Audio Analysis: A Path to Monitoring the Well-Being of Birds in Confined Housing

Walk into any broiler (chickens raised for their meat) growout house and you will hear an interesting chorus. An array of chirps, clucks, and squawks abound. Researchers at the Georgia Tech Research Institute (GTRI) are discovering that the unique sounds actually tell a lot about the birds’ well-being. Using their machine learning-based Growout Monitoring System, the team has characterized when birds are under stress due to sickness or adverse environmental conditions inside the house.

“It is well-known that environmental conditions during broiler growout can affect the performance of the birds,” explains Dr. Wayne Daley, GTRI principal research engineer and project director. “The goal of the research has been to monitor various audio characteristics of the birds to determine the flock’s health status and well-being based on environmental conditions.”

Early detection of adverse conditions or sickness can mean quicker intervention, saving dollars and birds, notes Daley. In other words, vocalizations can equal warning signs, and more importantly, understanding what they mean could help to improve production efficiency and bird well-being.

The system includes a computer data collection station and interconnected recording microphones. It uses machine learning algorithms to analyze the audio data (bird sounds, also known as vocalizations) and then trains the system to characterize those vocalizations. The techniques use Mel Frequency Cepstral Coefficients (MFCCs are typically used in speech analysis) along with other statistical and spectral features to extract and track significant occurrences from the audio stream. One-minute segments from this stream are then processed in a Vocalization Processing Testbed (VPT) that houses the algorithms that process the data.

Working with colleagues at the University of Georgia (UGA), Daley’s team has recorded thousands of hours of audio from birds grown in experimental conditions.

In several studies conducted at UGA’s Poultry Research Farm, data was collected under normal and stressed (temperature increased 10 degrees...
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above normal) growing conditions. Analyses of the data showed that it is possible to detect a change in the vocalizations of the birds due to a change in temperature. Similarly, two separate studies at UGA’s Poultry Diagnostic and Research Center investigated the correlations of vocalizations to two common broiler diseases: Infectious Bronchitis and Laryngotracheitis (LT). In both experiments, algorithms identified vocalizations that correlate with the progression of the diseases.

Recently, the team performed a study on breeders (chickens that are the parent stock for broiler chickens) being raised under different feeding regimens (i.e., birds fed every day vs. birds fed every other day) to determine if differences in vocalizations would be apparent between the feeding regimens. Preliminary data indicates that the rates of the vocalizations appear to be different on the off days.

“Our research to date shows that it is possible to determine the conditions of birds based on their vocalizations,” says Daley. “The question now being explored is how best to implement a system that uses this information to support farm managers in optimizing their production with animal well-being as one of the significant drivers.”

To address that question, researchers are refining the VPT and developing tools to make the system easier to use for practical field operation.

“In our current mode, we would have to detect every type of occurrence. This could be extremely difficult as you move from house to house and environment to environment. The approach now being explored is to detect anomalies,” explains Daley.

Simply put, the system learns to describe the acceptable environment and then looks for significant deviations that would signal a change that should be addressed. Daley says these could be described as novel or anomalous events. The team hopes these anomalous occurrences could be used to create a descriptor of well-being that could constantly be provided to the growout house manager for action when the need arises.

Researchers are also investigating the use of low-cost computers like the Raspberry Pi to acquire and analyze audio data, and have developed a smart phone app on the Android platform. The app is called SCAR (Sick Chicken Audio Recorder) and can be used to easily record audio samples in minutes, hours, or days.

“It is now possible to visualize an ecosystem that allows for overall confined housing management where data is collected and processed to determine the overall conditions of the birds,” says Daley.

Some of this data processing could be done remotely, reducing the power and computational capability needed locally while also ensuring that the data is being processed by the latest algorithms and classifiers.

“Successful implementation would provide the farm manager and integrator with significant control over the production process including almost 24/7 monitoring of the environment. This should enable a quick response to environmental or health issues based on a measure of the actual condition of the birds,” adds Daley.
Robotic handling technologies have been commonplace in the manufacturing industries for years. Think of an automobile production line where manufactured parts are usually very consistent, structurally rigid, and have known geometries. All these attributes make robotic handling fairly straightforward.

But this is not the case for production environments comprised mostly of non-uniform, naturally flexible parts like poultry products. As a result, automated handling of natural products lags far behind that of manufactured parts.

Here, researchers in the Georgia Tech Research Institute’s Agricultural Technology Research Program are exploring the development of better robotic imaging and sensing technologies and more dexterous grippers and manipulators for poultry handling tasks.

“We believe available commercial off-the-shelf hardware, particularly robot arms and grippers, are capable of properly handling and manipulating natural products,” says Dr. Ai-Ping Hu, project director and senior research engineer. However, hardware is just the beginning.

Hu and fellow researchers need to train the robotic arms and grippers to adjust to variable objects like a human hand does. So, the team chose to demonstrate the processing task of loading bird front-halves from a stationary pile onto moving deboning cone lines. The first step was to observe human workers performing the task. The team learned that workers will often first lift up a bird in an arbitrary way (to separate it from the pile) and then place it on a flat surface momentarily (slightly re-orienting it) before re-grabbing it (in a standardized way) and placing the bird onto the moving cone.

With knowledge of how humans perform the task, researchers then developed an experimental platform along with imaging and sensing algorithms. The main components include a six-degrees-of-freedom KUKA food-grade industrial robot, a three-finger adaptive robot gripper by Robotiq, and a Microsoft Kinect 3D sensor (see figure). The Robotiq gripper (hand) is affixed to the KUKA robot’s arm, while the Kinect sensor is used to obtain 3D recognition of the bird, first from within the pile and then how it is grasped in the gripper.

Next, using the experimental platform and an articulated 3D-printed bird front half — composed of a separate wing and body connected by a mechanical joint that simulates a bird shoulder — the team deconstructed the human approach into five steps:

1. Take a 3D image of a bird pile.
2. Use image processing to determine which wing should be grasped.
3. Use the robot gripper to approach and grasp the identified wing and lift the bird to an intermediate position.
4. Take another 3D image of the bird to determine its orientation in the robot gripper.
5. Determine the optimal path for the robot gripper to place the bird onto a moving cone facing a preferred direction.

The result is a dynamic motion imparted from the robot gripper, through the wing, to the bird’s body.

“Because a bird is not a rigid object, it won’t simply follow the movements of the robot gripper. The team’s robotic task is to design the gripper motion to act through the wing and shoulder joint to get the bird to move in a desired way onto the cone. As an analogy, we like to refer to the ball-in-cup game where a ball is attached to a cup by a string. The player has to move the cup to use the string to force the ball into it,” explains Hu.

The team is using the articulated 3D-printed bird to research and design robot motions and plans to begin testing on real birds next year. The intention is that the articulated bird will capture the important dynamic features of real birds, even though it is not a perfect model.

Hu believes, if successful with real birds, the developed robot technology will find numerous applications in the food processing and agricultural sectors where interaction with naturally flexible and non-uniform products is an everyday challenge.
Researchers at the Georgia Tech Research Institute (GTRI) have optimized their proprietary filtration method for processing facility effluents. The so-called dynamic filtration method was tested on actual processing effluent and found to provide significant advantages over currently used filtration methods. Specifically, dynamic filtration gives increased recovery of fine suspended solids such as fats and proteins, providing more material for rendering. It also provides enhanced opportunities for water reuse and recycling inside a processing plant.

The research team, led by John Pierson, principal research engineer, has filed a full patent application under the name Cyclic Filtration System. Research efforts are now focused on confirming scale-up design parameters that achieve high throughput with optimal filtrate quality.

“The preliminary development work used commercially available off-the-shelf components to fabricate the filter apparatus versus manufacturing a one-off prototype,” says Pierson. “The scale-up will follow the same approach, but build on the lessons learned regarding the physical rate processes affected by scale.”

While the off-the-shelf parts were relatively inexpensive, the team used a more costly servo motor driven with a programmable logic controller (PLC) to provide motive force. The servo with PLC was used so that in addition to time, the team could monitor position, torque, or pressure data, and use that data as feedback for managing the flux rate and backwash.

Moving forward, researchers plan on constructing a device that will more closely resemble a commercial prototype, which means using a variable frequency drive and pneumatic actuated valves.

Pierson says funding from the U.S. Poultry & Egg Association’s Harold E. Ford Foundation allowed the team to understand the considerations that needed to be addressed to move from a bench-top device toward a prototype that could be demonstrated on-site.

“With base funding from GTRI’s Agricultural Technology Research Program (ATRP), we have commissioned a device that has about five-times the total chamber volume of the first machine. Using the servo motor and position feedback control, we can simulate a variety of chamber sizes in order to ensure the design parameters are valid,” adds Pierson.

Current research efforts are focused on validating the design parameters needed to scale-up the bench system. According to Pierson, three criteria for scaling-up the system have been identified, and work is underway to verify those. These include confirming the volumetric flow versus working volume ratio for the new prototype, considerations for the inlet design, and maintaining the flux rate. An additional objective is to confirm the overall balance of system requirements for scaling-up, depending on the flow rate and separation surface selected.

“We know that poultry processors want a device that is ‘fit for purpose,’ or in other words, ready to treat poultry processing water. Our goal is to examine all the system components that are needed to make our system work so that licensing partners have the best starting point from which to work,” comments Aklilu Giorges, GTRI senior research engineer and co-inventor.

The team is actively seeking an industrial licensing partner that can bring the technology to market. In fact, plans are underway to showcase the technology in ATRP’s booth at the 2016 International Production & Processing Expo (IPPE) scheduled for January 26-28 in Atlanta. The Expo is the world’s largest trade show for the poultry, meat, and feed industry.

“We are really looking forward to the IPPE, which will give us unparalleled exposure to industry experts within the poultry processing business, including equipment specialists and suppliers of separation technologies,” says Dr. Doug Britton, ATRP program manager.

Such exposure, adds Britton, will hopefully bring the Cyclic Filtration System one step closer to making its way to processing plants.
Poultry World Celebrates 20th Anniversary

Poultry World tells the storied history of Georgia’s number one agribusiness sector. 2015 marked the award-winning exhibit’s 20th Anniversary at the Georgia National Fair in Perry. Brand-new interactive displays highlight the poultry industry from farm to table, while other additions showcase allied industries and educational and career possibilities. A private grand re-opening ceremony was held October 8 and attended by several agricultural and poultry leaders, including Georgia Commissioner of Agriculture Gary Black. You can view a video of the ceremony at https://youtu.be/vgJKFurPmWI.

Poultry World was established in 1995 by the Georgia Poultry Federation, along with industry and academic partners, including the Georgia Tech Research Institute’s Agricultural Technology Research Program.

Here’s a look inside the new Poultry World and a glimpse of what supporters had to say.

“The poultry industry does it right. … What you have is a professional exhibit that is going to touch a lot of lives. … It’s a premier exhibit.”
– Gary Black, Georgia Commissioner of Agriculture

“I think it’s wonderful. … It’s very attractive. It’s engaging. And that’s what you want in an exhibit.”
– Craig Wyvill, Retired Director, Agricultural Technology Research Program

“With the 20th Anniversary, we thought it was a great opportunity to put a fresh face on the exhibit and think of different ways to tell the story that we’re so proud of in the poultry industry.”
– Mike Giles, President, Georgia Poultry Federation

“I think it’s very exciting. … It’s beautiful. It tells the story very well. … I think it’s going to clearly be the most popular exhibit at the Georgia National Fair.”
– Abit Massey, President Emeritus, Georgia Poultry Federation

“The visuals are beautiful. … As you walk through, you’ve got the whole story. Very nice.”
– Dr. Louise Dufour-Zavala, Executive Director, Georgia Poultry Laboratory Network

“I think it turned out great. It looks fresh, new, modern, catches your attention. It’s just really a nice job. Designed to be educational. It’s going to be a big hit.”
– Dr. Mike Lacy, Department Head, University of Georgia, Department of Poultry Science

“A lot of people contributed in many different ways, so I think it’s really a fantastic showpiece for the industry but also for the universities to show that agriculture is high tech and there’s a lot of engineering and science that goes into modern agriculture.”
– Dr. Doug Britton, Program Manager, Agricultural Technology Research Program
Since December 8, 2014, the United States has been dealing with an ongoing outbreak of highly pathogenic avian influenza (HPAI) H5. Wild waterfowl, migrating south from Canada along the Pacific Flyway, brought the virus to the U.S.

While the HPAI H5 virus has caused some severe devastation for the U.S. commercial poultry industry, there have been no reports of infections in humans, and the Centers for Disease Control and Prevention (CDC) considers the risk to people from this virus to be low.

The first U.S. cases were identified along the West Coast — Washington, Oregon, and California — in wild bird populations. Since then, the virus spread from wild birds to commercial poultry in 15 states. To date, 219 individual detections have been recorded and just over 48 million birds have been euthanized as a result of HPAI.

The last detection was June 17, 2015. Most experts expect the virus to reappear when the waterfowl again begin their annual migration this winter.

The original virus strain was H5N8, but it mixed with other viruses in bird populations in the flyway, and the H5N2 and H5N1 strains emerged.

Nearly all previous cases of human infections with avian influenza involved close, direct contact with infected poultry, but little to no direct transmission from person to person. Humans won’t be infected with avian influenza by eating chicken or poultry products.

Influenza comes in three types: A, B, and C. Avian influenza is a type A influenza virus that occurs naturally in wild, aquatic birds worldwide. Type A influenza has been the source of every pandemic outbreak of flu; however, type A influenza viruses do not usually infect humans.

Type C influenza causes mild disease in humans. Type B influenza causes more severe disease in humans but has never caused a worldwide pandemic.

Those who get an annual flu shot might be familiar with another designation for influenza: H and N. This refers to the hemagglutinin and neuraminidase proteins that are present on the surface of all influenza viruses. These proteins are used to identify each strain of the influenza virus. The H protein also helps to determine how pathogenic, or severe, a virus may be.

There are currently 16 H- and nine N-type proteins known. Avian influenza can be found in all combinations of H and N, though only the H5 and H7 subtypes can be highly pathogenic for poultry.

In the rare instances in which there were reported cases of human infections with type A avian influenza, direct or close contact to live, infected poultry was identified as the originating source. The spread of type A avian influenza viruses from person to person is rare.

H7 avian influenza did infect people in China in 2013 and in British Columbia, Canada, in 2015. In both cases, the people were in close contact with live, infected birds in China. Documented cases have been sporadic and not widespread.

Of course, there is always a chance that type A influenza could develop the potential to infect and spread easily among humans. Extensive monitoring protocols are followed by state and national government agencies for both human and poultry infections.

The current HPAI H5 outbreak in the U.S. is a concern for the commercial poultry industry, not the general population. This virus is not likely to infect people. It is being very closely monitored, and all infected birds are properly disposed of and documented.

For more information on avian influenza, visit http://cdc.gov/flu/avianflu.
Animal Agriculture Sustainability Summit at 2016 IPPE

The International Production & Processing Expo (IPPE) will host the eighth annual Animal Agriculture Sustainability Summit during the 2016 Expo. The half-day program will be held Tuesday, January 26, from 9 a.m. to noon, in Room A-411 at the Georgia World Congress Center in Atlanta. The program is free to all IPPE attendees, and will provide viewpoints from industry and agriculture experts on sustainability and why it matters to the animal agriculture industry.

Scheduled Speakers/Topics

Dr. Marty Matlock and Dr. Greg Thoma, University of Arkansas
Retrospective Analysis of U.S. Poultry Production — A 50-Year Comparison of the Meat Bird Industry’s Sustainability

Dr. Joy Mench, University of California, Davis
The Sustainability of the Layer Industry — Laying Hen Housing Research — The Coalition for Sustainable Egg Supply

Dr. Claudia Dunkley, University of Georgia
Carbon Footprint Tool for Poultry and Egg Producers

In addition to the above presentations, a panel discussion by the Poultry & Egg Industry Sustainability Workgroup will provide an update on the Poultry and Egg Industry Sustainability Assessment Program. The Summit will conclude with a ceremony to recognize and present honors to winners of the 2016 Family Farm Environmental Excellence Award.

The 2016 Expo will be held January 26-28, at the Georgia World Congress Center in Atlanta. Visit www.ippexpo.org for more information and to register to attend.

Researcher Profile

Alex Samoylov

Job title: Senior Research Scientist

Education: Ph.D., Civil and Environmental Engineering, Georgia Institute of Technology; M.S., Information Systems, Georgia State University; B.B.A., Computer Information Systems, Georgia State University

Areas of research expertise: Air Quality, Poultry Systems, Modeling

List of any poultry industry projects you’re working on and your role: Currently, I work on several poultry projects: I am the Principal Investigator (PI) for “On-Farm Harvesting, Stunning, Slaughtering, Loading, and Unloading” project, which is evaluating the suitability and economic feasibility of using new technologies for on-farm bird harvesting and related tasks.

I am the Co-PI on the “Poultry System Simulation Model” project where we are generating a systems-based model of water usage in a typical poultry processing plant with the goal of defining areas to potentially improve water quality or reduce water use.

I also work on the “Correlations with Broiler Processing Characteristics and Genetic Traits” project as an experiment designer and statistics lead. The project is exploring the weight and physical measures of different genetic species of broilers in an effort to determine the most efficient processing machinery.

What I find most rewarding about working on poultry industry projects: Being able to transform and shape the way that the poultry industry will look in the future

A talent I wish I had: I wish I had many talents that I do not possess, but if I have to list one, it would be the talent of a great writer.

Another occupation I’d like to try: Race car driver

My first job: Landscaper

One thing people may not know about me: I used to be able to solve a Rubik’s Cube in 50 seconds.

My day would not be complete without: Each day is different, one day it may not be complete without hugging and kissing my wife and daughter, the other without reading something new, etc.

The last book I read: Countdown to Zero Day: Stuxnet and the Launch of the World’s First Digital Weapon

My motto: “If you aren’t in over your head, how do you know how tall you are?”

My hobbies: Collecting license plates and playing golf
Visit ATRP’s Exhibit in Booth B9 at the 2016 International Production & Processing Expo

The Agricultural Technology Research Program (ATRP) is excited about its plans to participate in the 2016 International Production & Processing Expo (IPPE), scheduled for January 26-28, at the Georgia World Congress Center in Atlanta.

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 industry.

Program researchers will be available to answer questions, and a program video and handouts will describe current projects.

THE EXHIBIT WILL BE LOCATED IN EXHIBIT HALL B, LEVEL 2, BOOTH B9.

The IPPE is a collaboration of three trade shows — International Feed Expo, International Meat Expo, and the International Poultry Expo — representing the entire chain of protein production and processing. The event is sponsored by the American Feed Industry Association, North American Meat Institute, and U.S. Poultry & Egg Association.

For more information, visit www.ippexpo.org.

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.

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.

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!

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