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Intelligent Architecture for Tactile Sensor

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In this paper, we emphasize the role of intelligence in realizing fingertip tactile sensors like those of humans. First, we describe how the human fingertip perceives very fine surface motion and texture even though its receptors are only sparsely distributed. To realize such a sensing capability, we show that a method based on the following three kinds of intelligent structure is successful: 1) intelligence in tactile media — the use of 3-D transfer property from surface to elastomer, 2) intelligence in a sensing probe geometry — orthogonally arranged vertical sampling probes and variable contact by flexible spherical surface, 3) intelligence in sensing algorithms — temporal to spatial spectral reconstruction from vertical sampling probe signals, and tomographic 2-D slipping velocity reconstruction from the orthogonally arranged sensory probes.

1. Introduction

How can we realize a sophisticated tactile sensor like that of humans? The major approaches to the artificial sensor have been focused on 2-D arrays of pressure sensors or some position-sensitive devices utilizing conductive rubber, piezoelectric effects, capacitive techniques, and optical methods.[1,2] The concept of an intelligent sensor has been generally recognized as an additional feature extraction unit from an enormous amount of acquired data.[3,4] These sensors have been successful mainly in determining object contours; unfortunately it is not as straightforward for them to sense other important tactile features, i.e., fine surface textures, compliance of an object, and dynamics of slip and rolling of a grasped object.[5]

Let us consider the human skin and its structure. As described in the literature,[6,7] two