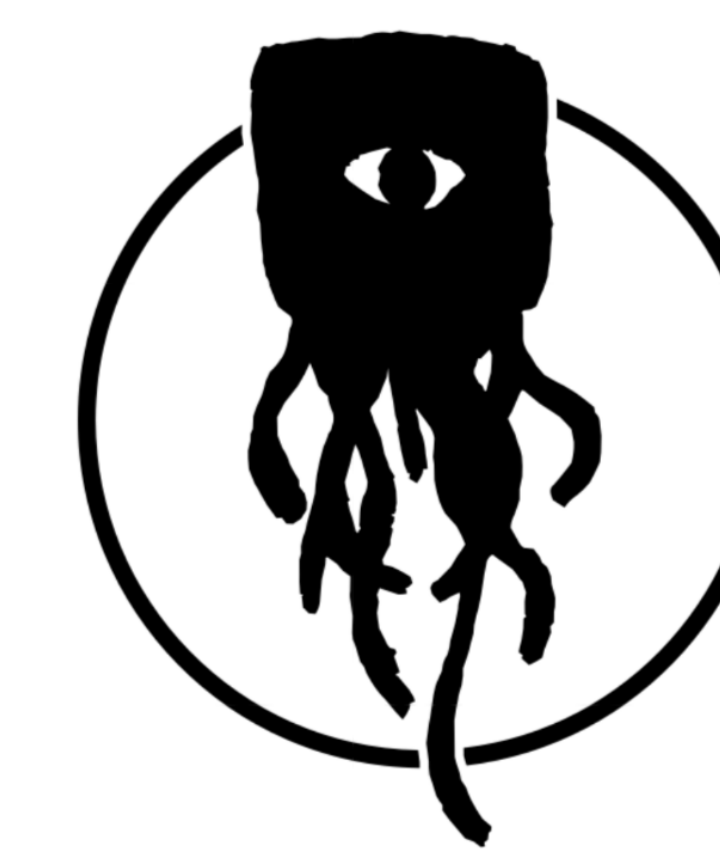




Automation of Processing Fish

SCOPE Processing Fish



The Problem

Most scope projects come with a fair amount of structure. This was not the case for our project. Our problem statement left lots of room for exploration: **find a way to remove defects from fish fillets autonomously.**

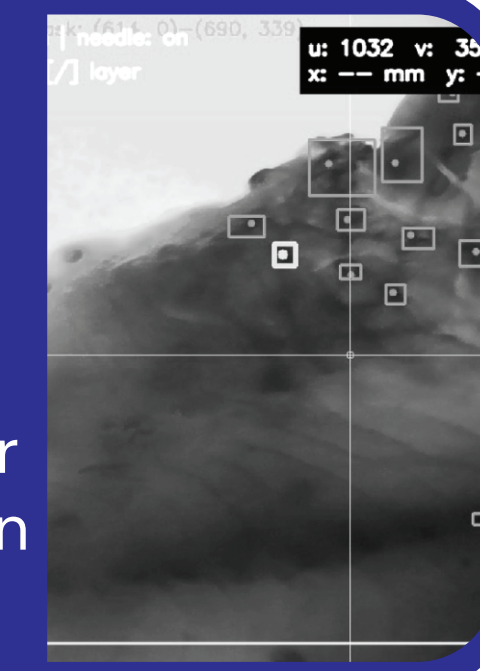
Spectrometer Testing

To start this project we used a spectrometer to identify the wavelengths of light that correlated most highly with our points of interest.



Detection On A Still Frame

Once we knew the color signatures of the defects we were able to use computer vision to detect our inspection points.

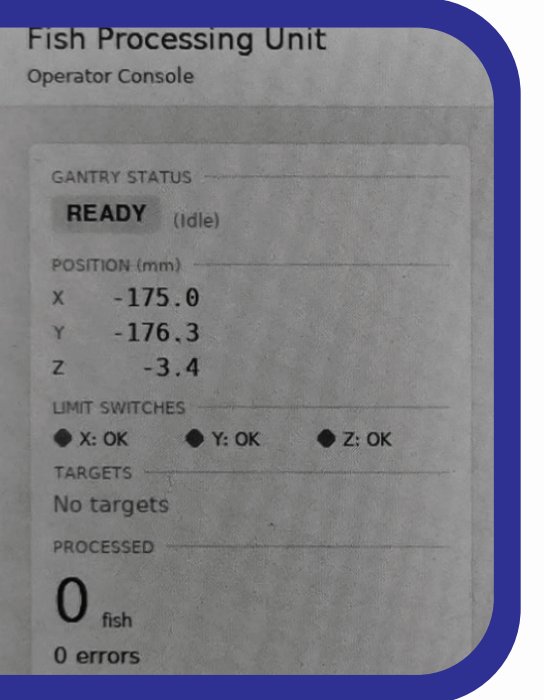


The Pivot

We found that we could remove fish fillet defects with a robotic arm, however, robotic arms are tens of thousands of dollars and we thought there was room for a much more cost effective alternative.

Control Integration

We then integrated our gantry and vision systems using custom control architecture to achieve fully autonomous fish inspection



Manual Inspection Testing

The next step was to manually remove defects from fish to develop an understanding for the tasks we were aiming to automate.



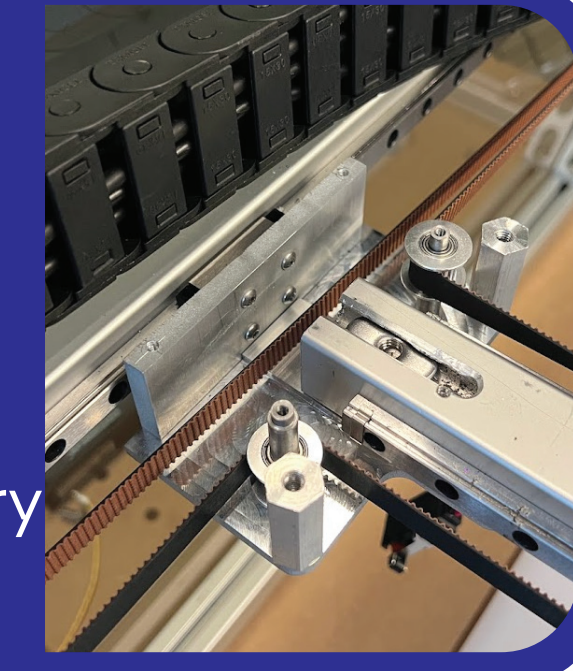
Robot Arm Experimentation

To test the feasibility of autonomous defect removal we performed our initial test using a robotic arm as it could most closely mimic human movement.



Gantry Movement

In order to drastically reduce system cost while maintaining equal levels of precision and speed we decided to pivot to a gantry system.



Current State of Fish Processing



Anglers don't have perfect control over the environment their fish live in. This can result in defects, which lower the quality of the fish

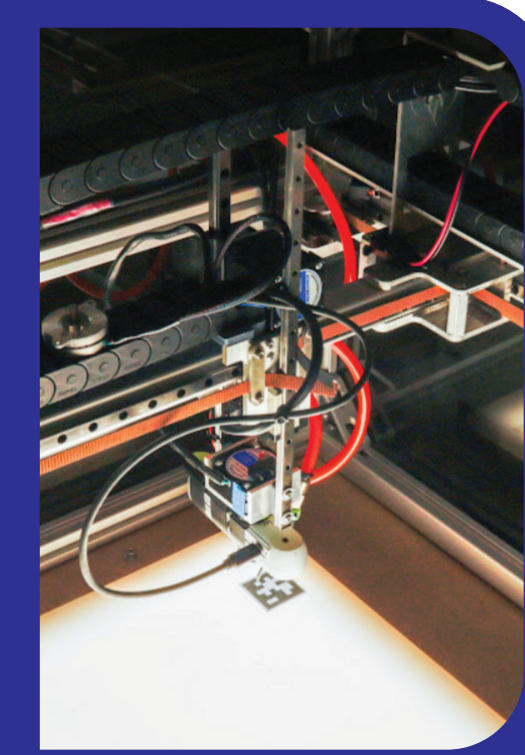
This means that fish must be processed before sale to remove these defects. Currently, the inspection and processing are done by hand, causing strain to workers in the form of over exposure to light and extreme repetition of precise movements.



Automation can reduce the manual labor necessary for processing, reducing the impact on workers and reducing costs. Automation could also simplify the supply chain logistics, decreasing the carbon footprint of transport.

Our Gantry

Our gantry has four degrees of freedom with the main X and Y movements being belt driven in a coreXY configuration. It is capable of sub millimeter precision and acceleration of up to 3 Gs for less than a sixth of the cost of the robotic arm we started testing with.



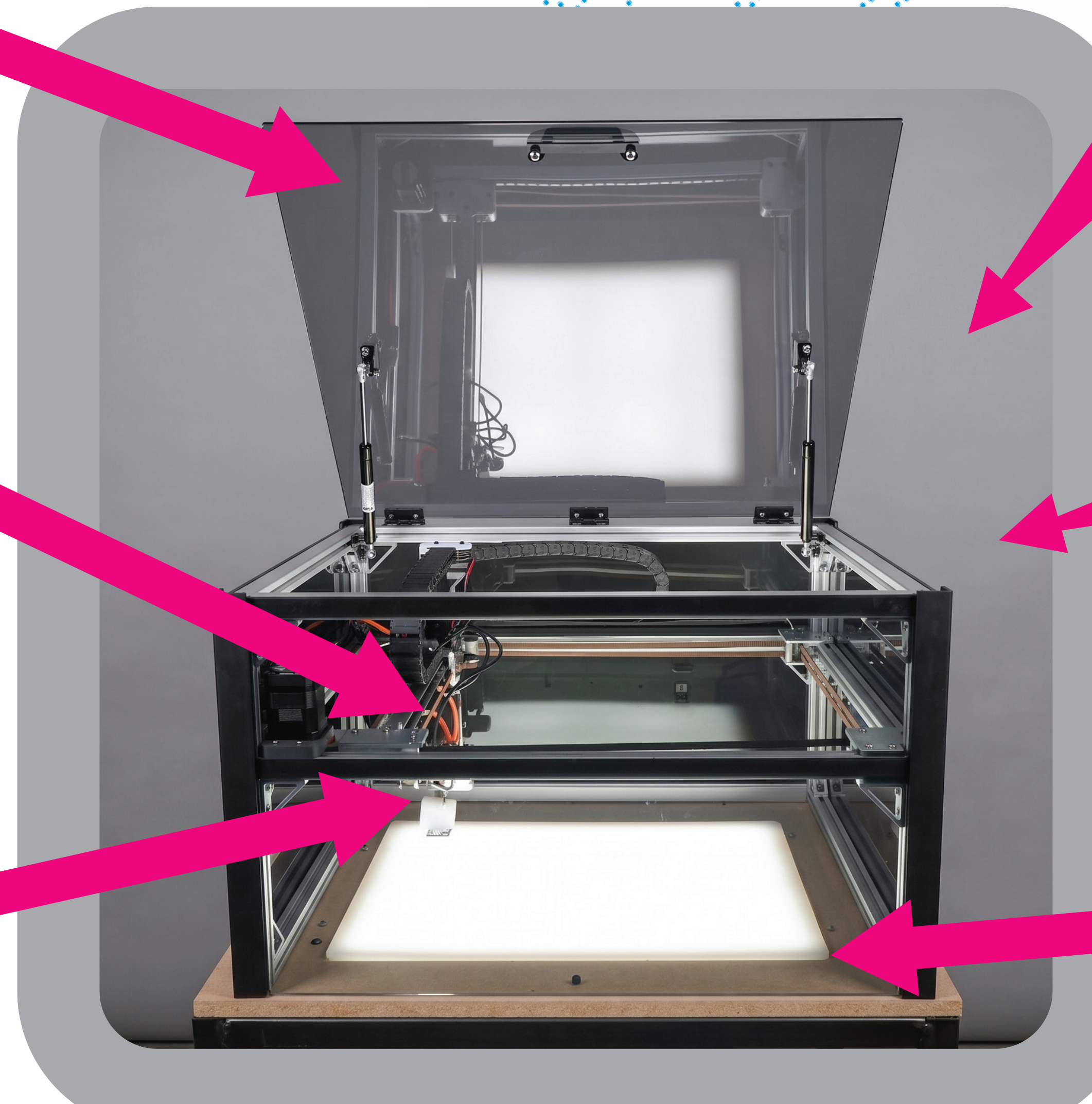
Bespoke End Effectors

We developed two custom end effectors for removing defects from fish fillets. One end effector emulates common practices in the fish processing industry and the other implements a novel approach that synergizes better with automation.

Classical Computer Vision

Our system uses an Intel RealSense camera and classical image processing techniques to find defects. The detection algorithm can be highly accurate despite being exclusively classical; a machine-learning based solution demands the challenge of leveraging a very large dataset that we currently do not have access to.

Our Solution



Contained Electronics

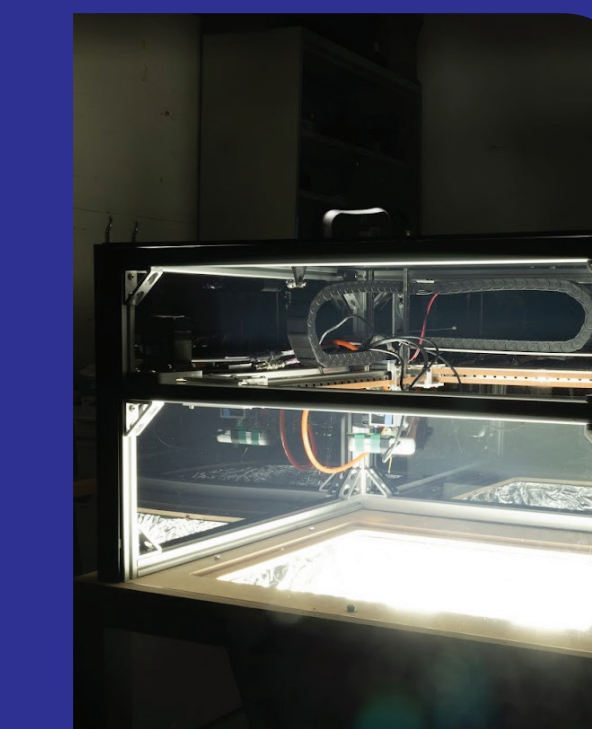
In order to improve the portability and ease of repair of our system we created a waterproof electronics box that neatly houses all of our gantry controls and controllers. The electronics box also protects the sensitive electronics from the hazardous environment of a processing line.

Intuitive User Interface

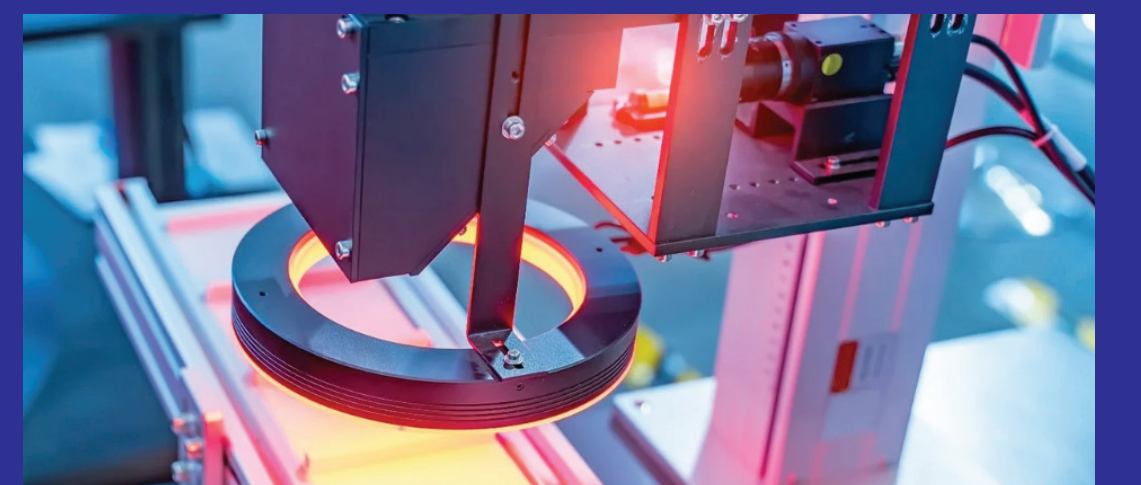
To streamline interactions with our system we developed a user interface that allows the operator to manually jog the gantry as well as start any of the available defect removal operations.

Back Lighting Table

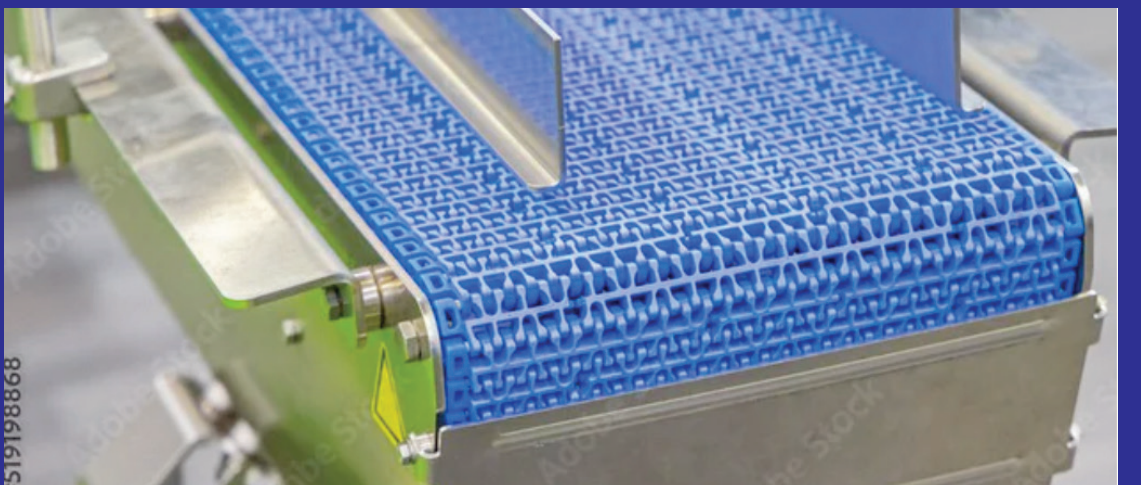
One of the biggest advantages of automation is being able to backlight fish fillets with amounts of light that would be damaging to human workers. This drastically increases the ease of defect detection.



The Future of Our Project



Extended testing and data collection to validate system performance and advance vision-based defect detection capabilities.



Industrial-scale integration through multi-gantry configurations and conveyor based workflows to maximize throughput and minimize human intervention



Broader deployment across additional stages of the fishing industry supply chain

Insights

Multispectral imaging enables comprehensive defect identification

Multispectral imaging provides a robust, non-invasive method for detecting a wide range of defects throughout the fish processing pipeline

Computer vision validates automated detection

Traditional computer vision techniques demonstrate feasibility as a scalable, automated solution for defect detection in fish processing environments

Minimal degrees of freedom for effective inspection

A four-degree-of-freedom system is sufficient to achieve full spatial coverage for reliable defect detection and inspection

Modular tool heads enable versatile defect remediation

An interchangeable tool-head design supports targeted removal and repair of various defect types, offering adaptability across different processing stages

The Team



Our Advisor

