ENGINEERING TOMORROW'S POULTRY INDUSTRY

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Researchers Test Refined Poultry House Robot in Push to Demonstrate Commercial Readiness

Researchers in the Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program (ATRP) have been on a years-long pursuit to develop a viable mobile robot assistant for managing chicken flocks in commercial poultry houses. The research team, led by Colin Usher, senior research scientist, has been hard at work the last two years field testing and hardening the robot, which shows promise as a fully autonomous solution for navigating and performing labor-intensive tasks specifically in broiler breeder houses.

ATRP researchers are field testing an autonomous mobile robot in a push to demonstrate its commercial readiness. The robotic assistant is designed to perform management tasks in commercial poultry houses with the goal of reducing labor while potentially mitigating disease and contamination factors.

Receiving Feedback from Potential Stakeholders

As the robot matured and neared a threshold for commercialization, the team obtained considerable feedback from potential customers and suppliers.

According to Usher, the customers, the chicken farmers themselves, pointedly made it clear that a robot that only senses the environment and provides information, while valuable, is just not enough. Farmers and farm hands have to enter the houses daily to remove mortality or pick up floor eggs. During this time, the farmers are visually observing the birds and doing their own data collection, making the robot a redundant system. "So, what would be most valuable to them is a robot that could perform the more labor-intensive tasks like egg picking and mortality removal," says Usher.

Equipment manufacturers, who would ultimately license the technology and commercialize a product, had a different kind of feedback. In addition to demonstrable performance of the system, they also want to see a more turnkey solution with a higher technology readiness level (TRL). "They essentially wanted to have a TRL 7-8, which is a system/subsystem development readiness level. At the time of this feedback, our robot was at a TRL 6, which is a technology demonstration level," explains Usher.

Addressing Chicken Farmer Concerns

To address the concerns of the chicken farmers, the team explored both egg picking and mortality removal. A custom robot arm was fabricated and tested for removing mortality. This arm was demonstrated lifting an object that weighed more than 20 pounds. Simultaneously, egg picking was explored for automated removal of floor eggs in broiler breeder houses. Ultimately, the team chose the egg picking function as a more viable entry point into the market, as broiler breeders are typically a higher value bird.

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Addressing Equipment Manufacturer Concerns

To address the concerns of the equipment manufacturers, several improvements to the robot system and subsystems were performed. This includes both software and hardware improvements to elevate the system's TRL. For hardware, researchers installed a battery management unit and automatic charging capability into the robot. In combination with a custom-developed docking station, the robot is now able to automatically dock and charge itself autonomously. They also changed the tires on the robot to ones more suited for the wood chip flooring in the poultry house. On the software front, several routines were added, such as an interface to support robot scheduling for operation and charging, more robust behaviors to reduce getting stuck while navigating, and a notification system that sends emails if the robot needs help or service. All of these enhancements lead to a higher TRL for the system, potentially making it more attractive to licensees. A picture of the robot docked on the charging station is shown in Figure 1.

Figure 1. Robot automatically docked on charging station.

Addressing Technical Challenges

The team recently completed a thorough evaluation of the robot's ability to successfully navigate a commercial broiler breeder house, which definitively demonstrated the robot's ability to move through the entire facility. This capability is achieved via interactions between the robot and the chickens, including actions such as stop/wait, nudge, circumnavigate, and advance. When a chicken is blocking the robot, it will stop for 2 seconds and wait for the chicken to move. If the chicken does not move, the robot will nudge the chicken to encourage it to move. If the chicken fails to move, the robot will plan around and circumnavigate the offending chicken. If the chicken moves out of the way, the robot will continue to advance along its path. On average, the robot was able to move approximately 15 feet per minute and traversed end-to-end repeatedly in a house 400 feet long containing approximately 15,000 chickens. Table 1 shows the average number of robot/bird interactions after traversing the entire house three times.

Table 1. Number of Robot/Bird Interactions by Type After Traversing the Entire House Three Times

Interaction Type	Average	Standard Deviation
Stop/Wait	291	41.3
Nudge	169	27.1
Circumnavigate	9.7	8.5
Advance	281	32.3

Table 2. Egg Detection Accuracy from Field Test 1

Total Number of Eggs	Total Number Detected	Success Rate
131	121	92.4%

Table 3. Egg Picking Accuracy from Field Test 2

Total Number of Eggs	Total Number Picked	Success Rate
108	91	84.3%

Automated floor egg removal is also currently being evaluated. A routine for dropping off eggs once the robot has filled its egg basket was implemented, allowing the robot to continuously pick up floor eggs without human intervention. This capability is achieved by tracking the number of eggs the robot has picked up, and when the basket is full, the robot will drive to a predetermined location and drop off the eggs. From the moment of detection, the robot typically picks up an egg in less than 1 minute. Tables 2 and 3 show current egg detection and egg picking success rates, respectively. The results are from two separate field tests. Further improvements are expected to increase accuracy rates.

Additional Field Testing Underway

Extensive field testing of the robot is underway with the goal of demonstrating a fully autonomous operation where the robot will run on a schedule, pick up eggs, and self-charge for continued hands-off operation. "We hope that this testing and demonstration of the robot's capabilities will lead to a desirable platform for realizing a commercial product," says Usher.

MANAGER'S CORNER

While many view the Agricultural Technology Research Program (ATRP) primarily as a research program, a pillar of our mission is to serve the industry through various forms of outreach. During the summer and fall, ATRP participated in several events that facilitated our outreach goals. I am pleased to share a brief overview of each, which allowed us to engage with not only our industry stakeholders but the general public as well.

In August, ATRP co-hosted the 40th National Safety Conference for the Poultry Industry with the U.S. Poultry & Egg Association in Sandestin, Florida. This event drew more than 200 worker safety and health professionals and vendors from all over the country. Discussion topics ranged from occupational health management, mental health awareness, onboarding and training, and industrial hygiene, to sanitation safety and managing contract workers in facilities. Part of the conference includes breakout sessions where this year participants shared best practices in fleet safety, workplace violence, hazardous materials response, lockout/tagout procedures, weather impacts and response, and workers' compensation claims management. Highlights of the event include a Washington update on current, new, and impending policies that will impact the industry as well as the ever-popular "ask the lawyer" session. The industry's commitment to team member safety is highly commendable, and it is having an impact as evidenced by the recent Department of Labor's Bureau of Labor Statistics reporting of a record low injury and illness rating for 2023 (https://www.bls.gov/iif).

In September, ATRP hosted the International Food Automation Networking (IFAN) conference in Atlanta, Georgia, focused on bringing together decision makers from the food and allied industries to discuss current and emerging technologies that could enable and impact the automation of food manufacturing. This year the conference attracted participants from 10 different countries representing many different food processing sectors. Hot topics included artificial intelligence, robotics, advanced sensing, food safety, human-robot interactions, as well as technologies to manage and recycle waste streams. Held every other year, the organizing team is already looking toward the 2026 event to be held in April in Atlanta.

In October, ATRP team members showcased a new robotics exhibit as part of the Poultry World exhibit at the Georgia National Fair. With funding provided by the USDA National Institute of Food and Agriculture, the team, which included undergraduate and high school students, assembled a chicken tender tray-packing demo that showed a 3D sensor and robotic arm detecting a collection of chicken tenders on a belt and then placing them in a case ready tray-pack. This demo was run continuously throughout the 10 days of the fair, with thousands of fairgogers, including school groups, stopping by to see it and the other exhibits on display.

Looking forward, ATRP is once again excited to be hosting a booth at the International Production & Processing Expo (IPPE) scheduled for January 28-30, 2025, at the Georgia World Congress Center in Atlanta. Researchers will showcase our poultry house robot and a one-handed rehang device for simplifying the post-chiller rehang process. Each of the projects highlights novel technologies that are being leveraged to solve key industry needs. The poultry house robot seeks to autonomously monitor and collect floor eggs in a broiler breeder house. The rehang device provides a contoured surface for locating and positioning a carcass for easier and faster transfer to the post-chiller shackle line. If you are planning to attend the Expo, be sure to visit us in Exhibit Hall C, Booth C19158.

As you can see it has been an extremely busy summer and fall for ATRP. However, one of the most rewarding aspects of conducting research is being able to share it with our key stakeholders and friends. And hopefully, ATRP can play a small role in inspiring others, whether it be the school children visiting the fair or seasoned professionals in the industry, to think creatively about solving challenges that keep the industry viable and successful in the long run.

Doug Britton, Ph.D.
ATRP Program Manager

RESEARCH Q&A

Multi-Mycotoxin Detection in Poultry Feed

Daniel Sabo, Ph.D., senior research scientist, discusses his research project "Multi-Mycotoxin Detection in Poultry Feed." The project is investigating the use of volatile organic compounds (VOCs) for earlier detection of mycotoxins in poultry feed to improve poultry health and reproduction rates.

Q: What industrial challenge is the project addressing?
A: Mycotoxins are a natural toxin produced by certain fungi. Poultry can get sick from ingesting these mycotoxins in the grain typically used in poultry feed. It has been reported that mycotoxin contamination contributes to $52.1 million to $1.68 billion in losses annually. This serious impact on poultry health and reproduction indicates that the detection and detoxification of mycotoxins are of high priority. Research has shown that the most common mycotoxins that impact poultry health include: aflatoxins, zearalenone, ochratoxin A, fumonisins, and deoxynivalenol.

Q: What is the project's approach and how is it different from current practice?
A: Today, there are typically two ways to measure for mycotoxins in grain and feeds: rapid (field-based) and slow (lab-based). Each has its advantages and disadvantages. The on-site tests, which are based on enzyme-linked immunosorbent assays (ELISA), produce results within 15 minutes. However, these tests lack sensitivity and selectivity and are unable to differentiate between mycotoxins. They are designed to screen for a predetermined concentration, and reported results are expressed as present/absent. The most often used lab-based tests are based on liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS), which allows for the detection of a high number of analytes. The detection of any number of mycotoxins and other targets of interest is possible with LC-MS/MS. The main drawback of lab-based measurements is the need to send samples out for analysis, slowing down the detection process significantly while increasing cost.

VOC collection of contaminated feed samples.

Over the last few years, we have performed studies that investigate the use of volatile organic compounds (VOCs) for the detection of aflatoxin (one type of mycotoxin) from both peanut plants and peanut pods. The results from those studies indicate that VOCs can be used to separate samples containing aflatoxin from uncontaminated samples.

Q: What are the results to date?
A: We have found that we can identify samples that contain mycotoxins compared to samples that are clean, meaning they have no contamination, using only VOCs. We are currently looking to improve the sensitivity and test the lowest concentration of mycotoxins that we can detect.

Q: What has been the most challenging and/or rewarding aspect of working on the project thus far?
A: The most challenging aspect is the separation of the various mycotoxin VOCs since we are working with five target mycotoxins. This will be one of the biggest hurdles that we will have to overcome. Additionally, the identification of the VOCs that are related to mycotoxins and separating them from other VOCs from the feed itself has and will be a challenge in our research to come.

Q: What are the project's next steps and long-term goals?
A: Our next steps are to continue to collect and analyze samples. By collecting a large enough sample set, we can then start to identify the VOCs that are related to mycotoxin contamination. Once these VOCs have been identified, we can then work on sensor development that will allow for rapid and accurate detection of mycotoxin contamination within minutes and without having to send it to a laboratory for analysis. This will save time and prevent losses due to mycotoxin-related illness and death in poultry.

Q: What are the potential benefits for poultry processors?
A: As noted earlier, mycotoxin contamination contributes to millions to billions of dollars in losses annually and seriously impacts poultry health and reproduction rates. Therefore, earlier detection of mycotoxin contamination of feed will help prevent its consumption. Further, detection of multiple different mycotoxins at the grain and feed production level would allow for "hot" loads to be removed from the production line, before the birds have a chance to eat it.

Q: Is there anything else you would like to add?
A: This has been an exciting project that has resulted in a promising collaboration with the Toxicology & Mycotoxin Research unit at USDA-ARS. They have donated the samples used for analysis, and have expressed interest in further collaborating on future mycotoxin detection research.

RESEARCHER PROFILE

Kamala Krishnan

Job title: Research Engineer I

Education: M.S., Robotics and Artificial Intelligence, University at Buffalo, New York
B.E., Computer Science and Engineering, Anna University, Chennai, India

Areas of research expertise: Machine Learning, Computer Vision, Vision for Robotics, AI for Automation

List of any poultry industry projects you're working on and your role: I'm actively involved in several innovative poultry projects, including:

- Developing AI-enabled simulations for precision farming in broiler houses
- Implementing state-of-the-art AI models for virtual reality interfaced with robotic operations for poultry processing
- Field testing and commercializing a poultry house management robot
- Automating scripting and AI modeling to identify diseased birds

What I find most rewarding about working on poultry industry projects: Contributing to the future of sustainable poultry farming through technology. I'm always in awe of how powerful and resourceful current technological advancements can help this field in various ways.

A talent I wish I had: I wish I could master an instrument, like the guitar or the piano.

Another occupation I'd like to try: I've always been fascinated by airplanes and aviation, so I'd love to be an Aeronautical Engineer or a Pilot.

My first job: Software Engineer internship at a startup

If I could meet someone famous, who would it be and why: Christopher Nolan, favorite filmmaker

One thing people may not know about me: I can speak five languages!

My day would not be complete without: Talking to my mom over the phone

The last book I read: *Kane and Abel* by Jeffrey Archer

The last movie I saw: The Martian

My favorite song: "What Goes Around ... Comes Around" by Justin Timberlake

My hobbies: Crocheting, working out, and playing video games

Visit ATRP in Booth C19158 — Exhibit Hall C at the 2025 International Production & Processing Expo

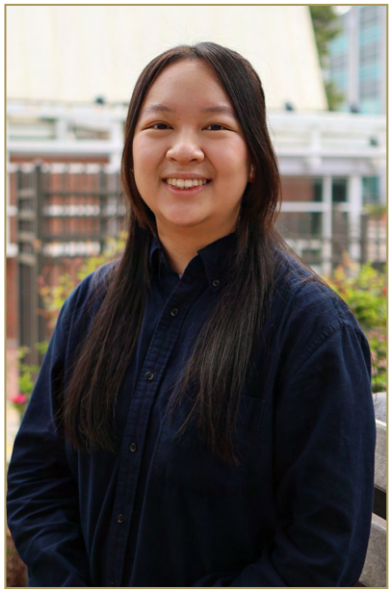
The Agricultural Technology Research Program (ATRP) is excited about its plans to participate in the 2025 International Production & Processing Expo (IPPE), scheduled for January 28-30, at the Georgia World Congress Center in Atlanta, Georgia.

ATRP's exhibit will highlight the program's research advancements and display prototype systems that seek engineering solutions that enhance process efficiency and product safety in today's poultry plant. Program researchers will be available to answer questions, and a program video and handouts will describe current projects.

For more information, visit ippexpo.org

Jenny Hou and Sidney Wise Selected as R. Harold and Patsy Harrison Student Interns in the Abit Massey Student Internship Program

The Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program (ATRP) has selected Jenny Hou and Sidney Wise as the latest R. Harold and Patsy Harrison Student Interns. The internships began with the Fall 2024 semester and will continue through the Spring 2025 semester.



Jenny Hou

Funded by an endowment from the R. Harold and Patsy Harrison Foundation, the internships are awarded to Georgia Tech students participating in ATRP's Abit Massey Student Internship Program. During the academic year, interns work alongside ATRP researchers on real-world challenges facing poultry production and processing, and have the opportunity to gain practical industry knowledge by networking with staff at local poultry companies. The goal is to prepare the next generation of researchers and professionals to produce significant advances in innovation and technology.

Hou, a fourth-year computer science major, is working with Walker Byrnes, research engineer II, on designing robotic systems for poultry processing applications with an emphasis on human-computer interaction. Hou, who is from Fremont, California, said she has always been interested in how robotics fits into our world today. "This internship will give me the opportunity to investigate a large industry in which robotics can have a big influence on how the industry advances," she said. "Being able to work closely with robots will allow me to learn and understand more about the dynamics between humans and robots, and explore how they can coexist harmoniously."

Sidney Wise

Wise, an Atlanta native, is pursuing a master's degree in robotics. She is working with Colin Usher, senior research scientist, on the development and field testing of an autonomous robot that can perform management tasks in commercial poultry houses, easing labor requirements while potentially mitigating disease and contamination factors. With research interests in human-robot interaction and artificial intelligence, Wise said she is excited to gain the technical skills and insights needed to excel as an engineer. "I love robotics and believe this internship will provide an opportunity for me to further explore my research interests with the goal of identifying the technology fields I am most interested in pursuing as a career."

"We are pleased to have Jenny and Sidney as our latest R. Harold and Patsy Harrison Student Interns. They are outstanding student researchers. We are also so thankful for the R. Harold and Pasty Harrison Foundation's support that allows us to provide these practical training opportunities to equip future technology leaders," said Doug Britton, ATRP program manager.

Established in 1973, ATRP develops advanced technology in support of Georgia's multibillion-dollar poultry industry, the state's leading agricultural sector. The technologies help poultry processors optimize operations and improve efficiency, safety, product yields, and environmental sustainability.

The R. Harold and Patsy Harrison Foundation was founded by the Harrisons' daughter, Bobbie Ann Harrison Reynolds, and her husband, Raymond H. Reynolds, Jr. (a Georgia Tech industrial engineering alumnus), in honor of her late parents with a primary goal to strengthen and support education. Her father founded Harrison Poultry in 1958 in Bethlehem, Georgia.

The Abit Massey Student Internship Program is in honor of the late Abit Massey, president emeritus of the Georgia Poultry Federation, who was instrumental in ATRP's founding.

U.S. Poultry Industry Provides 2 Million Jobs and $663.6 Billion in Economic Impact

Updated Study Quantifies the Economic Impact of the Poultry Industry in the United States

The U.S. Poultry & Egg Association (USPOULTRY), National Chicken Council, National Turkey Federation, and United Egg Producers recently released an updated economic impact study that highlights the positive impact the poultry industry has on jobs, wages, and federal and state revenue in the United States.

A dynamic and integral part of the national economy, the U.S. poultry industry provides 2,012,560 jobs, $132.7 billion in wages, $663.6 billion in economic activity, and $54 billion in government revenue.

"This valuable tool shows the positive economic impact the poultry and egg industry has on our nation and communities, and we are pleased to continue providing it," said Nath Morris, president of USPOULTRY.

The data is hosted on interactive websites that can be viewed collectively or by individual product, and then sorted nationally by state, congressional district, state house district or state senate district, and county. For more information about the U.S. poultry industry's economic impact, visit:

poultryfeedsamerica.org
chickenfeedsamerica.org
turkeyfeedsamerica.org
eggsfeedamerica.org

USPOULTRY funded the economic impact study, which was conducted by New York City-based John Dunham & Associates. The study was updated using the most current methodology available and uses data from 2024.

The study breaks down poultry into three subcategories: chicken, turkey, and eggs. Key economic data from each is shown below:

The chicken industry provides:
1,375,952 jobs
$90.9 billion in wages
$449.5 billion in economic activity
$36.7 billion in government revenue

The turkey industry provides:
423,707 jobs
$28.0 billion in wages
$138.7 billion in economic activity
$11.34 billion in government revenue

The egg industry provides:
163,829 jobs
$10.5 billion in wages
$58.2 billion in economic activity
$4.68 billion in government revenue

Technical Assistance Is Just a Phone Call Away

The Agricultural Technology Research Program (ATRP) provides no-cost technical assistance to Georgia-based firms and individuals in the poultry industry. These assists range from simple inquiries regarding information or help needed to address a problem to extensive on-site consultations in which researchers collect data and provide a report on their findings and recommendations.

The program also offers in-plant energy usage/cost assessments and workplace safety evaluations.

ATRP uses input from all assists to gauge situations calling for new research initiatives in energy, environmental, safety, and other areas.

To inquire about the program or to schedule an assist, call ATRP Program Manager Doug Britton at 404-407-8829 or email him at doug.britton@gtri.gatech.edu.

Organic: What Does the Organic Label Tell Me About My Chicken?

Is it safer or more nutritious?

According to the U.S. Department of Agriculture (USDA), the organic label does not indicate that the product has safety, quality, or nutritional attributes that are any higher than conventionally raised product.

The USDA requires that any product carrying the USDA Certified Organic seal, including poultry products, must meet the following guidelines set by the USDA's National Organic Standards Board:

- The chicken may not have antibiotics or hormones administered. Note: by law, no chicken you eat, organic or not, is given added hormones or steroids.
- The chicken must have been feed 100% organic feed and forage, including organic grains.
- The chicken must have had a degree of access to the outdoors.

Once the chicken goes to the processing plant, most of the practices are the same for chickens raised organically or conventionally. The major difference is that in processing chicken that is labeled organic, any processing aids or sanitizers used must also be approved for organic use.

Why are processing aids and sanitizers used at all?
Processing aids are substances approved by the U.S. Food & Drug Administration (FDA) and USDA to enhance food safety and reduce potential contamination during processing. One example is antimicrobials, which are commonly used in poultry processing. Food-grade antimicrobials, not to be confused with antibiotics, work to kill bacteria and foodborne pathogens like *Salmonella*. If an antimicrobial is used, it is used at levels determined by the USDA, which require substantial dilution.

Natural: What Does the Term "Natural" Mean?

The USDA regulates the use of the term "natural" on meat products, and according to USDA regulations, the term "natural" may be used on labeling for meat products if it meets the following guidelines:

- The product does not contain artificial ingredients, coloring ingredients, or chemical preservatives.
- The product is minimally processed.

According to the USDA, all natural products should include a brief statement on the product label that explains what is meant by the term "natural" (i.e., that the product is natural because it contains no artificial ingredients and is only minimally processed). This statement should appear directly beneath or beside all natural claims (or, if elsewhere, an asterisk should be used to tie the explanation to the claim).

Source: chickencheck.in/faq
(a website sponsored by the National Chicken Council)

Like Us on Facebook

ATRP's Facebook page features information about exciting research initiatives underway, interesting poultry and food industry news, industry events, photos, videos, and more!

facebook.com/ATRP.GTRI

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