# Nerves of Plastic: A Transparent Approach To Distributed Tactile Sensing for Safer Robots

University of BRISTOL | BRISTOL ROBOTICS LABORATORY

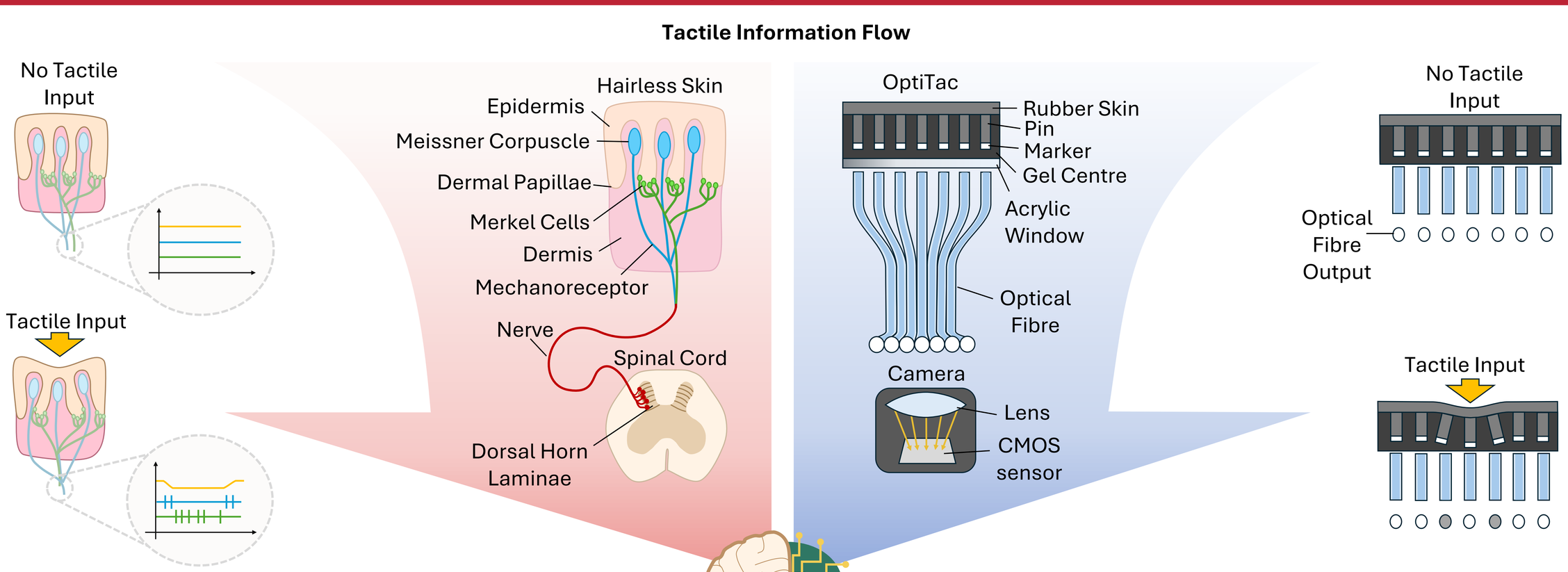
*Laura Butcher, Chris J. Ford, Nathan F. Lepora, Efi Psomopoulou*

MANiBOT

## Introduction

Humans rely on touch for everyday tasks, from locating a light switch in the dark to judging fruit ripeness. For robots to operate effectively in human environments, they need a comparable sense of touch. We introduce OptiTac, a bioinspired tactile sensor that mimics the mechanoreceptor-to-nerve architecture of human skin. Each pin on a deformable surface is paired with an optical fibre acting as an artificial nerve, transmitting tactile information to a remote camera. This design enables distributed sensing while preserving high spatial resolution. By treating tactile signals as images, simple analytical methods, image moments for contact localisation and Hu moments for shape discrimination, replace opaque deep-learning models, offering interpretable tactile intelligence. Inspired by biology, OptiTac represents a step toward scalable artificial nerve systems for robots, laying the foundation for human-like tactile perception in next-generation robotic platforms.

## Bioinspiration

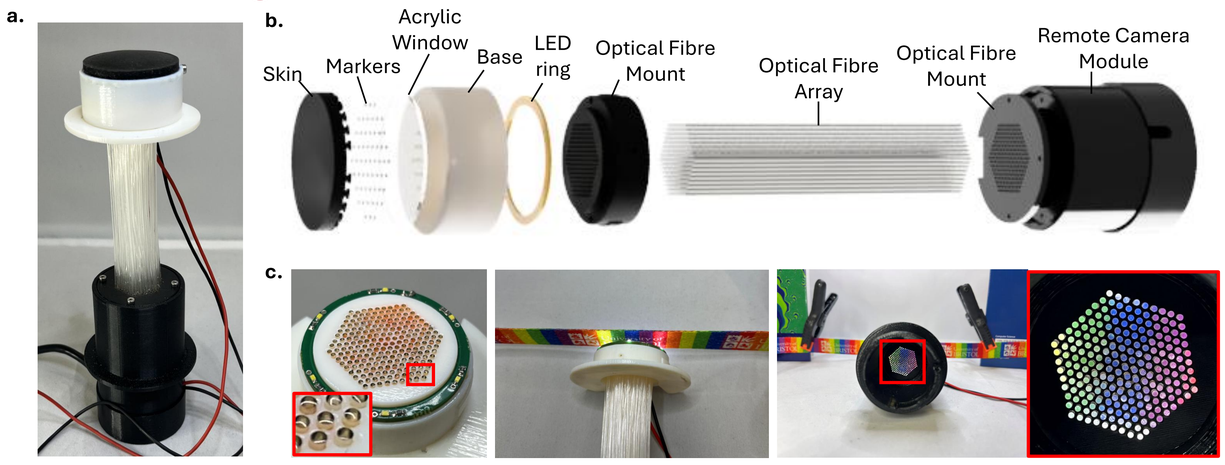



- Estimated 230,000 mechanoreceptors distributed across the skin [1]
- The density can range from 241, 81, 58 units/cm$^2$ in the fingertips, fingers and palm, respectively, compared to 13 units/cm$^2$ in arms [1]

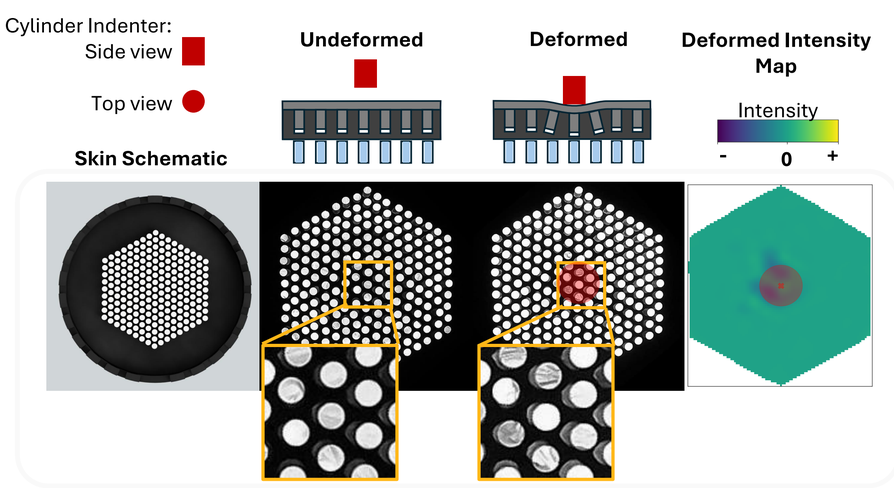
- 217 one-to-one pin-optical fibre pairs
- 1mm Ø, 96mm long plastic optical fibres
- Hexagonal arrangement (1.5mm between neighbouring pairs)

## Design

### Sensor Design



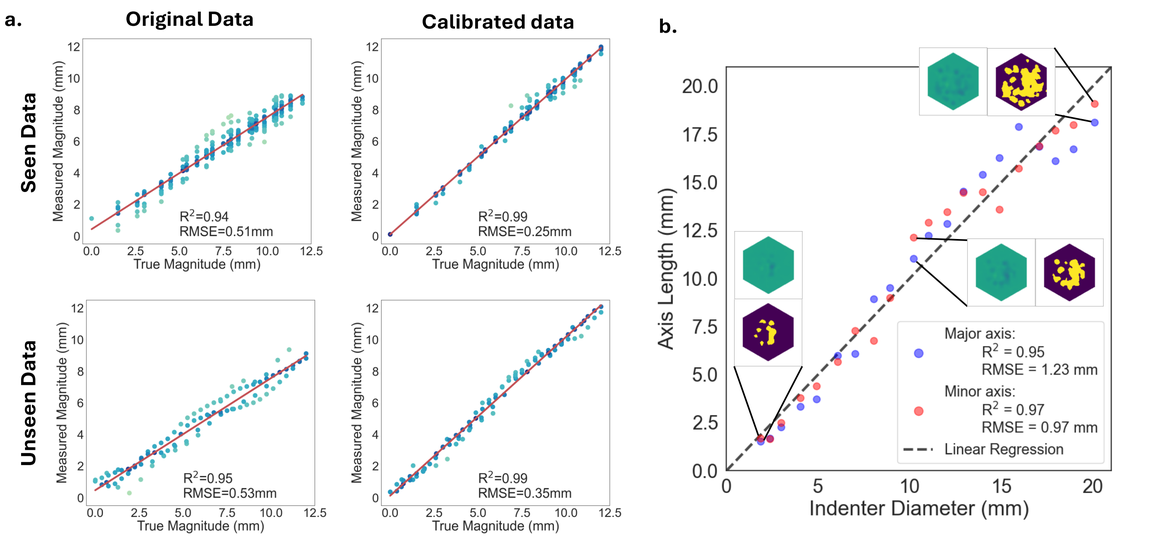

### Contact Inference



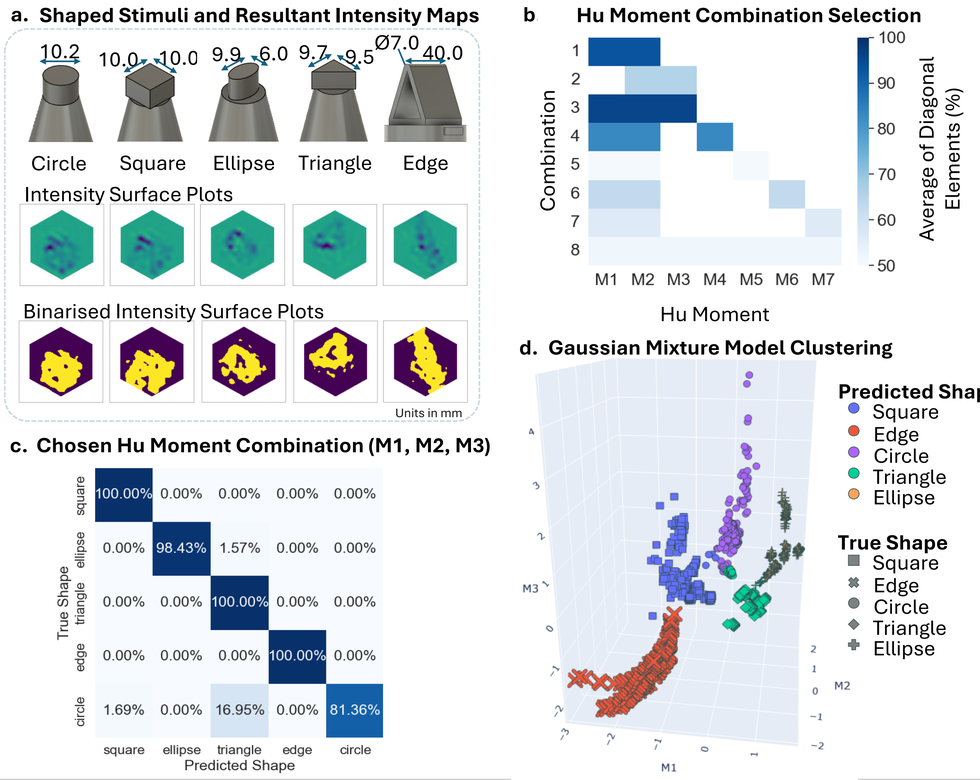

## Results

- Analytical methods were applied to extract key contact parameters.
- Image moments were used to measure contact position and size
- Hu moments were used to extract shape features and a Gaussian Mixture Model used for clustering

### Contact Position and Size




### Contact Shape




[1] Corniani, G., Saal, H.P.: Tactile innervation densities across the whole body. Journal of Neurophysiology 124(4), 1229–1240 (2020)