BCOE Undergraduate Research Initiative

PROJECT TITLE: Physical Dimensions, Surface Area, and Envelope Volume of Modern Poultry Birds

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PROJECT ABSTRACT:
Mississippi’s climate is classified as humid-subtropical, having hot, humid summers. These weather conditions can precipitate thermal conditions in poultry housing which can compromise bird well-being and cause decreased production efficiency, requiring more feed and energy to reach market weight. Energy (heat) exchanged between an animal and its environment occurs via conduction, convection, and radiation, as well as through evaporation. In terms of broiler housing (especially tunnel-ventilated housing), increasing heat loss through convection is most easily accomplished. Convective heat losses will increase with air velocity as the boundary layer, which acts as insulation, is reduced. Hence, core body temperature of the bird will change with external temperature and air velocity. Recent tests at the USDA-ARS Poultry Research Unit (PRU) compared air velocities of 3.8 m s⁻¹ and 2.8 m s⁻¹ at moderate temperatures (27 °C) and found decreased body temperatures for birds in the 3.8 m s⁻¹ treatment for 52 d old birds. Multiple studies have documented the production benefits of increased air velocity in broilers, improving feed efficiency and body weight gain. The ability to accurately model convective heat transfer from birds would allow for the evaluation of the effects of differing thermal conditions, evaporative cooling systems, and ventilation strategies on bird body temperature and performance. There is an ASABE standard for livestock and poultry dimensions, however, poultry only illustrates weights by day of age (no physical dimensions, surface areas, or volumes). The objective of the overall ABE - PRU collaboration is to model heat exchange between the birds and environment to improve methods of heat transfer, bird thermal comfort and well-being, and to reduce energy use. The objective of this U.R.I. project is to characterize surface area, envelope volume, and body geometries of poultry broilers and layers to improve estimates of convective heat loss coefficients.

We have developed a 3D scanning methodology using a Creaform Megacapturor 3D Digitizer (~$80,000) and a commercially available software package to determine the above parameters with full-scale fiberglass models of farm animals (chicken, pig, dairy cow and horse). The non-invasive system uses four cameras with a built-in contour projector to scan an animal over a 3-4 s period. Broiler and layer birds will be provided and housed by USDA ARS PRU. Birds will be scanned and processed to develop 3D models to calculate envelope volume and surface area. Methods to determine important physical dimensions (height, width, length, girth, etc.) from the 3D models will also be developed and characterized. An IACUC will be submitted upon acceptance.

Anticipated Outcomes/Impacts:
Poultry is Mississippi’s most valuable agricultural commodity valued at $2.3 billion and produced on 1,478 farms in 2012. Mississippi is home to the fourth largest broiler integrator, Sanderson Farms. We need these 3D models to find a way to increase heat removal, thus be able to increase bird performance (better feed conversion ratios) or use fewer fans (less energy) or combination of both.

The 3D models will be utilized in our 3D CFD broiler house model to improve our understanding of the bird-airflow interface. Secondarily, the models and data will be used to revise Standard ASABE D321.2 Dimensions of Livestock and Poultry. This will assist in housing and equipment design and provide quantitative data for animal welfare discussions. The student will develop a conference proceeding and present the findings in the American Society of Agricultural and Biological Engineers (ASABE) Undergrad. Res. Competition. I hope to make the digital 3D models available open-source so they can be used by other researchers. Peer journal article will follow.
Required qualifications: Self-driven student willing to learn new technologies and spend the time to develop accurate models of live animals. Student must be willing to be trained and work with live animals.

Preferred Qualifications: Student with an understanding of computer aided drafting (CAD) software programs or basic understanding of 3D modeling methodologies and terminology. Student that can be available to continue during part of the summer months.

Expected Number of UG Researcher Positions: One UG Student

Expected Hours Per Week: 20hr/week depending upon class schedules in Fall and Spring. 40/hr week during Summer.