Virginia Tech Tackles Head Injuries Using Wireless

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The Virginia Tech football team has joined with Simbex to measure head injuries and develop a wireless telemetry system that fits inside a football helmet.

When the Virginia Tech Hokies football team takes the field, 18 of the players are connected to a computer that sits quietly on the sidelines. Every hit, every tackle and every fall is recorded in a Sybase database that keeps track of head impacts.

Eventually, the data being gathered on the Virginia Tech football players as well as other participants in other sports will become part of a nationwide database that is intended to reduce concussions and the injuries that stem from them.

"We hatched this idea to use small accelerometers inside the helmets with a small chip to transmit the information to the sidelines," said Dr. Gunnar Brolinson, team physician for the football players at Virginia Polytechnic Institute and State University in Blacksburg, Virginia. Brolinson is also chief of the division of sports medicine at the Virginia College of Osteopathy, also in Blacksburg.

"When I came to Virginia Tech I got in touch with Stefan Duma, who is director of the impact biomechanics lab at Virginia Tech," Brolinson said. Duma had already established his lab as a top research facility for the study of head injuries related to car crashes. Brolinson said that he wanted to study concussive forces and concussions in athletics, which

had similar biomechanics issues.

Brolinson worked with Simbex, based in Lebanon, N.H., which was already working to measure head injuries and develop a wireless telemetry system that fits inside a football helmet without interfering with the player's use of the helmet. To do this, they also worked with Riddell - part of Easton-Bell Sports - which makes nearly all of the football helmets used at the college and professional levels.

"Simbex developed the HITS (head impact telemetry system) initially because there's a large gap in the information as to what causes brain injury, especially in sports. But there's this big hole about how people got the injury," said Simbex president Rick Greenwald. "We wanted to understand the injury from a biomechanical basis so we could come back to changes in equipment and rules."

Greenwald said the technology works by taking small accelerometers, similar to what are used in car airbag systems, and placing them against the head.

"We place them in the helmet with a radio transmitter that can reach across an entire football field, and it can relay information about impacts that are occurring during the game," he said.

Greenwald said that the helmet-based telemetry systems use a frequency hopping spread spectrum wireless transmitter that works in the 900MHz band. He said that as more teams adopt the technology, the radio signals will be differentiated so that one team won't receive the other's telemetry.

"We initially started out with eight instrumented helmets and rotated them among players," Brolinson said. "We needed to get a feel for the type of impact we were seeing, get an idea of the direction of the blows

they were receiving. The first year was spent getting a feel for the technology," he said.

Things have expanded since then, as Brolinson now has around 18 players that are instrumented, and they remain instrumented for the entire season.

"The idea is that concussions are a very common thing. There are 1.5 million traumatic brain injuries on a national basis in a given year and about 300,000 are athletes. Football has the largest total," Brolinson said.

"One of the things that is important is to understand the biomechanics," Brolinson added. "This system has allowed us to dig into the kinds of loads and motions that give a concussion to the athlete. It allows us to study this in a real environment."

Greenwald said that one of the factors that make this study important is that the information can be learned in real time. The system that allows for recording real time impacts on the field and it provides a clinical tool for the medical staff to see injuries they might otherwise have missed in the busy environment of a football field, Greenwald said.

The telemetry information is sent from the wireless transmitter to a Sybase database that's running on a laptop computer located on the sidelines of the football field.

Chris Kleisath, senior director of engineering at Sybase iAnywhere, explained that the product, called SQL Anywhere, has two components.

"The first component is our embedded database, which is used on the laptops on the sidelines while the system is in use by the football teams. So when the helmets wirelessly transmit data back to the sidelines, that data is initially stored in the database," Kleisath said.

While immediate local storage is critical for making sure that doctors are alerted when a player has a possible concussion, the work goes beyond that. "The second component is our database synchronization, MobiLink, which does data synchronization," Kleisath said. "After it captures the information of all the hits after the game, that information is then synchronized back to Simbex headquarters."

Kleisath added that Simbex has used its database tools to develop a number of applications, including one that alerts team doctors to possible problems.

"We have a pager that alerts me when we receive a high head acceleration," Brolinson said. "We set the pager at 98g - an impact of 98 times the force of gravity at the Earth's surface - . We think that's a fairly significant head acceleration."

Brolinson noted that if he's alerted to such a blow to the head of a player, then he watches the player for signs of a concussion.

"We frequently find that players sometimes don't notice that they have a concussion," Brolinson said. "Most sports related concussions don't involve a loss of consciousness. This system will generally allow us to determine that the athlete has received a head blow that could result in a concussion."

Brolinson said that so far the study of Virginia Tech's football players has turned up some interesting and useful data, the most notable being that different positions apparently sustain different types of blows.

"Linemen sustain frontal blows. They're usually low impact blows, but there are lots of them. Wide receivers receive fewer blows, but get higher blows when they happen. Linebackers sustain higher accelerations than linemen."

Brolinson said that he thinks the data developed by the instrumented helmets may lead to changes in football equipment. "One of the things that may come out of this research, as we start to understand the blows, is position specific helmets. A lineman may need a different helmet from a wide receiver," he said.

Brolinson said that he's planning to add wireless telemetry instrumentation to all helmets used by Virginia Tech football players as soon as he can. He is waiting for a large grant from the NIH (National Institutes of Health), which has provided major funding for the head injury studies, including the Virginia Tech football helmets.

"The NIH has recognized that head injury in children is a national problem," Greenwald said, adding that the information being gathered using the football helmets is directly related to a number of other areas as well.

Greenwald added that the technology is currently employed in hockey at the college and youth level, as well as in studies in equestrian sports, snowboarding, soccer, and in military applications.

"The military is very interested in understanding injury to their soldiers either from direct impact or impact caused by IEDs," Greenwald said. He noted that his company is providing helmets with similar wireless telemetry to the military for use in the field.

"The information that we can gather from the sports field is transferable to the car crash environment," Greenwald said, noting that until now, data on head injuries was difficult to come by, and not necessarily accurate in today's world. For example, the information in the car crash world is based on cadaver data from a long time ago, he said.

Greenwald said that his company is looking to expand the use of

telemetry in studying head injuries as a part of the overall research at Simbex.

"We work with fall prevention in the elderly and exercise for the elderly, injury prevention in sports and prosthetics. Much of this work has been funded by the small business innovation research - SBIR - program at NIH," he said.

Right now, though, the partnership between Simbex, Sybase, NIH and Virginia Tech is proving that it can have real and immediate benefits to the organizations and to the athletes who use the equipment.

"It allows us to keep an eye on the player, and bring them to the sideline to see what's going on," Brolinson said. The result, he said, is that players can be treated for injuries immediately, when they need it the most.

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