ATRP AGRICULTURAL TECHNOLOGY RESEARCH PROGRAM

ENGINEERING TOMORROW'S POULTRY AND FOOD PROCESSING INDUSTRIES

Autonomous Robotics for Layer House Management - A Vision of the Future

Egg Industry Issues Forum
Scottsdale, AZ
April 2018

Colin Usher
Georgia Tech Research Institute
Food Processing Technology Division

Georgia Tech Research Institute

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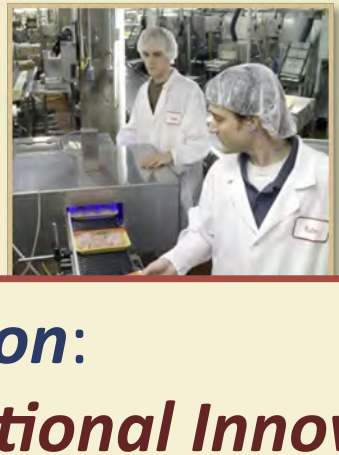
Robotic Sy




ty Sensors

Vision:

To drive ***Transformational Innovation*** in ***Advanced Technologies*** for ***Poultry, Agribusiness***, & ***Food Processing***


Worker Safety


Environmental Research


Separations


Air Quality Control

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Housed within the

FPTD

FOOD PROCESSING TECHNOLOGY DIVISION

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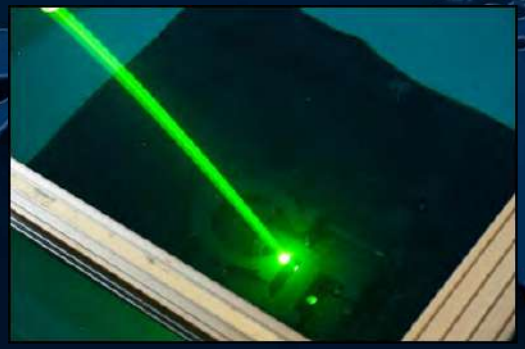
President, *Dr. G.P. "Bud" Peterson*

EVP- Research	Provost	EVP – Operations
Dr. Steve Cross	*Dr. Raphael Bras*	*Steve Swant*

Georgia Tech Research Institute (GTRI)
Dr. Andy Gerber






Applied Research Arm of Georgia Tech

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The ATRP Partnership

Faculty - Students - Staff

Research | Education | Tech Assist | Outreach

Agricultural Technology Research Program
Industry Advisory Board

Research Partners
Universities
Ag Innovation Ctr.
USDA – ARS
GA Poultry Lab

Trade Assoc.
GA Poultry Fed.
US Poultry & Egg
Nat'l. Chicken Csl.
Nat'l. Turkey Fed.
GA Agribusiness Council

Industry
Food Processors
Equipment Co.
Suppliers
Allied Industries

State Govt.
Gov. Office
Legislature
Dept. of Ag

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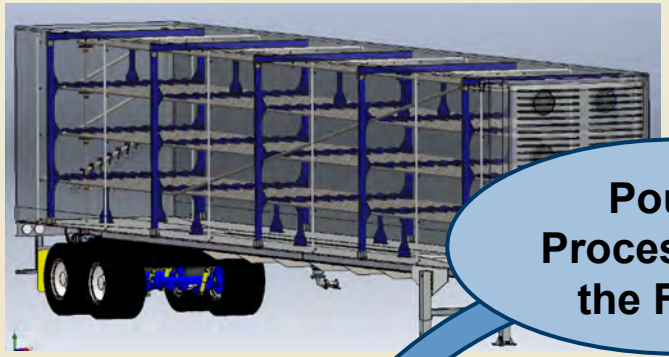
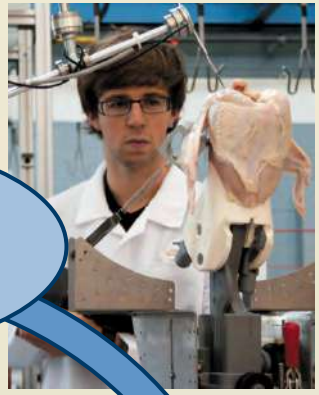
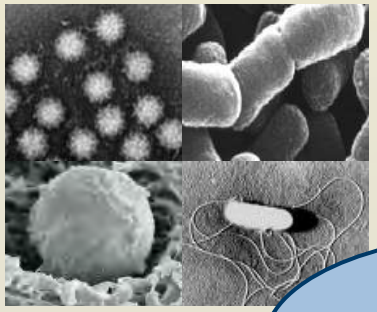
Strategic Research Thrusts



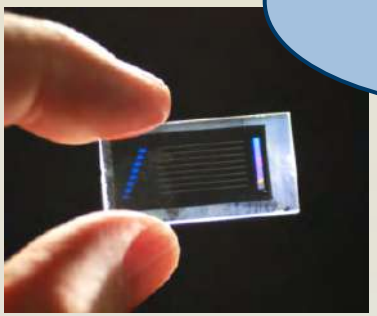


Poultry Processing of the Future

Universities
Industry
Government



Food Safety Sampling & Sensing



Agri-Robotics

Growing the Partnership

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What about 2050?

So what will the Poultry Industry look like in the Future?

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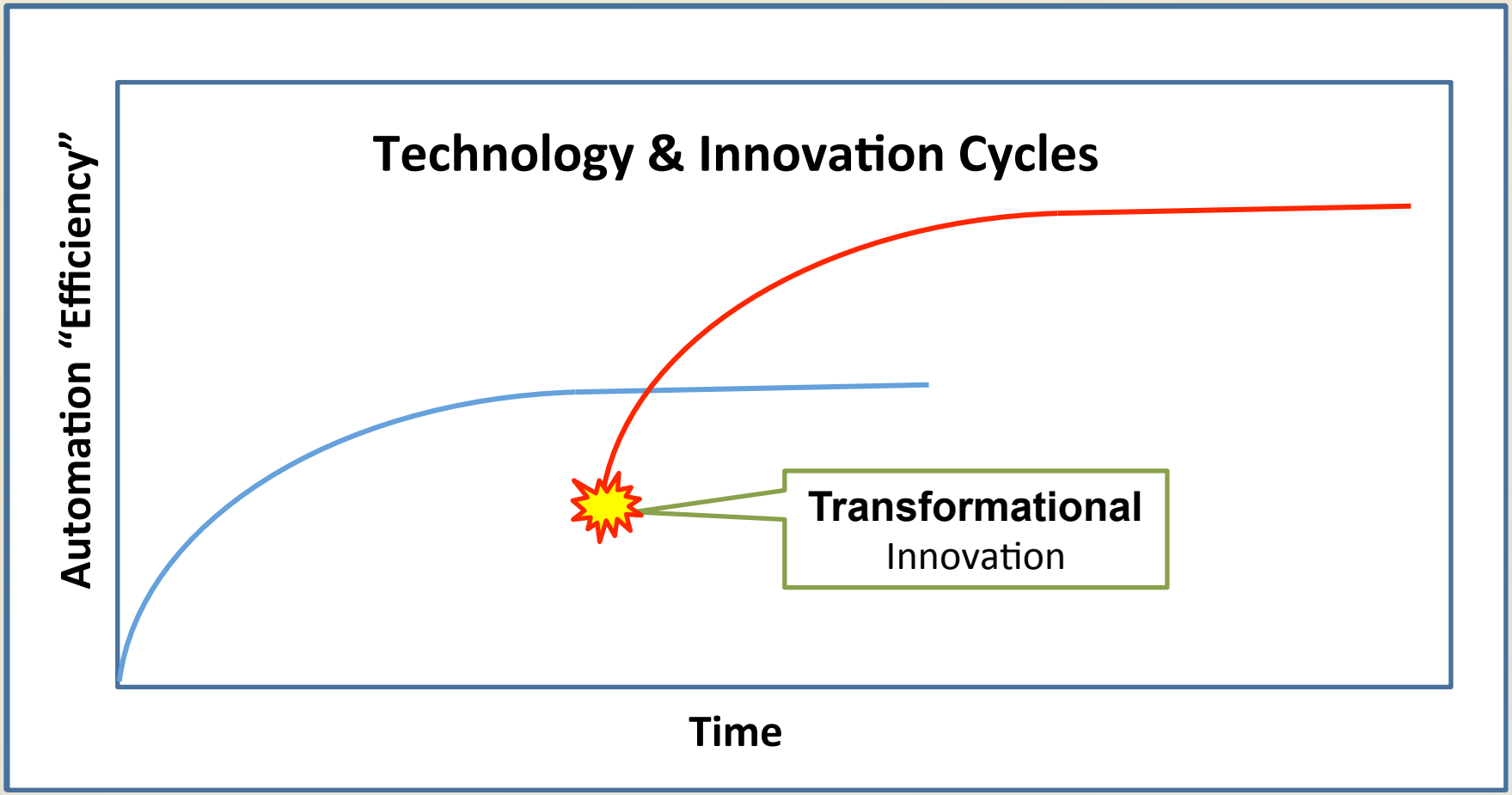
Innovation …



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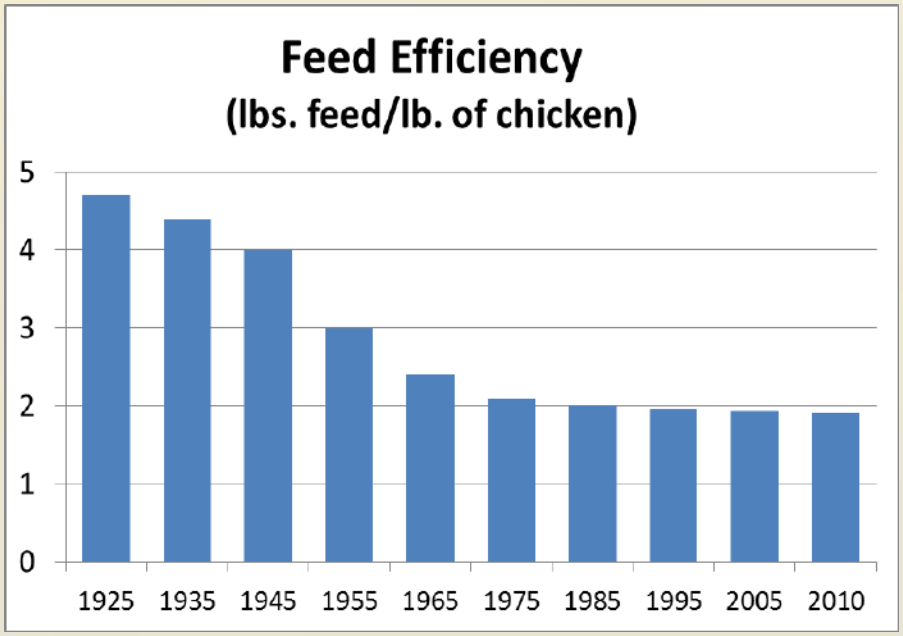
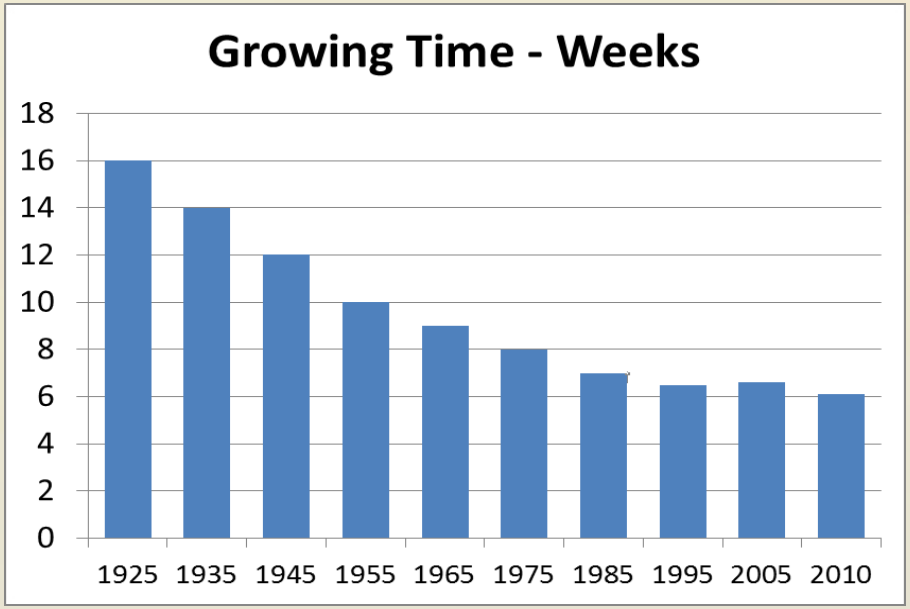
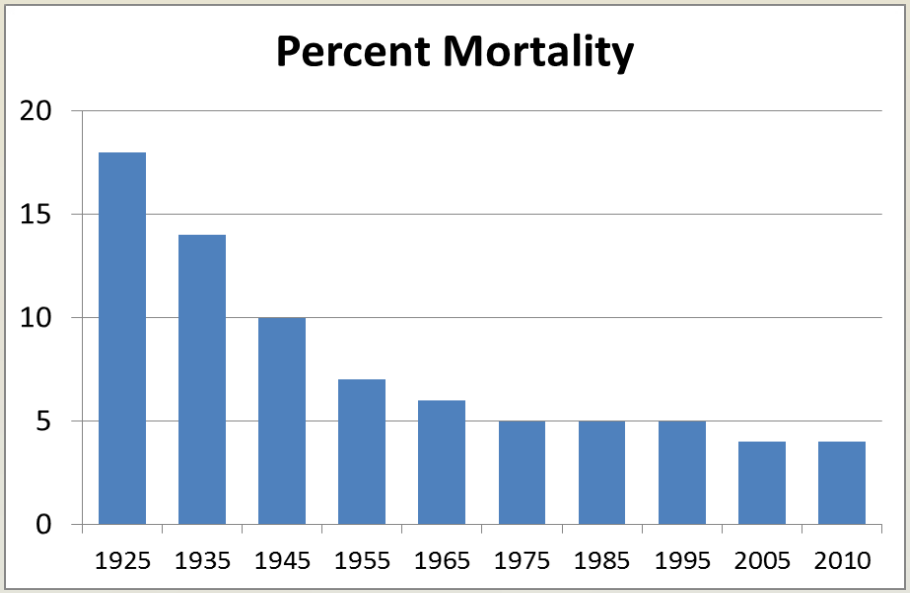
Production Improvements







A strong tradition of adopting innovation …

But the game is Changing …

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Source: NCC

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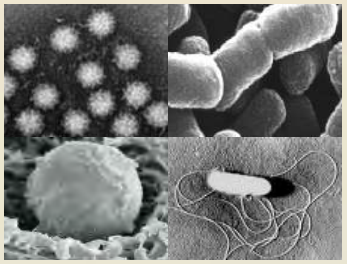
Poultry 2050 Vision

- Fundamentally **rethink** poultry processing & production
- Identify and solve **grand challenges**
- Pursue an **integrated, systems based** approach
- Ensure a **robust** and **resilient future**!



This is an entire ***Community Initiative!!***

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Robotics for House Management

- Outline
  - Introduction
    - Background
    - Previous work
  - Automating the Robot
    - Test environment
    - Robot system
    - Autonomy algorithms
  - Egg picking
    - Sensing and navigation
    - manipulation
  - Results

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Confined Housing

- Commercial chicken houses have thousands of chickens
- Farmers walk through daily
  - Assess equipment
  - Remove floor eggs/mortality
  - Qualitative analysis
- Problem:
  - Labor intensive - turnover
  - Cross-contamination

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Previous Work

- Performed feasibility study using manually controlled robots
- Broiler chickens
  - 6 weeks growth
- Conclusion: Robot interaction with chicken is not detrimental to their well-being.

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Automating the Robot

- Before robots can carry out specific tasks in animal environments, they must first be able to successfully navigate the environment and form plans.

Goal

- Implement routines to autonomously interact with the animals and navigate the environment using observed animal reactions to specific robot behaviors.

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Test Environment

- University of Georgia facilities
- Small-scale grow out house
- Breeder chicken
- Data recording systems:
  - Cameras
  - Microphones

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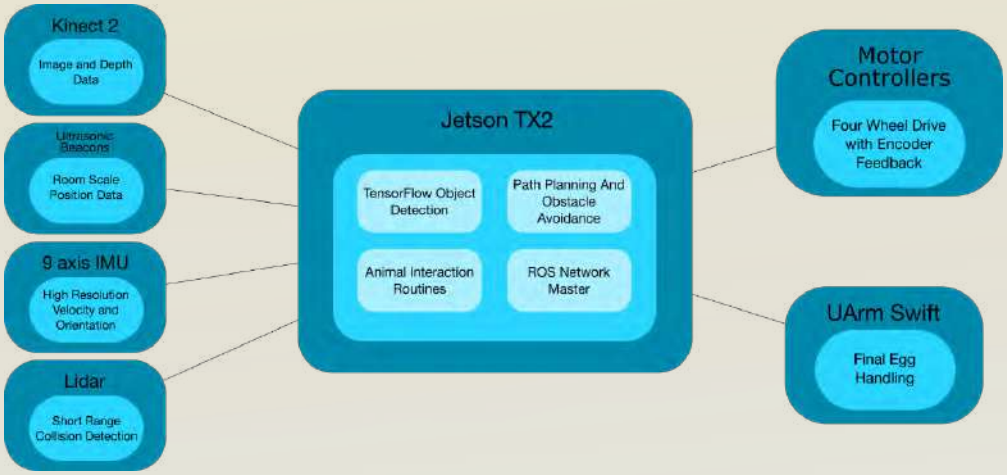
Robot System

- COTS chassis from SuperDroidRobots
- Custom control using ROS on Nvidia Jetson TX2
- Notable components:
  - Skid-steer base controller
  - Kalman filter fusing wheel odometry, IMU, and ultrasound indoor beacons
  - Navigation and planning with move_base package
  - Deep learning-based object detection framework
  - Egg localization and arm controls for picking



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Infrastructure for Robot Localization

- Marvelmind ultrasonic navigation beacon system

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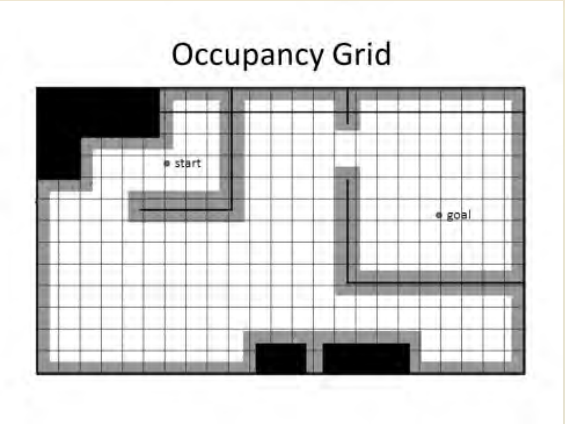
Robot Operation Software

- Utilize the Robotics Operating System (ROS)
  - Framework for all software
  - Query sensors
  - Motor control
- "Occupancy grid" mapping
  - Allows robot to have a map of the environment and insert obstacles (chicken)
  - Allows for dynamic path planning



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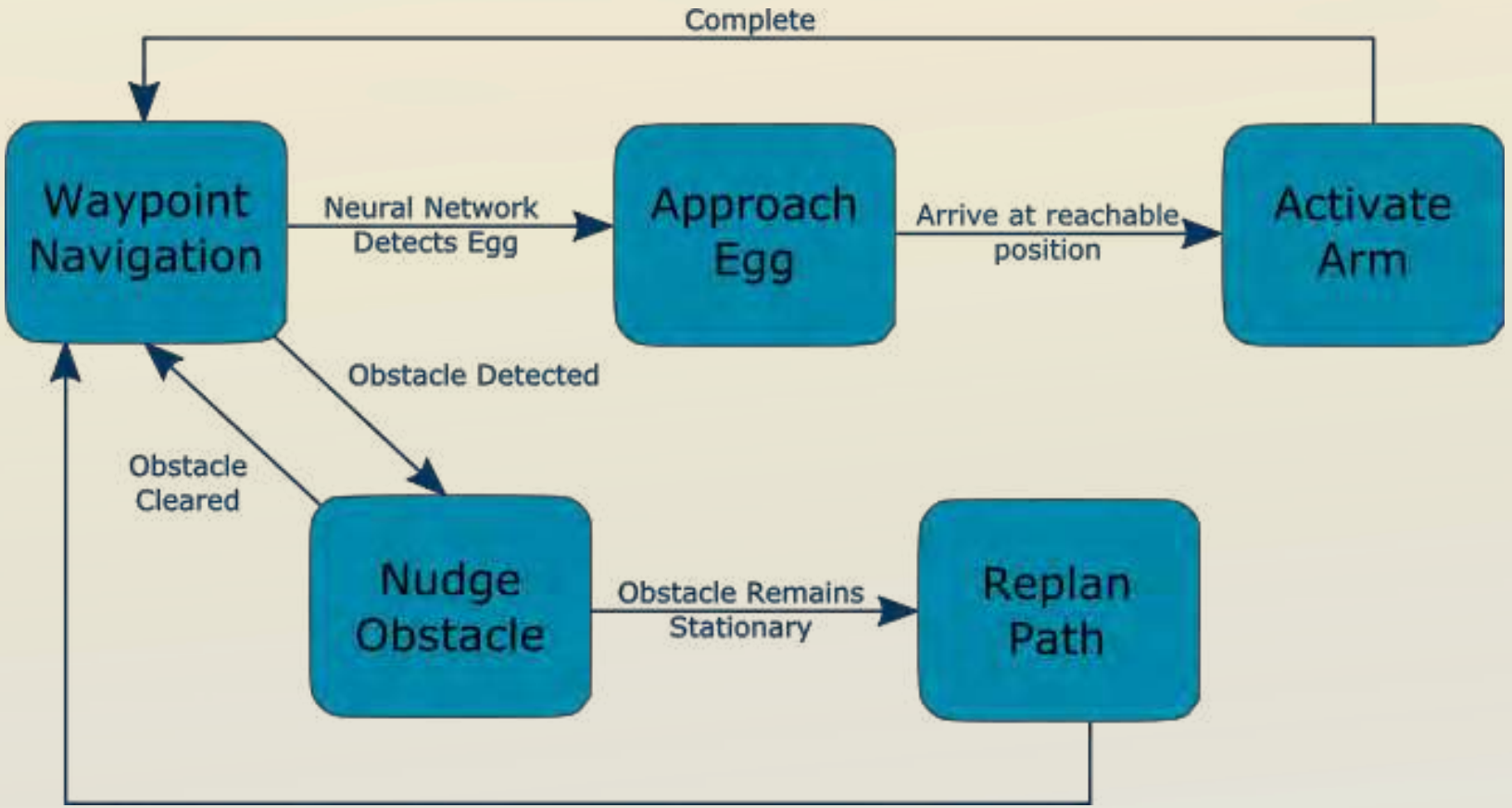
Autonomy Plan



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Results

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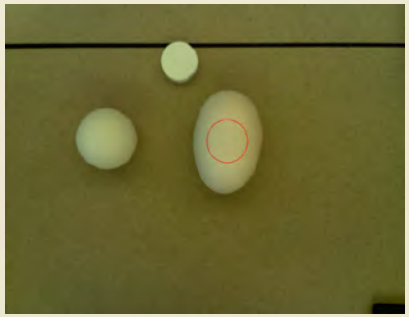
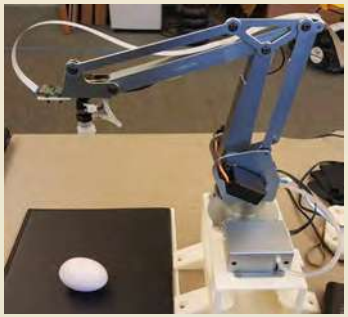
Automated Egg Picking

- Uses low cost robotic arm
  - uArm Swift Pro
  - Vacuum suction end effector
- Egg detection via DNN
  - 3D position identified
  - Robot issued waypoint
- Visual Servoing:
  - Camera on end effector
  - Fine adjustment of robot base
  - Final pick operation





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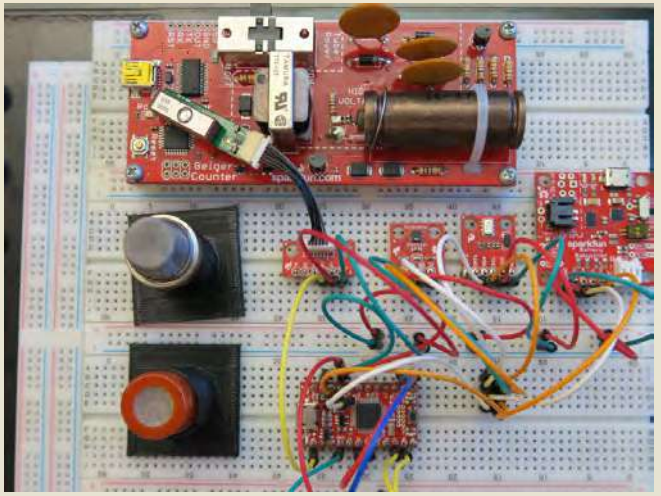
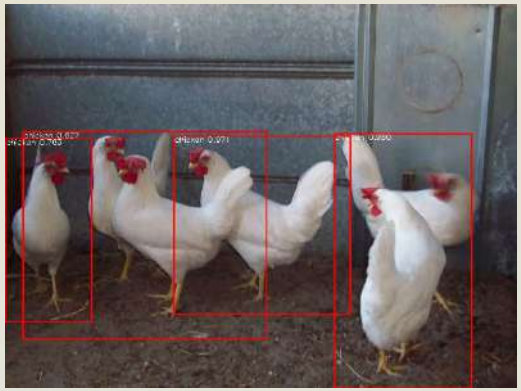
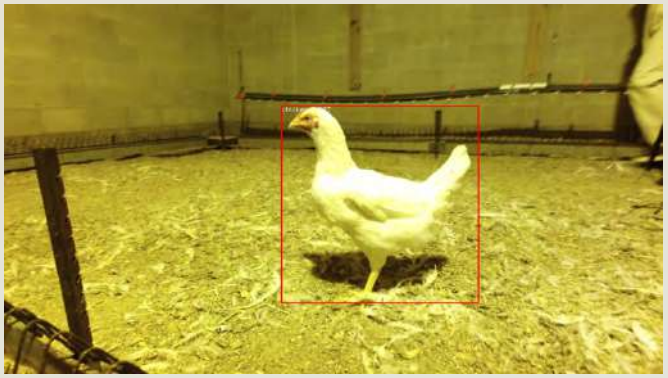
Sensing Enhancements

- Environmental sensing
  - Temperature
  - Gas
    - CO2, CO, CH4, LPG, NH3
- Vision-based sensing
  - Machine learning
    - Classification and segmentation







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Commercial House Testing

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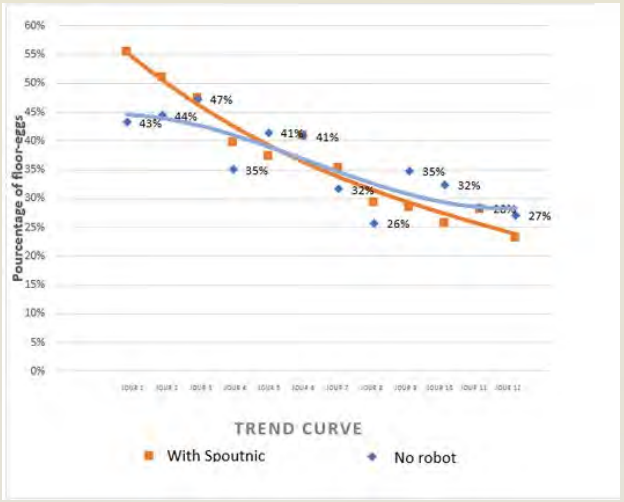
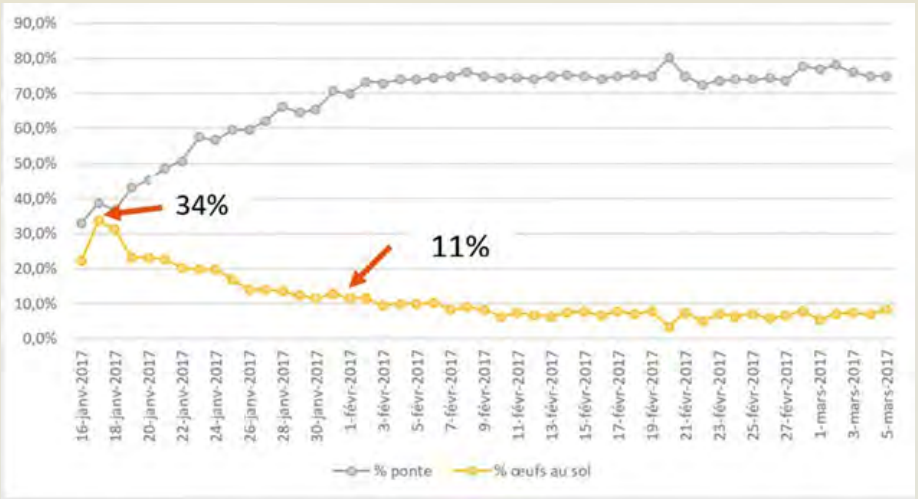
Commercial Systems

- Tibot
  - French company
  - Similar to Roomba
  - Moves through house to promote mobility
  - Reduces floor eggs (-23% in 15 days)





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Commercial Systems (Cont.)

- Octopus Robotics
  - Poultry house decontamination
  - Prevent and control disease
  - Monitor environment
  - Aerate litter

Commercial Systems (Cont.)

- Charoen Pokphand
  - Pinggu District, Beijing, China
  - 18 Houses, 168K hens/house
  - 1 human per house
- Robot housekeeper
  - Monitors house and hens
  - Feeding, egg collection, cleaning all automated

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Commercial Systems (Cont.)

- Metabolic Robotics
  - Robot feeders
- Tyson
  - High-tech hatchery
  - 6 Robotic Arms

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What Role Can Robotics Play?

- Sensing
  - Equipment
  - Environment
    - Temperature
    - Gasses
  - Animal welfare
- Manipulation
  - Floor egg removal
  - Mortality
  - Sampling
  - Litter distribution

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The GT Team!

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Acknowledgment

- Agricultural Technology Research Program
- Georgia Poultry Federation
- University of Georgia
- Georgia Tech
- Students!

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Thanks!!

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