An Imaging System for High Precision Targeting in Touch Sensation Assays of C. elegans

The sense of touch is the least understood sensing pathway in humans. However, peripheral neuropathy affects millions of people every year, particularly those undergoing chemotherapy treatments, diabetics, HIV patients, and elderly people. To gain insight into the sense of touch we are characterizing touch sensation in a model organism, the nematode C. elegans. We are seeking to break down the entire process of mechanotransduction in the animal: the conversion of mechanical energy on the cuticle to an electrical signal that the animal’s neurons can interpret and generate a behavioral response.

We know that there are exactly six neurons in the C. elegans that are responsible for detecting gentle touch. Each neuron has a long process that runs along the length of the nematode’s body. Along that process are ion channels that we know open in response to a mechanical stimulus. We are seeking the exact mechanism for this response. To study this we apply mechanical stimulus to the worm and record its behavioral response while modulating the genetic properties of the neurons and their channels.

Our technology combines novel optical techniques and computer vision to track freely moving C. elegans in real time while applying precise, micro-scale displacements and forces to the body of the worm using a micro-scale silicon cantilever with an embedded strain gauge. Our novel imaging system allows us to target a specific location of the worm with high precision as well as monitor the behavioral response. The imaging system uses an inverted optical set up with oblique lighting to exclusively capture light scattered by the worm without interference from the displacement probe. With high contrast between the worm and the rest of the image, computer vision algorithms can easily skeletonize the worm and find a target in real time. Real time tracking allows us to assay many genetic variations of the nematode in a well-controlled, high throughput, and precise manner.

The results of these assays performed in our combined displacement clamp and imaging system will provide insight in the mechanotransduction pathway in C. elegans, which can then be extended to the sense of touch in humans.