Researchers Develop Robot to Autonomously Operate in a Poultry Growout House

Can a robot autonomously navigate a poultry house? Yes, say researchers with the Georgia Tech Research Institute’s (GTRI) Agricultural Technology Research Program.

Autonomous navigation for robots in commercial facilities is not a new thing, notes Colin Usher, GTRI research scientist and project director. In fact, the highly structured environments of manufacturing facilities are conducive for robotic tasks such as picking and placing items on pallets for warehousing. And more specifically, the robot’s actions are unhindered by humans who are trained to allow it to carry out its tasks.

“A poultry house full of chickens does not afford this luxury,” explains Usher. “A robot system that can operate in a poultry house must interact with the chickens. It must be able to navigate the environment and form plans without human intervention.”

The research team’s solution: a commercially available ground robot outfitted with 2D and 3D sensors and cameras. Nicknamed GOHBot, the Growout House Robot was initially manually operated in an experimental growout house at the University of Georgia (UGA) to establish the feasibility of operating robots in poultry houses. Results of this testing showed there to be no negative impact on the birds due to robotic systems operating in the flocks.

“Interestingly, it appears that the birds were even more comfortable with the GOHBot than with humans,” says Usher.

Having established the feasibility of operating a robotic vehicle in the house, the team set out to determine if autonomous navigation was possible. Autonomous navigation could open the door for robotic handling of tasks ranging from automatic removal of floor eggs in breeder houses to constant monitoring of birds for disease and well-being.

Here, the team studied several interactions between the GOHBot and the birds to establish a path/routine for the GOHBot based on the birds’ behaviors.

“Simply put, it can be expected that a chicken will move out of the way of the robot to allow it to move unhindered,” says Usher.

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Welcome to the Spring 2016 issue of PoultryTech. We have had a very exciting start to 2016.

We began the year with an outstanding showing of our Dynamic Filtration System for Poultry Processing Liquid Streams and Poultry Processing Plant Water Usage Simulation Model at the International Production & Processing Expo (IPPE) in Atlanta in January, where researchers met with many industry partners and answered questions.

We also tweaked our vision statement to better reflect our “thinking outside the box” approach to creating the next generation of poultry and food processing innovations . . .

**To Drive Transformational Innovation in Advanced Technologies for Poultry, Agribusiness, and Food Processing**

ATRP was honored to co-host the 2016 International Food Automation Networking (IFAN) Conference at the Georgia Tech Research Institute Conference Center on April 25-26, which for the first time ever was held in the United States. More than 70 food and allied industry professionals representing seven European countries, the United States, Canada, and Australia attended the two-day event, which focused on automation and technology R&D challenges/opportunities for creating the food processing system of the future.

Indeed, IFAN 2016 was such a success that attendees overwhelmingly recommended holding the next conference here in Atlanta again in 2018. I would like to express our sincere appreciation to conference founder and co-host, Koorosh Khodabandehloo of BMC, United Kingdom, as well as our 2016 sponsors: Australian Meat Processor Corporation, E+V Technology-Germany, BAADER LINCO, Georgia Manufacturing Extension Partnership program at Georgia Tech, and the Georgia Center of Innovation for Agribusiness.

We also held our annual Advisory Committee Meeting in May, which was well attended by our members who provided excellent feedback on the progress of our research program as well as ideas for new research thrusts. On behalf of ATRP researchers and staff, I would like to once again say “Thank You” to this outstanding group of external advisors, as much of our success would not be possible without their expertise and committed support.

As always, we value you, our loyal readers, and hope you enjoy this issue. And, if you have any comments or questions, please email us at poultrytech@gtri.gatech.edu.

Doug Britton, Ph.D.
ATRP Program Manager

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**Researchers Develop Robot to Autonomous Operate in a Poultry Growout House**

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But, what if the chicken does not move? Usher says if a chicken does not move, then the robot can encourage it to move by nudging it. If nudging fails to clear a path, the robot will then plan a new path around that chicken.

This robot autonomy navigation plan was implemented and tested using the GOHBot in a UGA experimental growout house. The house contained enough breeder-age birds to simulate the capacity of a commercial breeder production house. Video cameras were positioned to collect video data for the duration of testing. To date, the GOHBot has successfully completed more than 20 hours of fully autonomous operation.

Usher says no robot-to-bird incidents were recorded, establishing the GOHBot as a feasible robotic system for safe, autonomous operation in a flock of birds. A sample picture taken from the recorded video data during the experimental tests is shown below.

Autonomous operation in test facility.

Given the successes of the experimental tests, the team hopes to soon test the GOHBot in a full-scale commercial house. Talks are underway with a local poultry company.

If commercial tests prove just as successful, Usher says there is a multitude of potential poultry production applications for the GOHBot, including:

- Automatic removal of floor eggs in breeder and cage-free layer facilities
- Automatic removal and logging of cadavers
- Mobile sensing of temperature, humidity, ammonia, etc.
- Examination of equipment for proper operation
- Characterization of flock well-being
- Automatic weighing and sizing of flocks

“Our ultimate goal with the GOHBot is to completely eliminate, or at least, vastly minimize the need for farmers and farm hands to enter their growout houses,” says Usher. “This not only reduces labor, but could also reduce the incidence of contamination, whether chemical or biological, by minimizing the need for people to enter the houses.”
The U.S. poultry industry places a top priority on food safety. Yet, the dynamic nature of daily processing and the ubiquitous nature of pathogens require a constant vigilance that today cannot be completely ensured through real-time, accurate, and sensitive sensing. As a result, colony culturing (bacterial enrichment) or plate counts remain the preferred laboratory procedures for the detection of viable pathogens (bacterial, viral, parasitic, plus yeast and mold) and microbial toxins in food products.

These traditional culturing methods, while very effective and sensitive if the plating conditions are optimal, have a number of less than desirable drawbacks. The most often cited concern is that even with pathogens that exhibit rapid growth rates, 24 to 48 hours are typically needed to enrich, isolate, and then enumerate those pathogens. In addition, pathogens like Shiga toxin-producing Escherichia coli (STEC) can become injured but not inactivated during poultry processing, thus growing slower or not at all on culture media. Lastly, all detection methods must consider sampling methods as bacteria are not evenly distributed on the product, and growth may also be inhibited by the product surface. Thus, even with all of its challenges and intricacies, the enrichment step remains a critical stage for rapid STEC detection.

Project Overview

Here, a team of researchers at the Georgia Tech Research Institute (GTRI) are examining whether detection times might be reduced. They have developed a new technique that allows for faster bacterial enrichment, which they believe holds promise for improving pathogen prevention and control in large-volume poultry processing samples.

“We began working on new ways to concentrate bacteria. In reality, food producers are interested in detecting any possible STEC bacteria in finished products, so biosensing devices require enrichment or pre-concentration before sensing to compensate for extremely low concentrations, if any, in typical sample volumes relative to the overall processing volumes. The real challenge is quickly detecting the presence or absence of viable pathogenic bacteria in a representative sample,” explains John Pierson, GTRI principal research engineer and project director.

The team has examined several techniques for processing larger sample volumes that have low concentrations of STEC bacteria. One of the approaches currently being explored focuses on rapid initiation of exponential growth rates.

Bacteria initially undergo a lag period during which the apparent metabolic activity is insubstantial, explains Stephanie Richter, GTRI research associate. This stage is often attributed to bacterial acclimation to a new environment.

“If we can find a technical approach for minimizing the lag time before cell division becomes exponential, the period needed to achieve a detectable bacteria concentration will be greatly decreased,” says Richter.

For instance, the doubling time for Salmonella is about 20 minutes, so if every cell grew exponentially, the enrichment step could be complete in less than 2 hours. However, due to nutrient limitations and the secretion of inhibitory metabolites, enrichment takes significantly longer.

Initial Results and Next Steps

“We have some preliminary data that shows we can manipulate the enrichment broth in a novel way to not only reduce the lag time before exponential growth starts, but to subsequently increase the overall growth rate. Our approach is not related to any of our previous fluidics work,” says Pierson.

Specifically, preliminary results with Salmonella enterica serovar Typhimurium indicated that the technology performed significantly better than the control, yielding a 37.6% shorter lag time followed by a 109.6% greater growth rate.

“We believe our advanced enrichment technique moves us significantly closer to real-time detection, and it may facilitate the use of either plate counts or biosensors for rapid detection that is crucial for effective food safety standards and microbiological quality control,” says Pierson.

Moving forward, the team plans on demonstrating the technique with low concentrations of bacteria.

“We now have a more efficient approach for enriching low concentrations in triplicate across seven dilutions. The data continues to be promising,” says Richter.
**Removal of Free Fatty Acids from Rendered Oil**

**Daniel Sabo, Ph.D., research scientist, discusses his exploratory research project that is investigating the use of magnetic nanoparticles for removal of free fatty acids from rendered oil to improve oil quality and shelf life.**

**Q: PoultryTech – What is the goal of the project?**

**A: Sabo** – Rendered oil from poultry byproducts is typically used for animal feed. Secondary protein nutrients (SPN), also called dissolved air floatation (DAF) skimmings, have a high oil content, but also contain large amounts of free fatty acids (FFAs), particularly after rendering. This limits the usefulness of SPN as a raw material for the range of products typically supplied. Hexane is often used to extract residual oil, but the method does not separate the oil from the FFAs.

The goal of the project is to develop a low-cost and efficient method to remove FFAs from the oil using magnetic nanoparticles (MNPs).

**Q: PoultryTech – How does the method work?**

**A: Sabo** – The MNPs remove the FFAs from oil based on a chemisorption principle. Chemisorption produces a chemical reaction between a surface and any substance on the surface.

In this case, the MNPs collect the FFAs in the oil. Specifically, the surface of the MNPs is known to exhibit a high affinity for carboxylic acids, including fatty acids. This high affinity is the property that is exploited to remove FFAs from oil systems. All FFAs include a specific property that will chemisorb to the particle surface. Once the particles are removed from the oil using a magnet, the FFAs attached to the surface will also be removed, thus lowering the FFA level in the oil.

**Q: PoultryTech – What are the advantages of the method?**

**A: Sabo** – We use MNPs that are synthesized under very controlled conditions to capture FFAs efficiently from oil systems. By controlling the synthesis of the MNPs a higher surface area-to-volume ratio is achieved, resulting in higher FFA removal. The magnetic response of the nanoparticles allows for faster capture from the oil.

An added benefit is that it is easy to regenerate the surface of the MNPs, and the chemical stability of the nanoparticles allows the MNPs to be reused more times before replacement MNPs are required.

Another advantage of this method is the ability to remove FFAs from oil systems without the use of harsh chemicals, which eliminates traditional waste streams. Since FFAs have intrinsic value themselves, the ability to strip them from the nanoparticles and use them in other industries is beneficial.

**Q: PoultryTech – What are the initial testing results?**

**A: Sabo** – We have tested the MNPs with a variety of oils including olive oil, a low-FFA fat, and brown grease. In each, we were able to improve the percentage of FFAs removed by using the MNPs. For poultry processing, in particular, the brown grease FFA level was reduced from an unacceptable level of 5% to a desired level of 3.6% with only a 4% weight loading of MNPs. We were able to reduce the FFA level even more with a 10% weight loading of MNPs, resulting in a 55% FFA removal rate (5% down to 2.3%). The industry standard states FFA content has to be below 4% for stabilized pet food poultry fat. The lower the FFA, the better for shelf life and oil quality.
We are excited that our initial tests showed successful removal of FFA from poultry oil, demonstrating that it is possible to take a low-quality product and turn it into a higher value product using MNPs. In fact, we have filed an invention disclosure on the method.

**Q: PoultryTech – What are the project’s next steps?**

**A: Sabo** – We just recently discovered that heating the oil system almost doubled its FFA removal capacity, so we plan to test the effect of temperature on system optimization. We also plan to test the effect of particle size on the adsorption capacity of the MNP system and finalize the optimization process. Lastly, we hope to scale up the testing and begin prototype development of a FFA removal system using MNPs.

**Q: PoultryTech – What are the potential benefits for industry?**

**A: Sabo** – The ability to remove problematic FFAs from rendered oil and DAF skimmings would provide renderers more product mix flexibility. The processors would, in turn, receive better quality animal feed while also having a byproduct material with a higher value.

The extraction of FFAs would provide a significant benefit, particularly for the poultry and allied industries. Notably, from 2011-2014, the average price of poultry oil decreased from $990 per metric ton to $660. It would be a benefit to the renderer to be able to have more options regarding markets for the rendered oil.

### Technical Assistance Is Just a Phone Call Away

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. In-plant energy usage/cost assessments and workplace safety evaluations are also offered.

Last year, ATRP provided 31 tech assists in 17 cities around the state. The tech assists covered several areas, including automation, environmental management, food safety, worker safety, and information technology. The program uses input from all assists to gauge situations calling for new research initiatives.

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.

### RESEARCHER PROFILE

**Milad Navaei**

**Job title:** Research Engineer  
**Education:** Ph.D., Bioengineering; M.S., Mechanical Engineering; B.S., Mechanical Engineering — Georgia Institute of Technology  
**Areas of research expertise:** Micro/Nanoscale Technology, Electro-Mechanical Systems Design, Thin Films, Wearable Sensors, Energy and Thermal Sciences, System Integration, Bioengineering  
**List of any poultry industry projects you’re working on and your role:** Multi-function sensor systems for detection of ammonia (Project Lead)  
**What I find most rewarding about working on poultry industry projects:** Working on intellectually challenging problems and working with a group of smart and motivated people to tackle these problems  
**A talent I wish I had:** Speak all the languages of the world  
**Another occupation I’d like to try:** Professional race car driver  
**My first job:** Math tutor  
**If I could meet someone famous, who would it be and why:** President Obama, he is inspirational  
**One thing people may not know about me:** I have been to all 50 U.S. states  
**My day would not be complete without:** A cup of hot tea  
**The last book I read:** Physics of the Future  
**The last movie I saw:** The Jungle Book  
**My favorite song:** Viva La Vida by Cold Play  
**My motto:** Work hard, play hard  
**My hobbies:** Running, playing golf, reading, playing tennis
Last fall, OSHA announced a comprehensive special emphasis program focusing on poultry processing plants in OSHA regions covering all states from the Carolinas through Texas, beginning the inspection and enforcement phase of the emphasis program in late January.

In its guidance document, OSHA justifies the special emphasis program by pointing out that the rate of serious injuries for poultry processing workers is almost double the rate for workers in private industry. This is hardly an apples-to-apples comparison, as private industry also includes banking, insurance, and the retail and service industries, hardly jobs with significant risk of serious injury. A comparison of poultry to All Manufacturing seems more suitable and there we compare favorably.

We understand OSHA's role in helping keep workers safe, and certainly, it has the authority to determine if an industry deserves special attention. OSHA inspections are nothing new to the industry as there have been over 635 inspections in poultry processing plants in the past five years, so the agency is welcome to come in and evaluate our programs.

The industry and OSHA prepared for the emphasis program by holding an informational meeting hosted by the Georgia Tech Research Institute in early December 2015. Senior representatives from OSHA’s Regions 4 and 6 described the program and answered questions from approximately 40 safety directors from the industry.

OSHA is proposing to evaluate all aspects of workplace safety in poultry plants with special emphasis on ergonomics, recordkeeping, and process safety management in addition to the basic safety programs such as lock out and machine guarding. These special emphasis program inspections will be conducted by a team that may include a compliance safety and health officer, an ergonomist, an industrial hygienist, a process safety management expert, and a medical officer. Early indications are that these inspections will last for well over 30 days, highlighting the tremendous amount of resources OSHA has devoted to this program.

We are currently awaiting the results of the first round of special emphasis inspections and believe the industry is well prepared. Our industry safety professionals work hard every day evaluating and addressing hazards in the workplace, training employees, and maintaining the extensive paperwork required to document policies and programs. Their efforts are obvious and are reflected by OSHA recordable injury and illness rates, which have declined in poultry processing facilities by 81 percent in the last 20 years. Where once poultry injury rates were almost double the entire Manufacturing Sector, we are now within a few tenths of a percentage point.

The poultry industry has much to be proud of with respect to workplace safety as we have made great progress in reducing workplace injuries. Does this mean that we are satisfied with our safety programs? No, of course not. We know that every injury impacts someone’s life, someone’s family. We also know that there is always room for further improvement, and we’re working hard every day.
Gary McMurray, division chief of the Georgia Tech Research Institute’s (GTRI) Food Processing Technology Division (FPTD) and John Pierson, GTRI/FPTD principal research engineer, were recently appointed to serve on Scientific Advisory Councils of the Foundation for Food and Agriculture Research.

Members of the Foundation’s Advisory Councils provide advice and recommendations on policy and program development, program implementation, evaluation, and other matters of significance to the mission and goals of the Foundation. They are chosen based on their scientific or general experience and knowledge in a particular research target area.

A robotics and automation systems expert, McMurray serves on the Spurring Food System Innovation Advisory Council. Pierson, an environmental engineer with expertise in water reuse and recycling systems, serves on the Optimizing Agricultural Water Use Advisory Council. Both are serving a three-year term, which began in April 2016.

“It is an honor to serve as a scientific advisor in the spurring food system innovation target area. I am excited to work with my fellow members to advance the food production system of the future by fostering innovative R&D,” says McMurray.

“I look forward to contributing to the national research agenda on agricultural resource sustainability by outlining ways to develop and optimize systems to extend the industry’s water use,” says Pierson.

Five additional advisory councils cover the following research target areas: transforming soil health; enhancing sustainable farm animal productivity, resilience, and health; improving plant efficiency; achieving a deeper understanding of nutrition and healthy food choices; and managing food production systems to enhance human nutritional outcomes.

The Foundation, a non-profit organization, was established by the 2014 Farm Bill with the goal of complementing and furthering the important work of the U.S. Department of Agriculture. Its mission is to build unique partnerships to support innovative science addressing today’s food and agriculture challenges. The Foundation exists to:

- fund cutting-edge research and development through grants and innovation challenges
- build unique public-private partnerships
- convene stakeholders and thought leaders to foster collaboration
- build human capacity and inspire the next generation of food and agriculture scientists
- utilize social, physical, and biological sciences to answer research questions

To learn more about the Foundation for Food and Agriculture Research, visit www.foundationfar.org.

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**McMurray and Pierson Appointed to Agriculture Scientific Advisory Councils**

**Gary McMurray**

**John Pierson**

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**REGISTER NOW**

**August 15-17, 2016**

**Hilton Sandestin Beach Golf Resort & Spa**

**Destin, Florida**

The 2016 National Safety Conference for the Poultry Industry is designed specifically for poultry facility and corporate safety personnel, as a three-day event with key presentations on important industry topics and updates on government policy. Other highlights include breakout sessions for discussing best practices and current challenges, as well as networking and knowledge exchange opportunities with other safety and health professionals.

To register, visit www.uspoultry.org/educationprograms

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[Logos of ATRP, National Chicken Council, National Turkey Federation, U.S. Poultry & Egg Association]
Georgia Manufacturing Extension Partnership Offers Energy and Environmental Webinar Series

The Georgia Manufacturing Extension Partnership (GaMEP) program at Georgia Tech is offering a series of free, one-hour webinars on energy and environmental issues affecting manufacturers across Georgia.

After each webinar, a discussion board will be opened on the GaMEP website at www.gamep.org/forums, where questions will be addressed on the topic.

GaMEP helps manufacturers increase top-line growth and reduce bottom-line costs. With 10 regional offices across the state, GaMEP offers a solution-based approach through coaching, implementation, and training in areas such as: Business Development, Process Improvement, Sustainability, Energy, and ISO Standards. To learn more about GaMEP, visit www.gamep.org.

UPCOMING WEBINARS

Achieving Energy Savings Through Behavioral Change  
August 19, 2016 – 11:30 a.m. - 12:30 p.m.  
Register at http://bit.ly/1Z7x7Px

Typically energy improvements focus on technological and economic approaches, but what about people? Learn to change your team’s energy behavior, which will contribute to greater results in energy.

Greenhouse Gas Reporting (GHG) and How Your Plant Is Affected  
October 21, 2016 – 11:30 a.m. - 12:30 p.m.  
Register at http://bit.ly/1Pas8x7

GHG Reporting can be complicated. During this webinar, GaMEP will teach you about emissions, who should report, what data is important, how to collect it, and with whom to submit the reports.

Stormwater Pollution Prevention (SWPPP) Compliance  
December 9, 2016 – 11:30 a.m. - 12:30 p.m.  
Register at http://bit.ly/1qW6MrV

Understand mandatory inspections and reporting activities and learn how to create and maintain a compliance calendar to keep your company on track of inspections.

Additional topics are scheduled for Spring 2017, including ISO 45001 Occupational Health and Safety Management System, Discover Energy Savings Within Your Plant Systems, and Using Online Tools to Track Your Energy Footprint. Registration for these webinars will open in Fall 2016; contact Sandra Enciso by email at sandra.enciso@innovate.gatech.edu for further details.

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

www.facebook.com/ATRP.GTRI

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