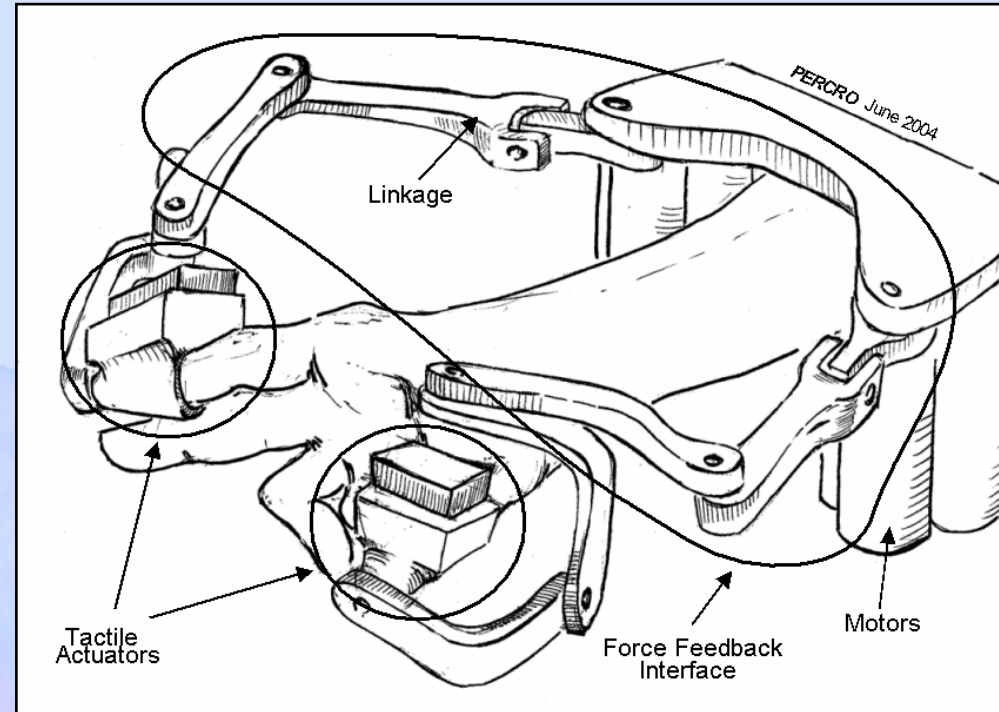
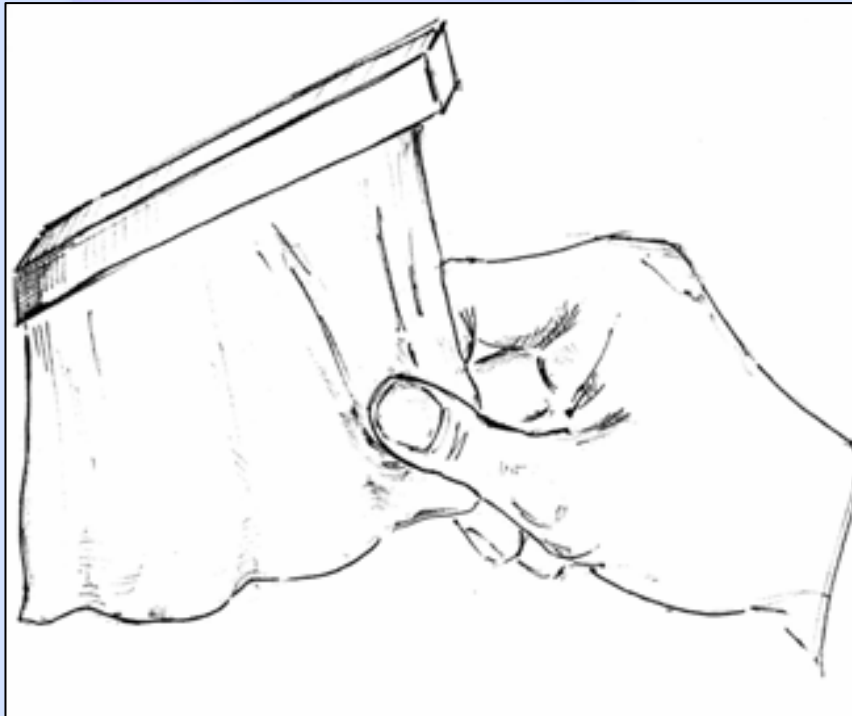


Human Perception and Tactile Discrimination

Dr. Ian Summers
University of Exeter
Exeter, U.K.



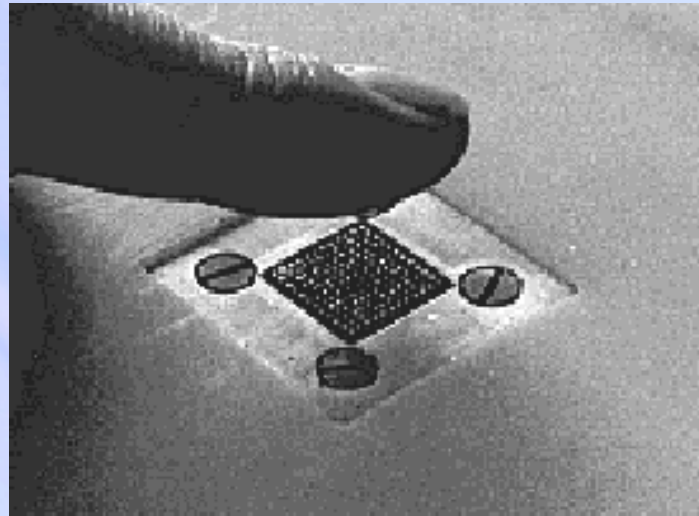
Tactile perception in virtual environments



- ◆ Stimulator arrays on the fingertips can produce touch sensations which are spatially distributed over the skin.
- ◆ This provides information about virtual objects, for example, information about contact area, edges, corners and surface texture.

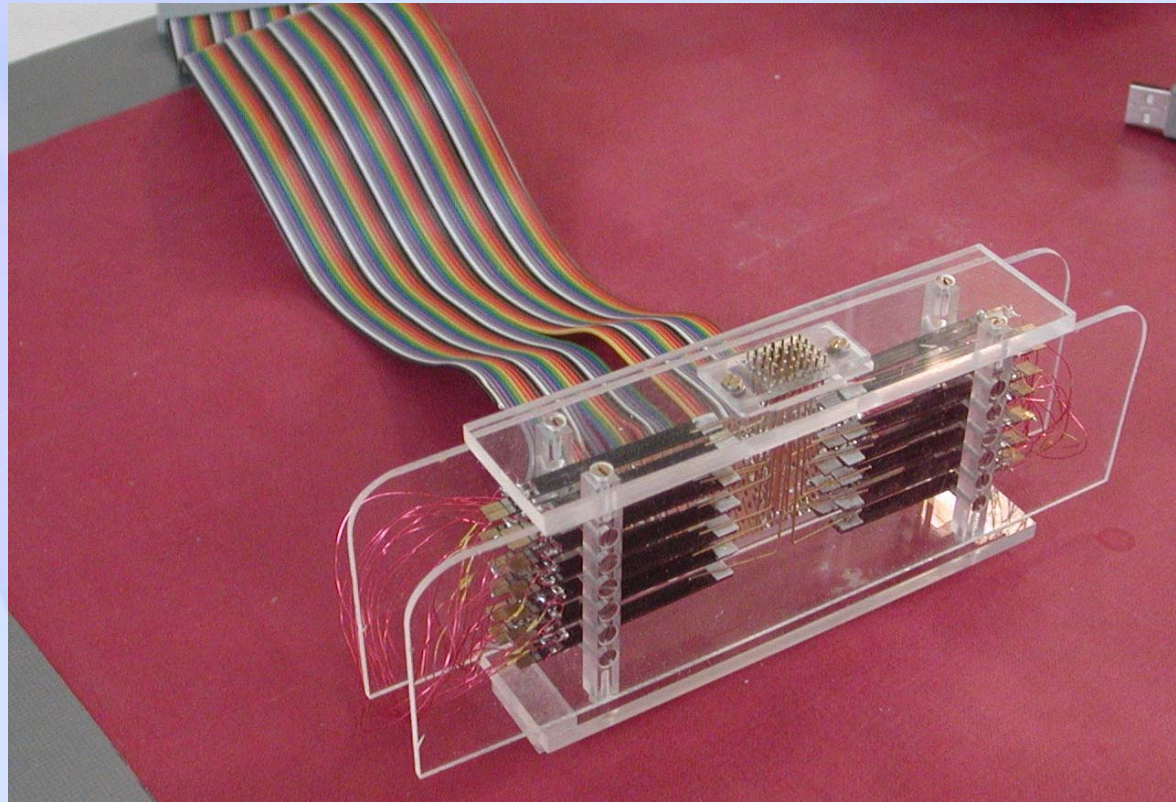
Design of a stimulator array

- ◆ Tactile stimuli are delivered via an array of contactors on the fingertip.

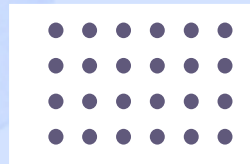


- ◆ A tactile stimulator array does not attempt to reproduce the surface topology.
- ◆ Instead it attempts to reproduce the perceptual consequences of the surface topology, i.e., appropriate excitation patterns over the various populations of touch receptors in the skin.

Stimulators developed in the HAPTEX project

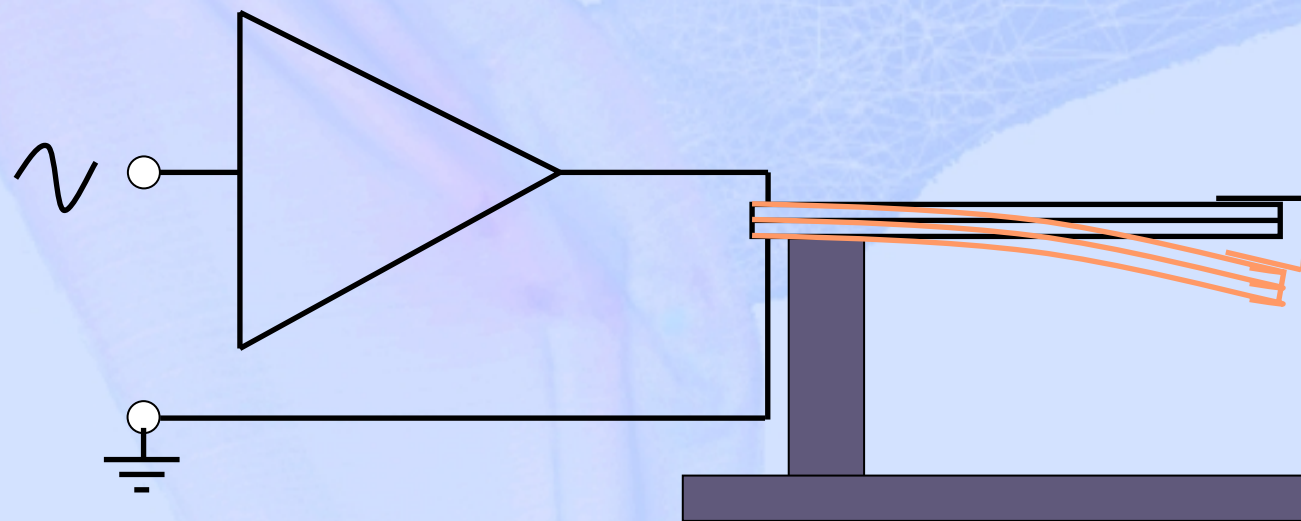


- ◆ 24 contactors distributed over the fingertip
- ◆ 2 mm spacing



Electromechanical drive system

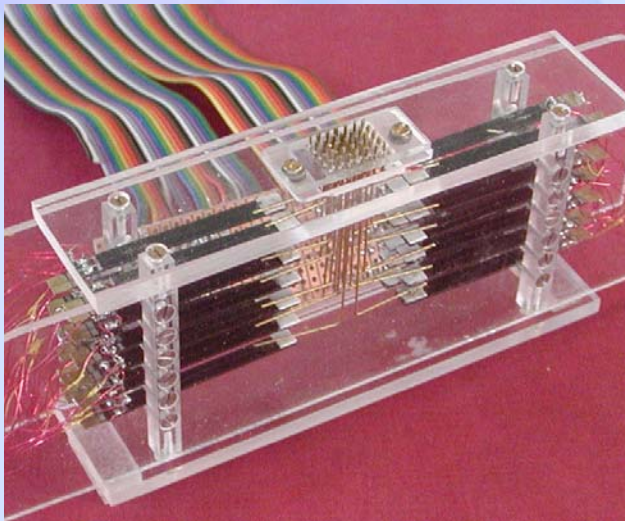
- ◆ based on piezoelectric bimorph actuators
- ◆ drive voltages around 30 V r.m.s.



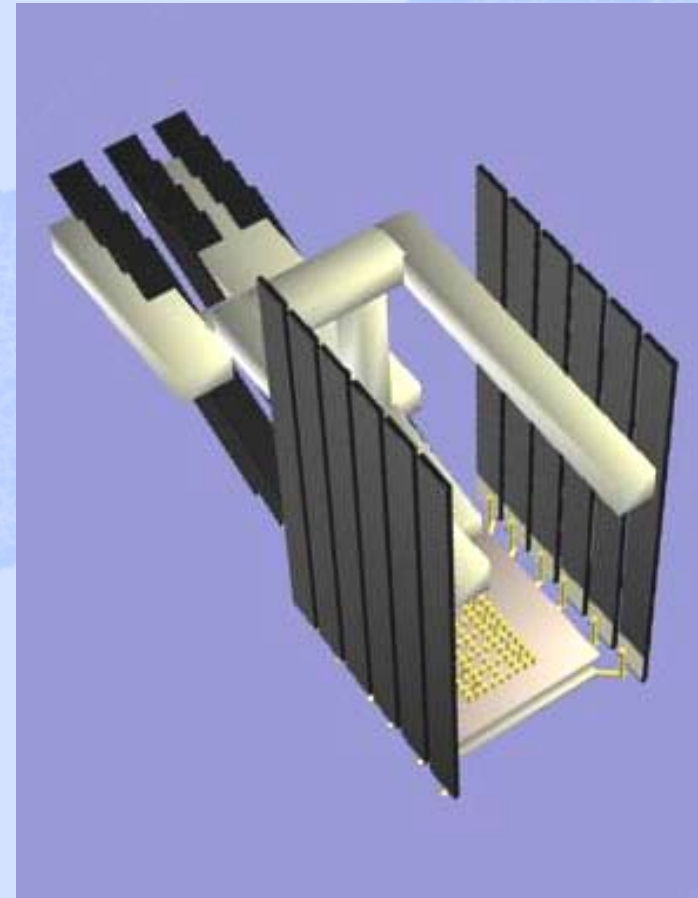
Stimulators developed in the HAPTEX project

The HAPTEX project involves two different tactile stimulators:

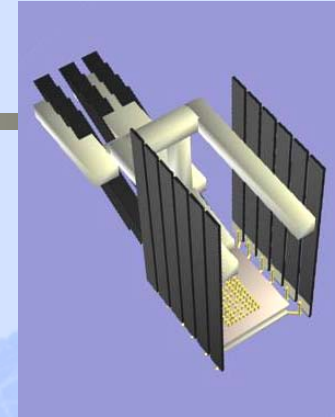
- ◆ Configuration A
with a palmar mechanism



- ◆ Configuration B,
with a dorsal mechanism



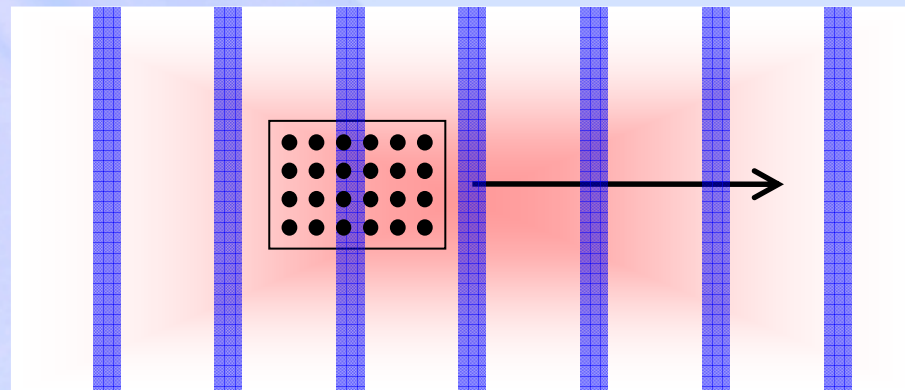
Stimulus design



- ◆ During active exploration it is necessary to generate in real time a drive waveform for each contactor of the stimulator array.
- ◆ To reduce the complexity of the problem, we choose to specify each drive signal as a mixture of sinewaves, within the tactile bandwidth of (say) 25 to 500 Hz.
- ◆ In the simplest implementation, each drive signal is a mixture of two sinewaves only: at 40 Hz and 320 Hz.

Stimulus design

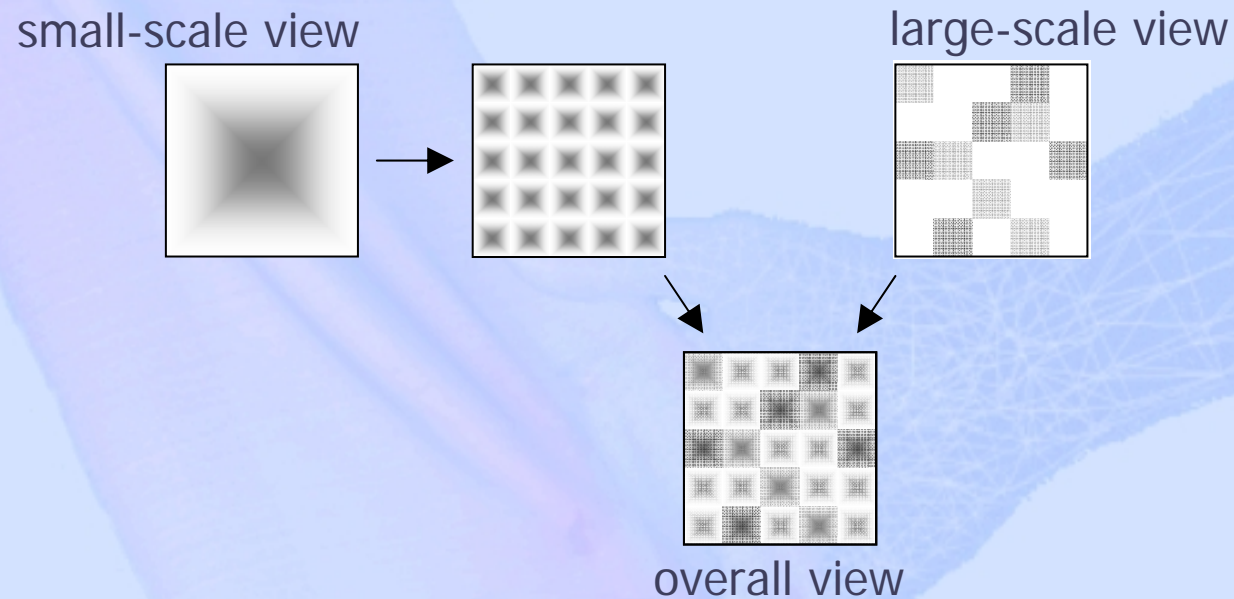
- ◆ Virtual tactile surfaces may be specified in terms of amplitude maps for different stimulus frequencies, for example:



spatial distribution
at 320 Hz
spatial distribution
at 40 Hz

- ◆ These are specified at a spatial resolution of 1 mm.
- ◆ Spatial filtering is used to achieve an effective resolution of 2 mm which matches the the spatial resolution of the stimulator array.

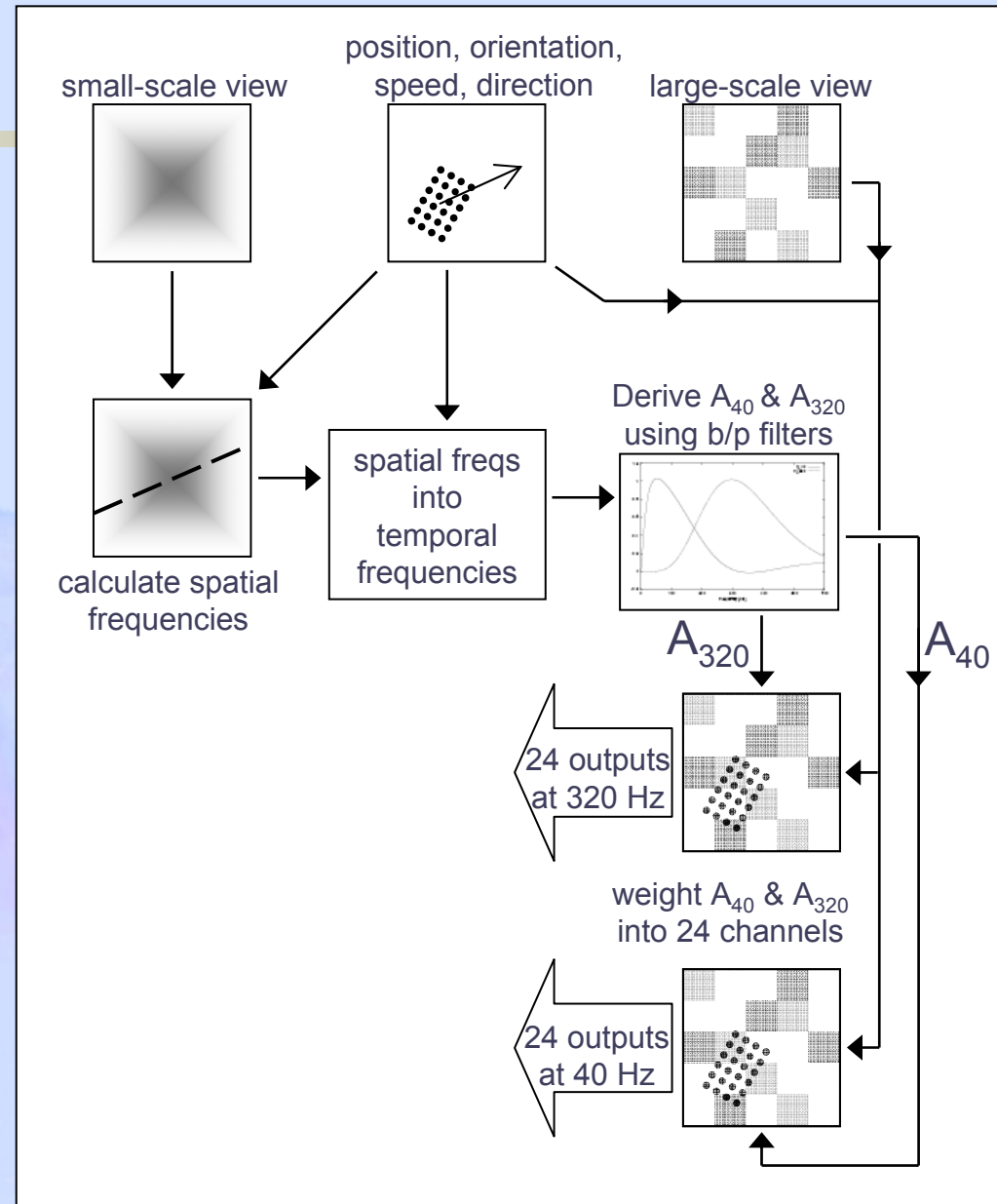
Software model of a textile surface



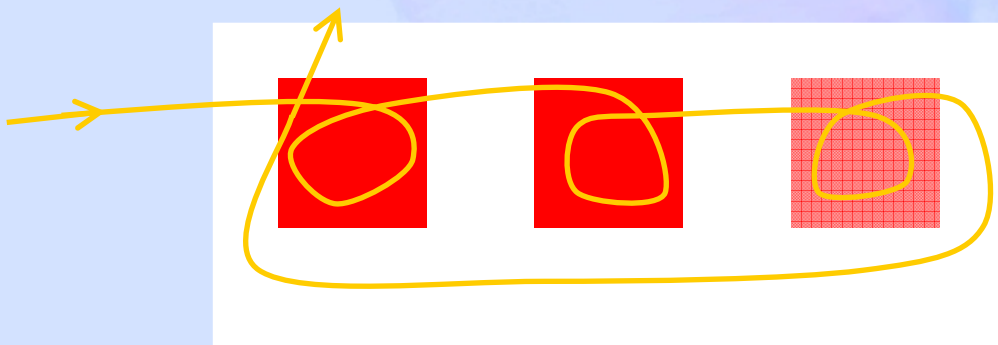
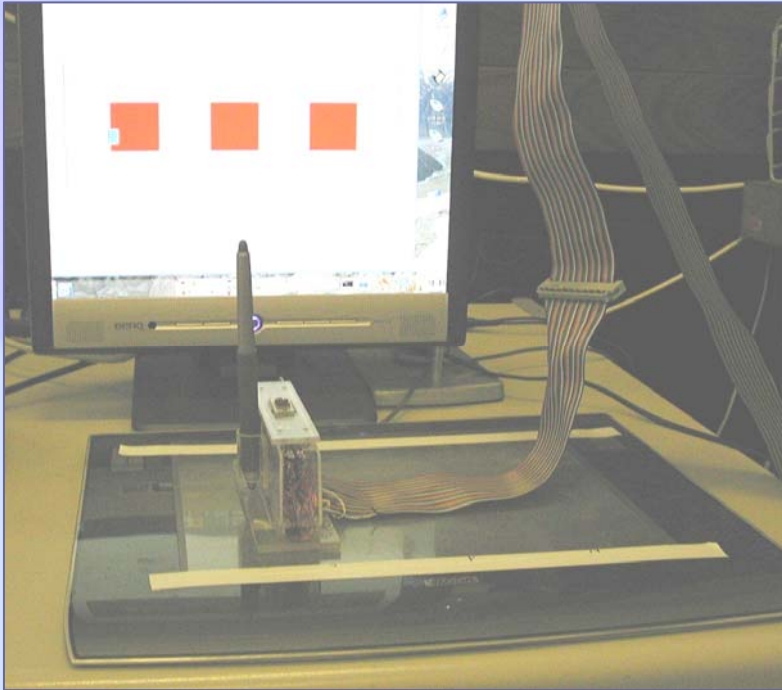
- ◆ Small-scale and large-scale descriptions of the textile surface combine to specify a virtual textile.

A simple tactile rendering scheme

- ◆ Spatial-frequency spectrum from the small-scale view
- ◆ Spatial-frequency mapped into temporal frequency
- ◆ Temporal-frequency spectrum reduced to two amplitudes, A_{40} and A_{320}
- ◆ Amplitudes for 24 channels by weighting according to the large-scale view
- ◆ Input and output data specified in 25 ms timesteps



Evaluation of Configuration-A device

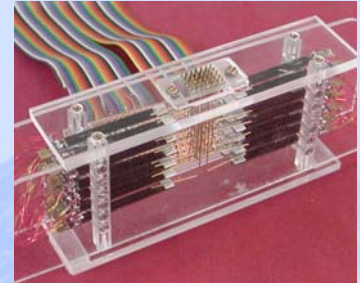


- ◆ Virtual textures in a 2D workspace have been investigated.
- ◆ Discrimination of texture in an odd-one-out-from-three task.
- ◆ Subjects were asked to explore at approximately constant speed – around 10 seconds for a single pass.
- ◆ Similar experiments in *ENACTIVE* NoE

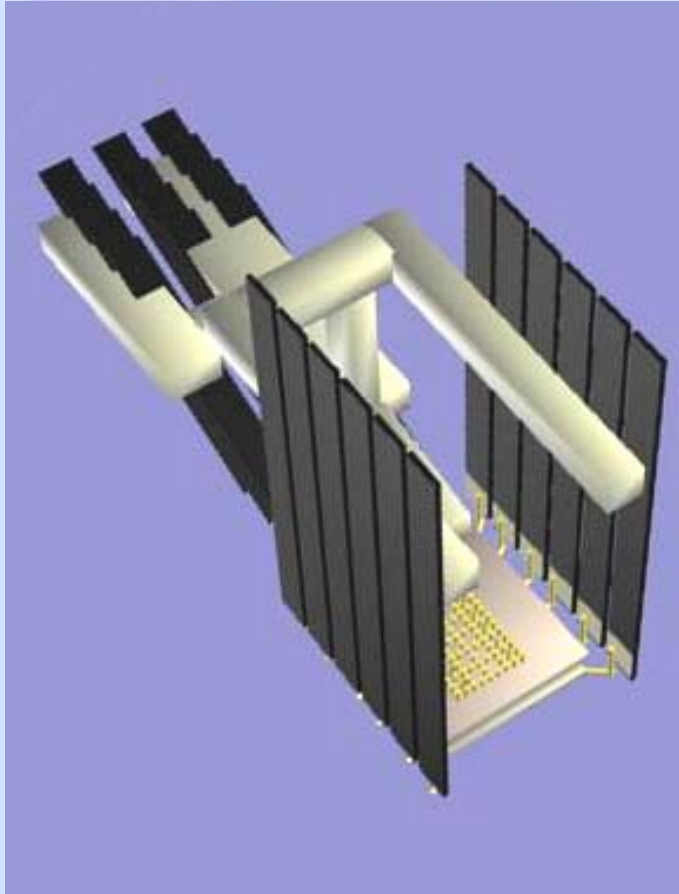
Evaluation of Configuration-A device

Preliminary evaluations of texture perception suggest:

- ◆ mixtures of 40 Hz and 320 Hz produce a two-dimensional perceptual space;
- ◆ a strong interaction between the spatial aspects of the texture and the stimulation frequency;
- ◆ stimuli with no spatial variation appear to lack “realism” – random variation of stimulation amplitude provides a more “natural” sensation.



Future plans



- ◆ The Configuration-B device offers exciting possibilities for providing information about virtual objects, for example, information about contact area, edges, corners and surface texture.


Acknowledgements

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- ◆ the project *HAPTEX - HAPtic sensing of virtual TEXTiles*
- ◆ the *ENACTIVE* Network of Excellence

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End of the presentation

Thank you for your attention