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Refreshable tactile graphics using a lateral skin deformation device

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Tactile graphics are useful to convey spatial information and concepts to visually impaired persons with maps, mathematical diagrams and other types of illustrations. Unfortunately, tactile graphics are currently produced on physical media, a slow and cumbersome process that results in static material. Tactile graphics also present unique challenges due to the relatively limited resolution of the tactile sense, often requiring a reduction in information density. Refreshable tactile graphics could alleviate these problems by allowing instant access to online illustrations as well as interactive control over features such as the visibility of layers of information.

Research on refreshable tactile graphics has focused on programmable arrays of moving pins that approximate 3D surfaces. For the past decade, we have been investigating an alternative approach based on lateral deformation of the skin. This approach relies on miniature bending motors that pull laterally on the skin, locally stretching or compressing it to stimulate tactile receptors. The latest prototype covers the surface of a typical fingerpad with a matrix of 8 by 8 actuators. Once mounted on a mouse-like planar carrier, the device can alter the tactile sensation felt in response to displacements by controlling the activation of the actuators, thereby creating a large virtual surface out of a small active area. The system can currently be used to draw refreshable tactile graphics with three types of features. The first produces a strong, localized vibration sensation. The second produces a sensation similar to that of brushing against Braille dots. The third produces the sensation of brushing against a grating texture with a programmable roughness and orientation. Recent experiments have shown that these features can be combined to display distinguishable textured shapes.

Recent joint work between McGill University and University of Montréal focuses on the adaptation of schoolbook illustrations for visually impaired children. Experiments were recently conducted to evaluate the effectiveness of the system at conveying the pedagogical content of graphics adapted from a high school history textbook. Participants answered questions based on their interpretation of a world map of the first civilizations, a bar chart of the population of ancient Athens, and an illustration of a cathedral. Results suggest that the system could become a valuable tool for the education of visually impaired children.

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