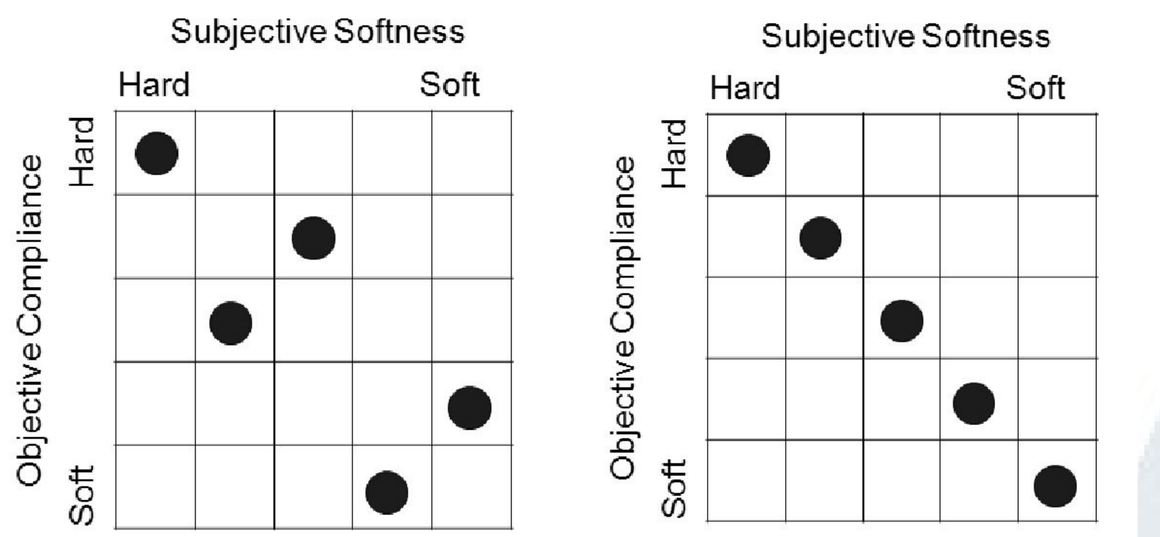

Figure 3: Confusion matrix for the C.A.S.R. display (on the left side) and for the F.Y.D. (on the right side).

Centro E. Piaggio
bioengineering and robotics research center

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