Awards issued prior to January 20, 2025, were funded under previous Administrations and may not reflect the priorities and policies of the current Administration.

United States Department of Agriculture
Project Initiation

Project Data for Accession Number 1031002

Project Title

PARTNERSHIP: Integrated Multi-Stage Robotic System for Automated Picking of Blue Crab Meats from Complex Compartments Extendable to Large-Scale Smart Food Processing

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** ACTIVE
Funding Source NIFA Non Formula	**Grant Year** 2023
Grant No. 2023-67021-40621	**Cumulative Award Amt.** $760,000.00
Proposal No. 2022-11142	**Multistate No.** (N/A)
Project Start Date Jul 01, 2023	**Project End Date** Jun 30, 2027
Program Code [A1521] Agricultural Engineering	

Project Director

Tao, Y.

Recipient Organization

UNIVERSITY OF MARYLAND, COLLEGE PARK

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Performing Department

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Non Technical Summary

Blue Crabs and their meat are an iconic cultural export for the Atlantic and Gulf Mexico Coastal regions. However, processing enough meat to satisfy the market demand is challenging; even on the largest scales, commercial meat is still hand-picked. The process demands a highly skilled and attentive worker utilizing a knife to separate the legs and joints, as well as break the inner cartilage to reveal the precious and fragile lump meat inside the meat compartments. The process is arduous and dangerous; and the most skilled of pickers can process at most two crabs per minute. Although various automated systems have been attempted for the past 50 years, none have deconstructed the crab and removed the meat without degrading the meat quality and value.Under the support of NSF/USDA NRI 2.0 program, we have achieved the goal of developing a two-stage vision-robotic system equipped with high-pressure waterjet knives for automated disassembly of complex crab compartments. After the crab has been cut into easily

accessible sections, humans can use their digital dexterity to gently remove the meat from each compartment. This is a semi-automated operation.To advance our results to a fully automated system, two additional tasks will be made: crab meat extraction and crab loading. In the crabmeat harvesting process, the toughest hurdle to overcome is the extraction of the coveted lump meat. This task requires a skillful application of force to maneuver through the complex exo-skeleton and inner structures of a cooked crab. Precision cuts must be made along complex curves to open access to the meat chambers to preserve meat wholesomeness and maximal values.This project is to advance the multistage robotic processes, moving beyond a semi-automatic system to a fully automated one. Machine-vision guided robotics, machine deep learning, and integrated system will be created toward the on-line automated smart food processing system technology. The result of this project canhavea broader impact in robot-assisted scalable technology to meet the USDA missions that benefit consumers and coastal rural communities. It will increase efficiency and productivity with reduced risk and sustainable food agriculture.

Animal Health Component

Animal Health Component: 0%

Research Effort Categories

Basic	50%
Applied	50%
Developmental	0%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
402	0811	2020	100%

Knowledge Area

[402] Engineering Systems and Equipment

Subject Of Investigation

[0811] Shellfish

Field Of Science

[2020] Engineering

Keywords

Machine vision, Robotics, Labor short, Large scale smart seafood processing, Multi-stage integration

Goals / Objectives

Blue Crabs and their meat are an iconic cultural export for the Atlantic and Gulf Mexico Coastal regions. However, processing enough meat to satisfy the market demand is challenging; even on the largest scales, commercial meat is still hand-picked. The process demands a highly skilled and attentive worker utilizing a knife to separate the legs and joints, as well as break the inner cartilage to reveal the precious and fragile lump meat inside the meat compartments.

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Project Methods

This systemwill be achieved through the integration of multistage robotic processes, advancing a semi-automatic system into a fully automated one.The methods will include 1) robotics integration with an automated crab clamping-down mechanism;2) vision-guided robotic actuator to harvest crab lump and chamber meat, where 3D vision,robotic picking end effector,machine deep learning algorithms for the pathwaywill be involved;3) integration of the mult-stage system; 4) tests and optimization of the overall system, and 5) evaluation of machine-picked crabmeat safety and organoleptic quality.