Integration of artificial tactile skin on the humanoid robot iCub

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ABSTRACT

In this paper, we describe the artificial skin of the humanoid robot iCub. It gives pressure measurement and surface information about the contact surface between the robot and the environment

General Terms

Measurement, Design.

Keywords

Pressure sensors, Tactile sensor, HRI.

1. INTRODUCTION

Humans use the tactile and kinesthetic systems to obtain information about their interaction with the world [1]. First impact contact, surface conformation, roughness and position are some examples of physical parameters. In the last years the challenge for researchers is the development humanoid robots with the ability of interacting with the external world, this leads to the development of reliable and stable tactile sensors able to provide similar information of human tactile and kinesthetic system.

The use of flexible sensors placed on robotic parts capable of measuring variable contact forces and pressures therefore becomes important both in research humanoids robots and real world applications for safety HRI (human-robot interaction) in industrial environment.

In literature are already presents survey on the state of the art of tactile systems [2] and current technologies available for humanoid robot [3]. Therefore, example of robotic system oriented to object grasping and manipulation are present in [4-17]

2. Tactile Sensors

The system consists of a networked structure of conformable mesh of sensors having triangular shape and interconnected each other. A flexible substrate allows to the sensor to conform to smooth curved surface, implementing 12 capacitive transducers. Three communications ports placed along the sides of the sensor (one for the input from an adjacent sensor, and the others as outputs toward adjacent sensors) allow interconnecting up to 16 sensors. The measurements are sent, using 4 serial bus communication links, to a microcontroller based module which send the tactile data to a host using a CAN bus. A schematic view of the system architecture is shown in Figure 1; up to 16 sensors can be networked and communicate with a microcontroller board, for a total of 192 taxels.

Capacitive sensors have been developed by the use of a capacitance to digital converter integrated circuits commonly used for touch screen applications [18]. These sensors detects the capacitance variation due by human fingertip (or other conductive materials) interaction with a copper plate. In this implementation, dielectric foam (Soma Foama by smoot-on) is covered with a conductive lycra, in order to make the sensor able to detect also non-conductive materials, a conformable ground plane has been introduced. In particular, capacitance variation is obtained when the ground plane moves nearby the taxel plate due by an external pressure.

This implementation makes the sensor able to conform to generic object shapes; therefore the material used for the ground plane and increases sensor robustness. Another important aspect about the use of the ground plane is the reduction of

3. Sensor Integration on iCub

Actually, the following parts of the humanoid robot iCub are covered with artificial skin: forearm, upper arm, torso, palm and fingertips. This makes the humanoid robot iCub able to detect impact in a very large area of its body furthermore it is able to grasp object

In particular, for large area parts (forearm, upper arm, torso and palm) the triangular modules described in [18] have been used, whereas for the fingertip a dedicated PCB has been used in order to fit it with the small area of the robot part [16].

Covers of forearm and upper arms of iCub are shown in Figure 2. Triangular PBCs are glued on the parts (made in ABS material) after that the Soma Foama is applied on the top of the PCB by polymerization inside a dedicated mold for each part. Therefore the conductive lycra has been placed on the top of the soft dielectric material and glued on the side of the plastic support. The stretch due by the gluing of the lycra on the side of the plastic support increase the elastic response of the ground plane, then improve performances of the sensor in terms of time response.

For fingertips (see Figure 3) the development steps are similar to the other parts but the addition of a succeeding step is requested. In particular the polymerization of a layer of Soma Foama up to the conductive lycra is necessary in order to increase the robustness of the fingertip and reduce possible perturbations of CDC output due by conductive object exploration tasks.

Figure 4 shows the humanoid robot iCub fully covered with artificial skin.

4. CONCLUSION

The tactile system of the humanoid robot iCub has been presented within an overview on tactile sensor operation principle and the integration process on the iCub parts. The sensor network is able to provide a tactile image of the robot body while interact with the environment.

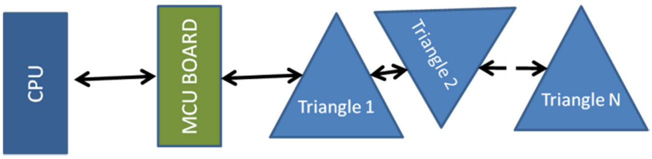

Figure 1 schematic of the system architecture.

Figure 2 demounted cover of the upper arms and forearms implementing the artificial tactile skin of the humanoid robot iCub.

Figure 3 demounted fingertips used by the humanoid robot iCub during grasping tasks.

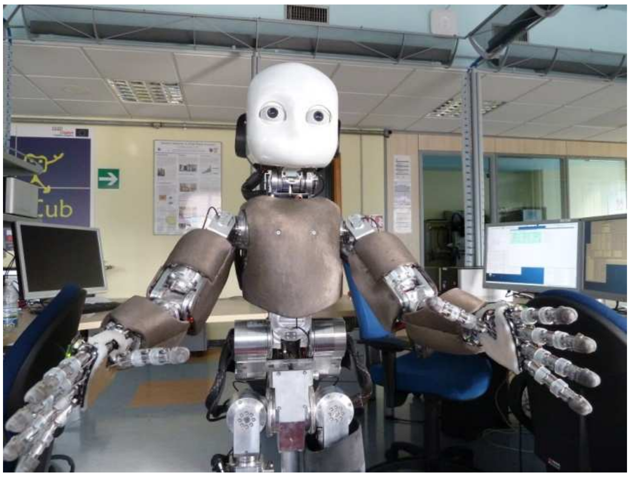

Figure 4 Humanoid robot iCub covered with artificial skin able to detect conductive and non-conductive materials (arms, torso, palms and fingertip)

5. ACKNOWLEDGMENTS

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