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Detection of Pinbones in Japanese Shime-Saba

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Research Interests

- Human-Computer Interaction
- Behavior Analysis
- Eye Tracking
- Virtual Reality

Background :: What is Japanese Shime-Saba?

Shime-saba is a Japanese dish that is marinated in salt and rice vinegar, which makes it last longer and gives it a sashimi-like flavor.

😟 The vinegar softens most bones, but pinbones **remain hard and need to be removed**.

😟 The food processing industry **manually removes** the bones of the Shime-Saba.

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Background :: Three pinbones to be removed

There are **three pinbones** in the shime-saba mackerel to be deboned. The presence of these bones is **not clear in the visible spectrum image**, so boning staff must touch the fillet to check for their presence.

Background :: Japanese Shime-Saba

Manual boning of the Shime-Saba

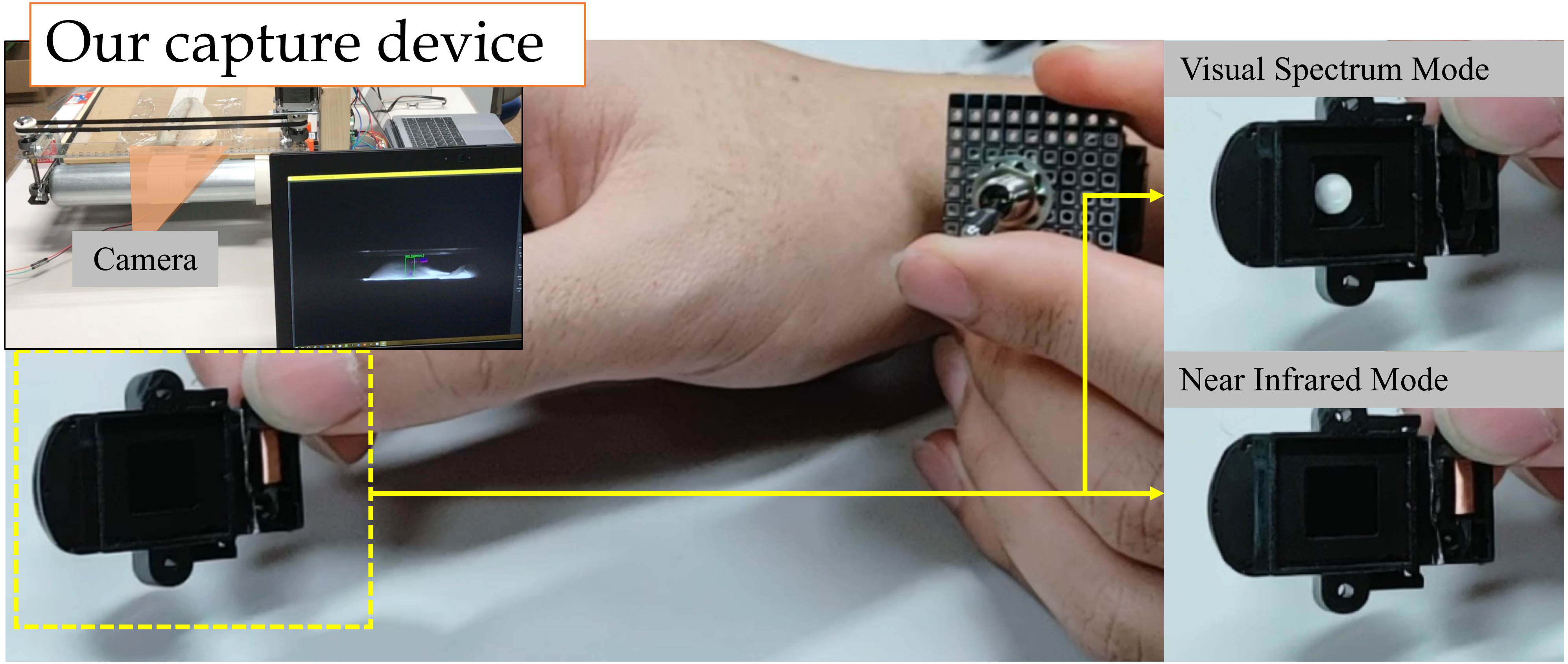
Study Aim

The aim of this study is to develop an image sensing system
that detects the pinbone tips of shime-saba to assist the deboning robot.

- To identify the tip of the bone by analyzing features from fillet image of shime-saba taken by a camera that can capture images in both visible and near-infrared light.
- To analyze the shape geometry of the fillet image from its features.
- To identify the geometry representing the tip of the bone.

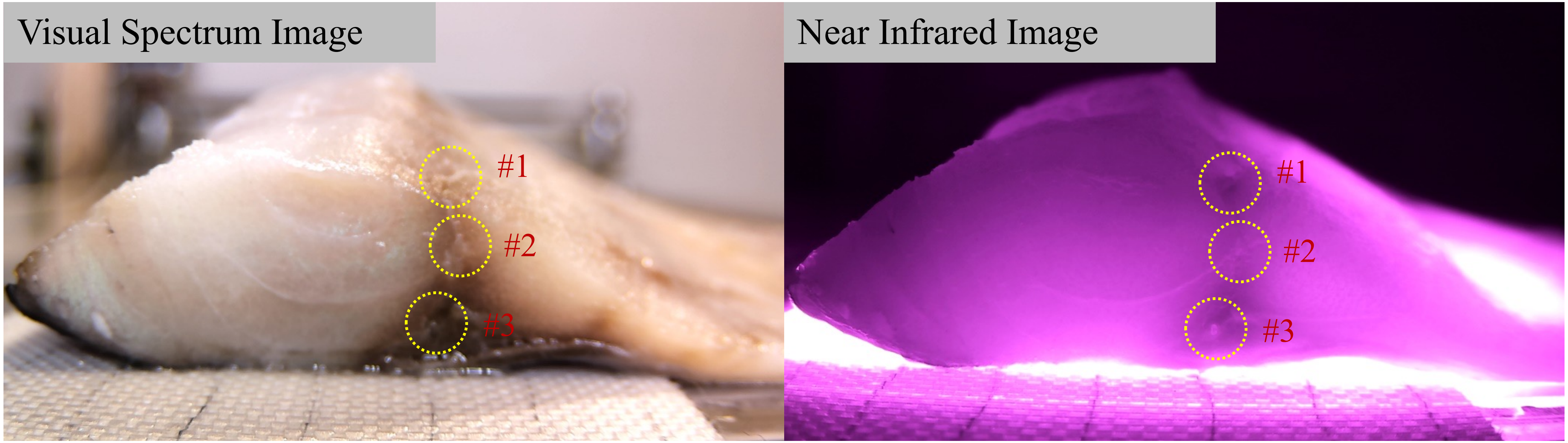
Methodology::Image Acquisition

We attempt to detect the tips of pinbones by photographing the NIR transmitted through the fish body.



Methodology::Image Acquisition

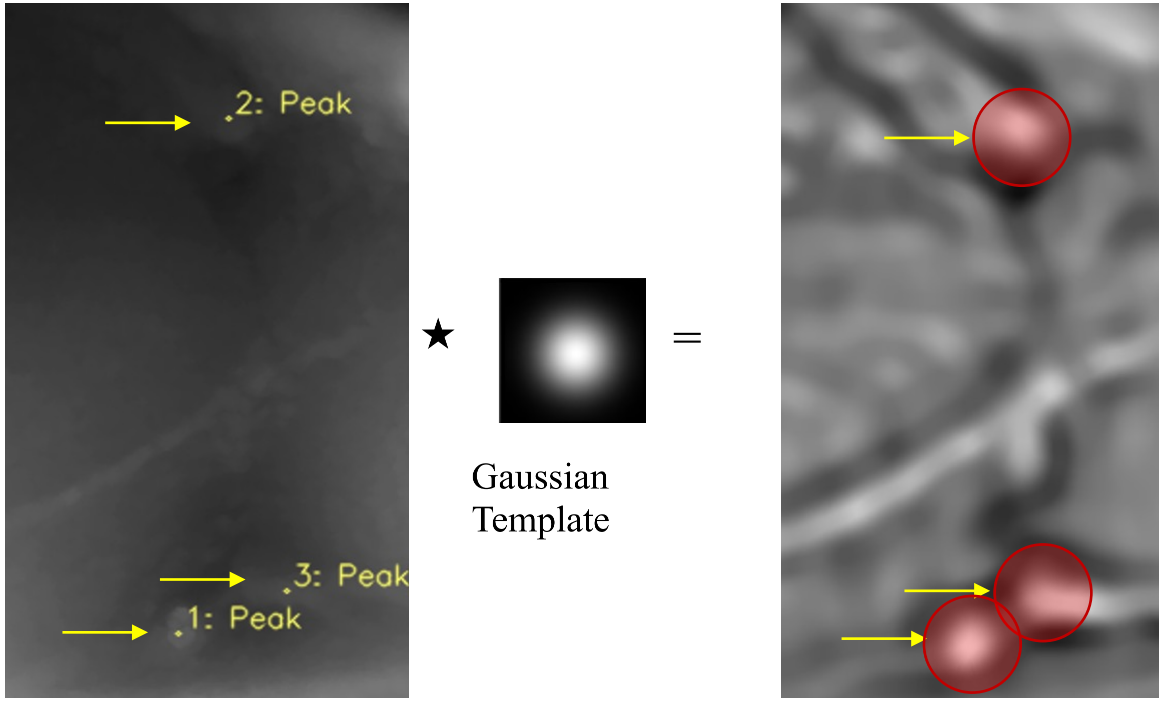
The presence of the pinbones is **not clear in the visible spectrum image (left)**, so boning staff must touch the fillet to check for their presence. In contrast, **the NIR image (right) reveals features** at the tip of the pinbone.



Methodology::Pre-processing

To **enhance** the features of the bone tips in the NIR images, these images were correlated with a **Gaussian template image**.

This template image produces a response image with the region of image maxima as the **convex-up region** of the image.



Methodology::Quadratic Surface

We developed a morphometric characterization algorithm to determine geomorphometric features from the derived response images.

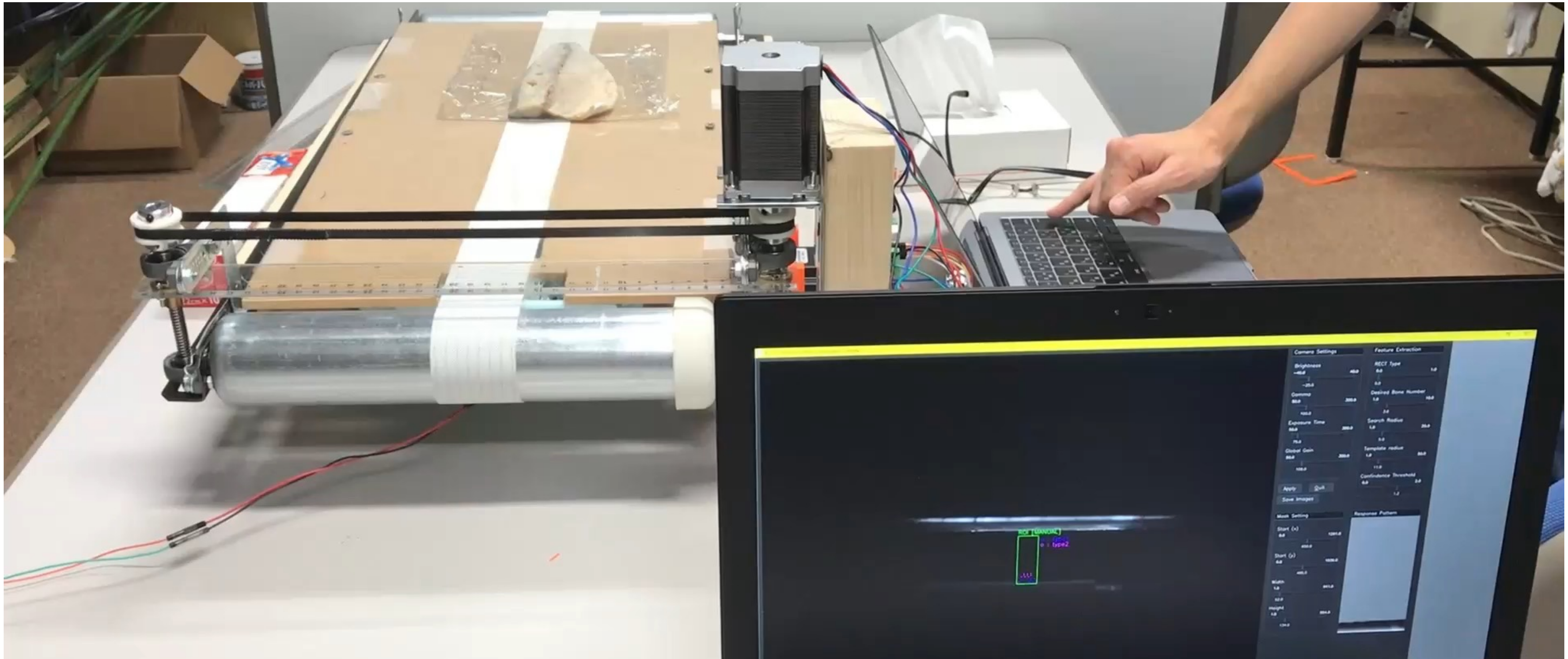
$$z = f(x, y) = Ax^2 + Bxy + Cy^2 + Dx + Ey + F$$

(x, y) is the location's coordinate, z is the pixel value calculated by the quadratic function, and A to F are the coefficients of the quadratic function.

- Elliptic paraboloid: $B^2 - 4AC < 0$ ➡ If the center of the convex-up surface is within the analysis window, this surface can be determined as the peak.
- Hyperbolic paraboloid: $B^2 - 4AC > 0$
- Parabolic paraboloid: $B^2 - 4AC = 0$

Experiments::Experimental Setup

For the experimental setup, a camera capable of capturing visible and near-infrared light and a conveyor for conveying the samples were developed.

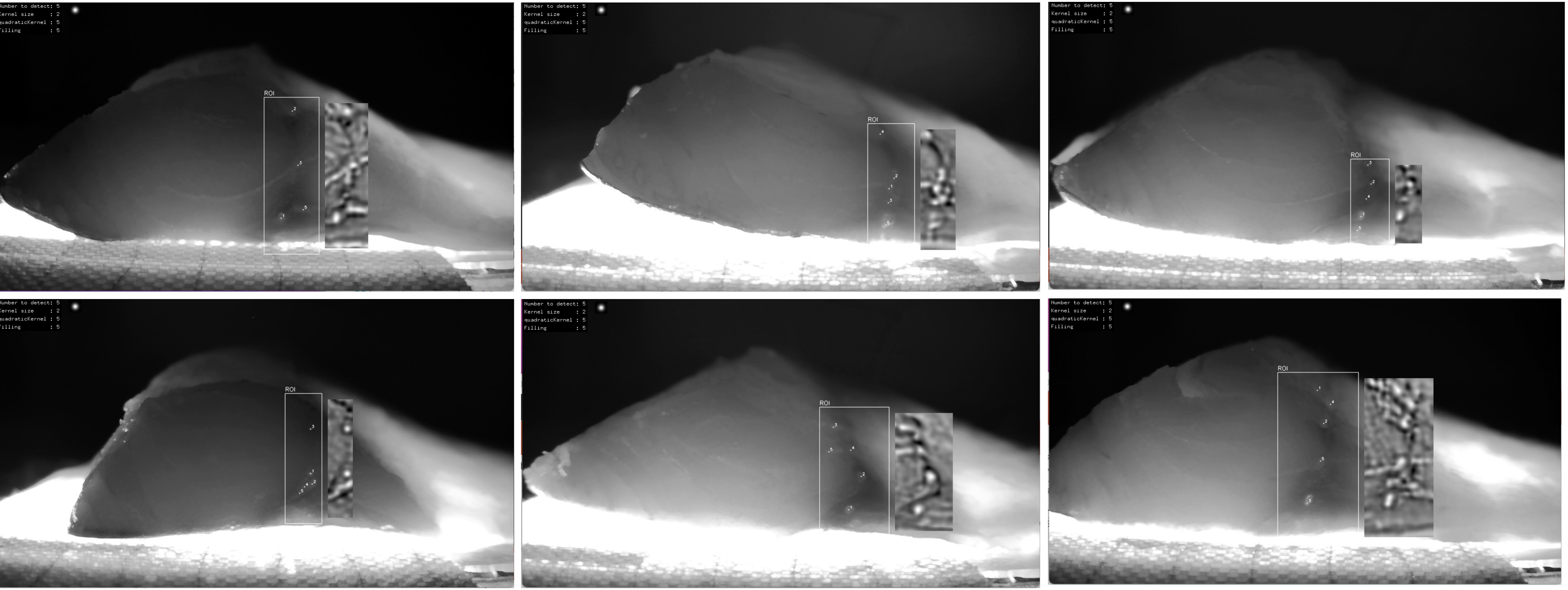


Experiments::Detection

The region in the center of the fillet was used to approximate the quadratic surfaces. Five candidates with the largest difference in convexity were displayed to confirm the presence of the pinbones.

Results

We were able to identify five potential locations where pin bones might exist. We confirmed that pin bones were present in those locations.



Conclusion & Future Perspective

- Our image sensing system were able to identify convex-up shapes that represent the tips of the bones by analyzing the surface geometry of a fillet transmitted by near-infrared ray.
- Candidates for the pinbones were narrowed down to five in order of size.
- The future focus will be on identifying tips of the bones from the candidates identified by the current system, including deep learning solutions.