A Novel Multi-modal Tactile Sensor Design using Thermochromic Material

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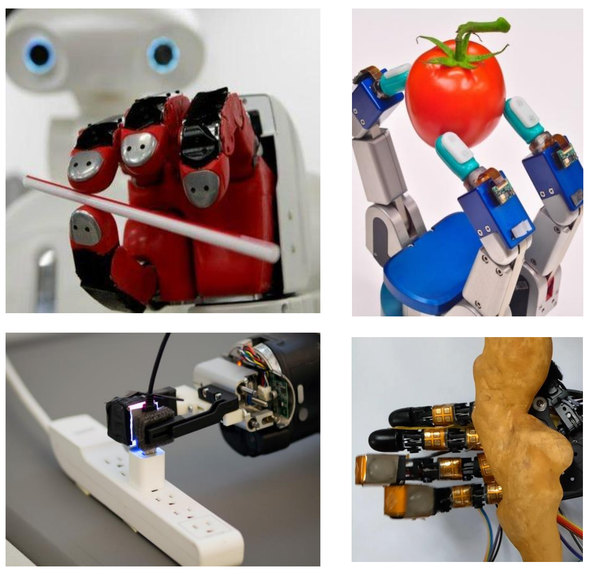
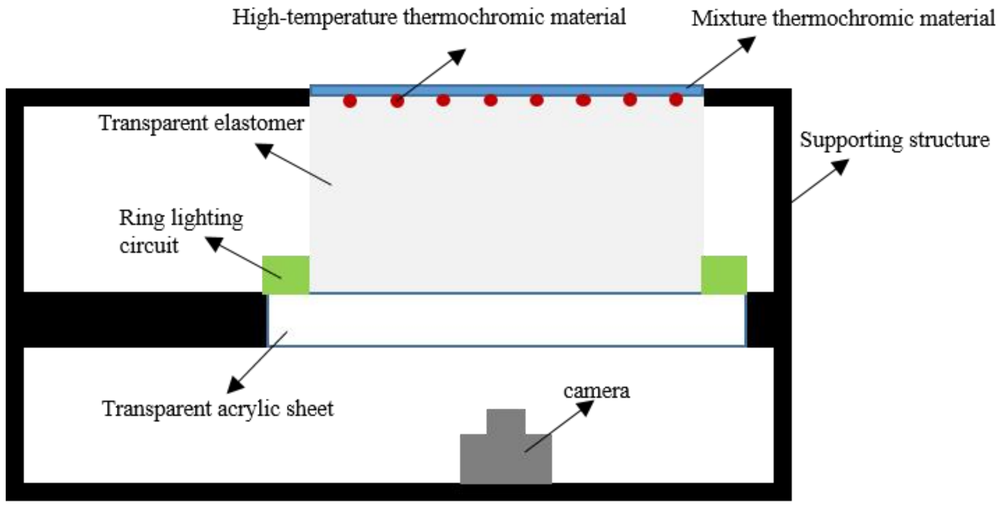
Background

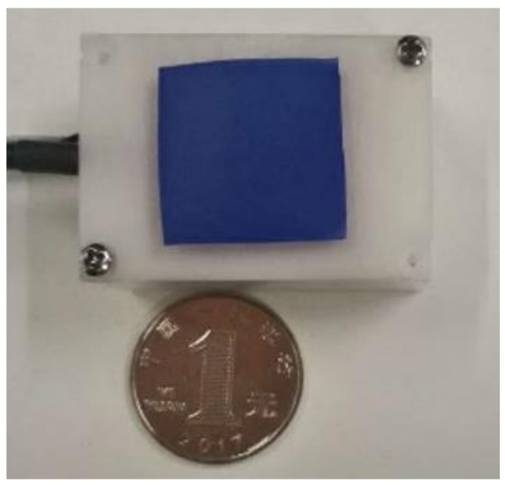


Vision-based tactile sensor commonly measures more tactile information

Design of the proposed tactile sensor



(a)



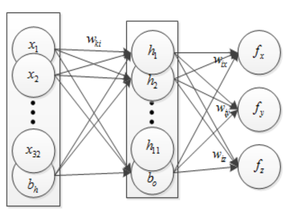
(b)

The proposed vision-based tactile sensor consists of a transparent elastomer, a camera, a piece of transparent acrylic board, LEDs and supporting structures. The thermochromic material was used to construct the markers and the refective membrane. A thermochromic material is a reversible colored material that transforms from dark to colorless in the presence of heat and returns to its original color in a cold environment. This material exhibits superior adaptability, and several thermochromic materials can be mixed according to the individual preferences that are required for sensing multiple temperature intervals.

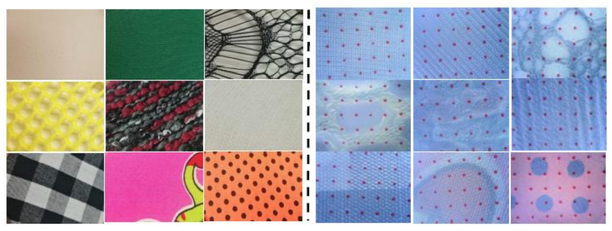
Algorithm

The markers can be detected as we make them white and choose black rubber as background. By preprocessing, binaryzation and eliminating the noise points of the captured image, we can get a binary image that only contain the all markers.

$$\begin{bmatrix} m_{x1} \\ m_{y1} \end{bmatrix} = \begin{bmatrix} h_{xx1} & h_{xy1} & h_{xz1} \\ h_{yx1} & h_{yy1} & h_{yz1} \end{bmatrix} \cdot \begin{bmatrix} f_x \\ f_y \\ f_z \end{bmatrix}$$

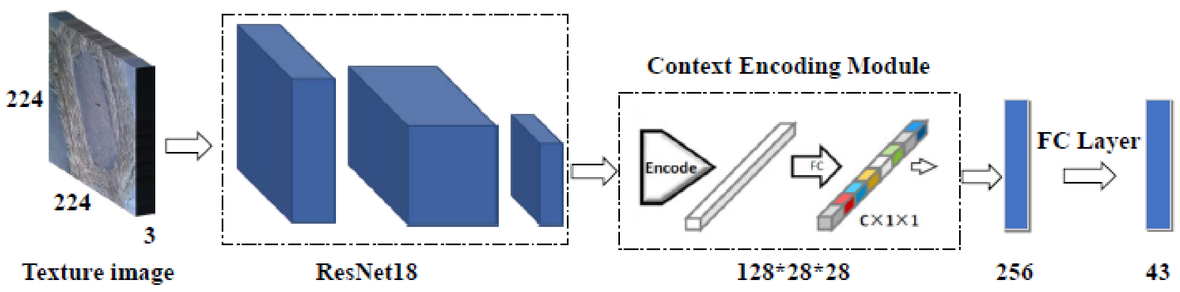


we design the neural network to gain the fitting matrix of H .

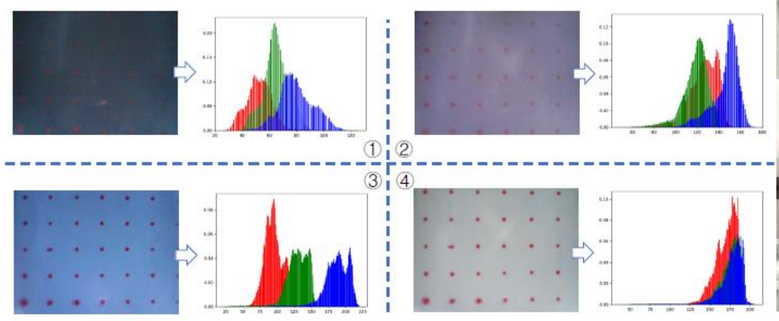


THREE ALGORITHMS' PERFORMANCE ON THE MINC-2500 DATASET AND OUR TEXTURE DATASET.

	MINC-2500	Texture dataset
FV-SIFT	46.0%	51.0%
FV-CNN	61.8%	73.2%
Our method	**80.6%**	**99.5%**

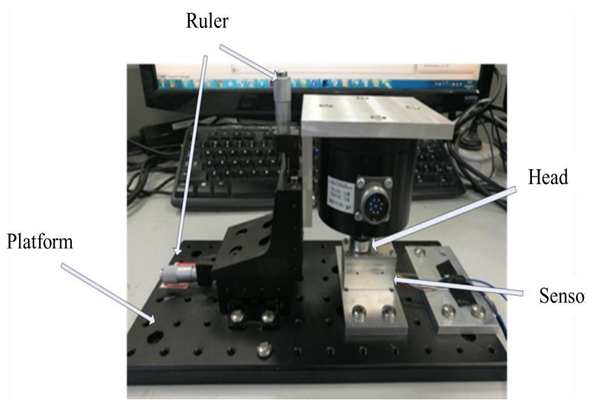


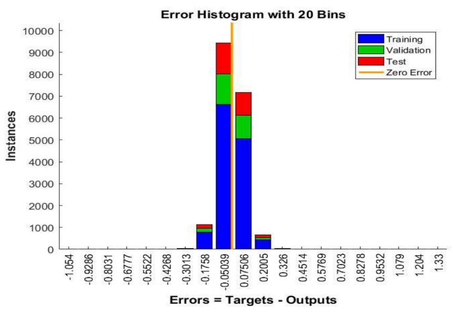
Temperature recognition

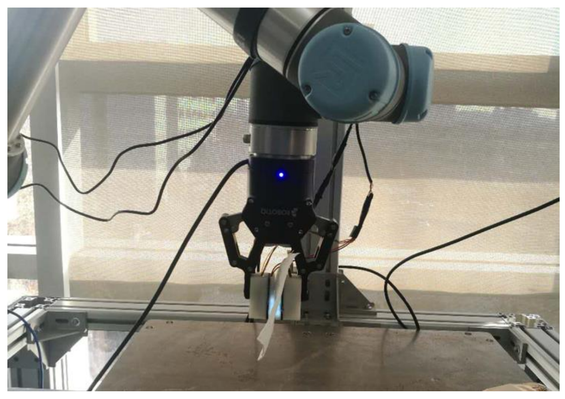


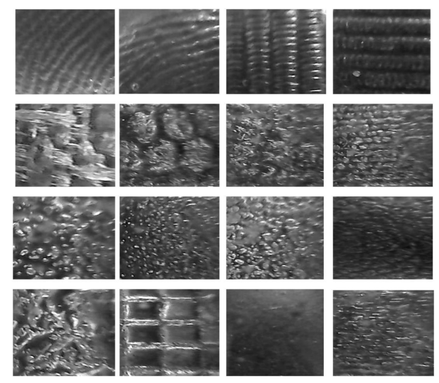
Collection scene	Temperature image	Human feeling	Temperature	Main color tone
		cold	-5.3°	blank
		clod	0.9°	blank
		cool	13.4°	light purple
		normal	23.5°	light blue
		hot	48.4°	white

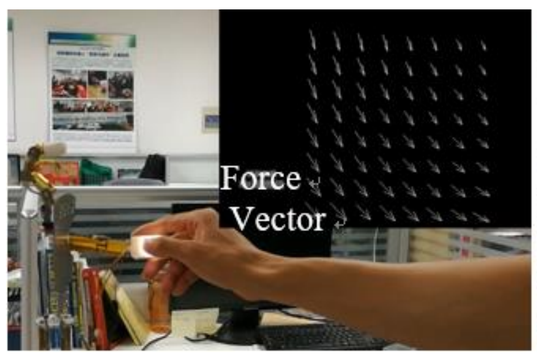
Experiments

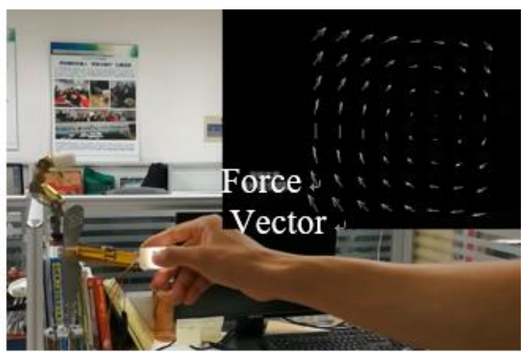












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