Researchers study sounds from colliding football helmets as alternative to understanding forces

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When football helmets collide, they produce an unmistakable sound. With concerns rising over concussion risks, some parents and others are increasingly concerned about each pop they hear.

Now, the sounds themselves are being studied.

University of Alabama student Brandon McChristian hopes his research of those sound waves begins the process of better understanding the forces involved in those collisions and, perhaps one day, enables inexpensive sensing methods for a safer game.

Working with Dr. Steve Shepard, a UA engineering professor, McChristian used a special University lab designed to eliminate acoustic reflections, microphones, a high-tech signal analyzer, a couple of helmets borrowed from the athletic department and some good ol' fashioned string to prove a direct correlation between sound energy and helmet impact energy.

Shepard recently incorporated data from McChristian's proof-of-concept research into a grant funding proposal to the National Science Foundation. The University has already filed a patent application on the technology, and, if additional research funding is secured, Shepard hopes to further develop methods for assessing helmet impact severity using sound.

McChristian, a sophomore from Nashville, Tennessee majoring in mechanical engineering, is one of more than 700 students who will present research findings April 7 during UA's annual Undergraduate Research and Creative Activity Conference at the Bryant Conference Center.

McChristian conducted the research as part of the Emerging Scholars program at UA. That program is designed to attract freshmen to research and has done so since 2009.

"This project has helped me when it comes to applying my coursework to the practicality of a research setting," McChristian said. "Seeing the research process from initial setup to data gathering and, eventually, processing has been invaluable."

The novelty of this research approach, Shepard says, is that sensors do not have to be mounted directly on player helmets.

As concussion concerns rise, it has triggered an interest in developing accurate, cost-effective ways of measuring the impacts of helmet collisions. Most systems under development rely on sensors, called accelerometers, placed within helmets to measure impacts. The NFL has experimented with these approaches.

However, Shepard said accelerometers and the required wireless communication system are not cost-effective for many non-professional teams who do not have an NFL-sized budget.

"Sound measurements on the sideline, though, would be much cheaper to implement and the hardware easier to maintain," Shepard said.

Working with Shepard in the University's hemi-anechoic chamber, a research lab isolated from external sounds, McChristian used a pendulum-type experiment to create and measure sound waves radiating from controlled helmet collisions.

With two helmets suspended in the chamber using string, a controlled collision is created by swinging one helmet from a known height and allowing it to collide with another helmet.

Two nearby microphones attached to a dynamic signal analyzer are then used to record the sound waves resulting from collision.

Using the data and careful calculations, McChristian proved that the sound waves' energy directly correlated to the helmet impact energy.

"Most people watching a football game on TV would not see this result as very surprising," Shepard said. "Nevertheless, the result is a vital first-step in the process in order to demonstrate to funding agencies the validity of a technique using sound."

Shepard is seeking additional funding to study more advanced techniques in collision assessment using sound.

The hemi-anechoic chamber, one of the largest in the Southeast, resembles a high-tech recording studio, with its walls and ceiling covered with a thick, foam-like material that eliminates all acoustic reflections. This isolation allows for detailed acoustic measurements on a wide range of experiments.

Gray, triangular wedges, some 2-feet thick, cover the walls' surface, while the 8-inch thick metal walls, themselves, are filled with insulation made from recycled denim. Additionally, the entire chamber and the supporting concrete floor, weighing a combined 150,000 pounds, float on springs to prevent outside vibrations from interfering with acoustic testing.

The chamber is located in UA's AIME Building, which has 18-inch thick exterior concrete walls, another sound barrier.

While the project remains in its early stages, Shepard says it appears promising.

"There are still lots of questions to answer," Shepard says, "but the idea is certainly feasible, based on previous research and Brandon's results."

And the results from the research experience gained by McChristian and the hundreds of other students conducting research alongside UA faculty are immeasurable.

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