Computational Model For Human Tactile Perception

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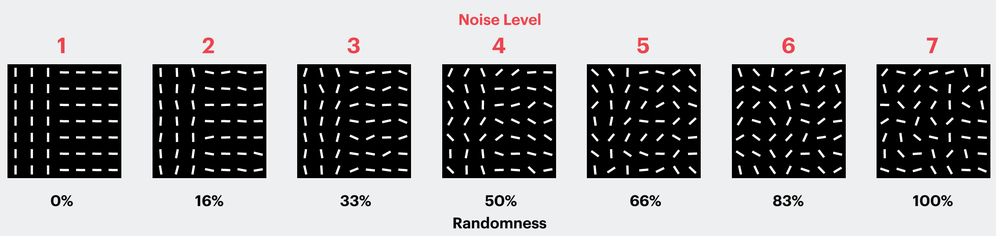
Introduction

Humans can use the finger tip to discriminate texture boundaries. However, the mechanisms subserving this discrimination are uncertain. This research aims to better understand those mechanisms by developing a computational model that mimics human performance.

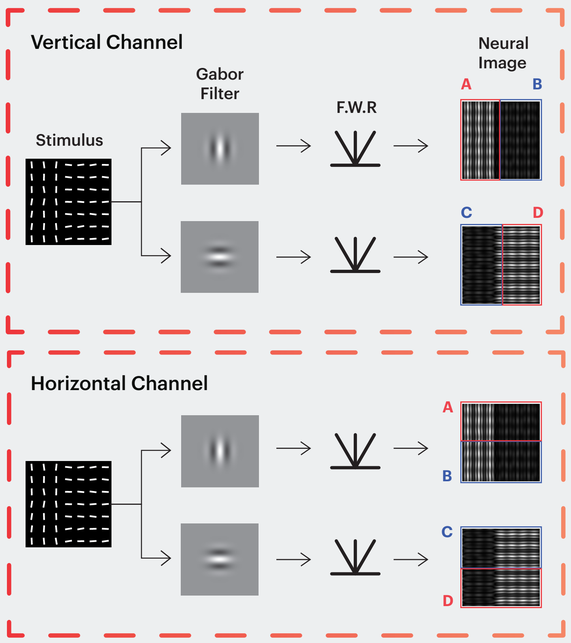
Method

Psychophysical Experiments

We 3D-printed textures comprising 7 rows and 7 columns of ridges (see examples below). Ridges were vertical or horizontal, and defined a texture boundary (below, the texture boundary is vertical). We systematically jittered the orientation of ridges, that is, we increased orientation noise. On each psychophysical trial, a blindfolded participant (n = 25) scanned the 3D-printed texture with their finger tip, and reported the orientation of the texture boundary (”vertical” or “horizontal”; 2-alternative forced-choice task).



Computational Model



We developed a linear-nonlinear-linear (LNL) model.

The vertical channel response

$R_V = | A - B | + | D - C |$

and the horizontal channel response

$R_H = | A - B | + | D - C |$

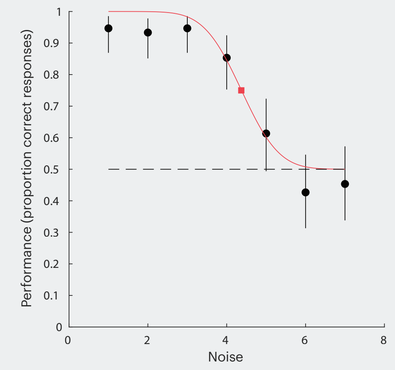
are used in the computation of the model response

$R_M = (R_V > R_H)$

We added late noise to the vertical and horizontal channels. When the vertical channel output is greater than the horizontal channel output, the model responds “vertical”. Otherwise, the model responds “horizontal”.

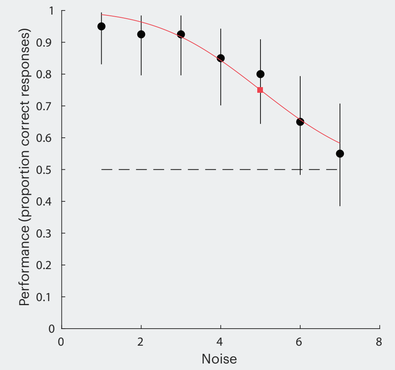
Results

Human Performance



Psychometric function showing the performance of participants (n = 25). As the orientation noise increased, participant performance decreased. At 100% noise, responses were no better than chance.

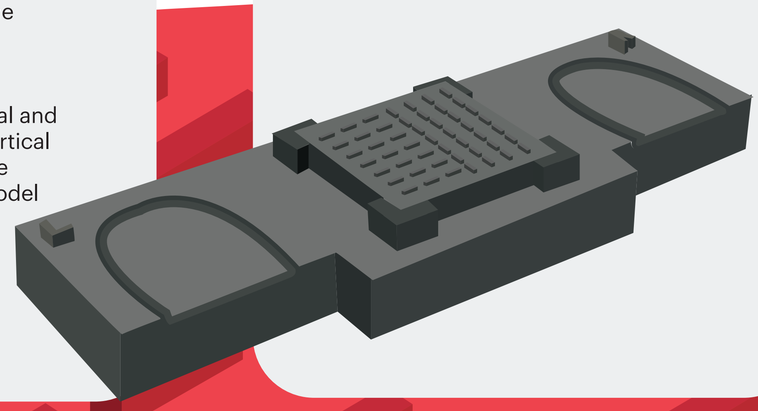
Model Performance



Psychometric function showing the performance of our computational model (see Methods). The model performance was qualitatively similar to participant performance.

Conclusions

We developed a computational model of texture discrimination that performs similarly to humans. In future work, we aim to systematically explore the effect of model parameters on model performance. We hope the model will elucidate the mechanisms of human texture perception.





Acknowledgement

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