Research
Report Summary

SAFER SIM
SAFETY RESEARCH USING SIMULATION
UNIVERSITY TRANSPORTATION CENTER

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Identifying Postural Control and Thresholds of Instability Utilizing a Motion-Based ATV Simulator

With Improvements in the Simulator to More Accurately Reflect Reality

ATV-related deaths and injuries have been an increasing public health problem over the past four decades, and there remains a disturbing lack of safety culture around these vehicles. In 2013, the Consumer Product Safety Commission estimated that ATV crashes resulted in about 650 deaths and 100,000 emergency department (ED) visits in the U.S. alone.[1] The total annual U.S. cost of these crashes is estimated to be over $4.3 billion.[2,3]

ATVs require "active riding," which means operators must rapidly assess changes in vehicle stability and adjust body position in order to maintain vehicle control as they negotiate various terrains and obstacles. Ethical issues related to the instability of the vehicle essentially prohibit controlled research studies of ATV riding. Simulation provides a safe and effective solution.

We have developed the only ATV simulator in existence that allows for the study of human subjects engaged in "active riding." This unique simulator has an ATV mounted to a six-degree-of-freedom man-rated Moog ECU-624-1800 electric motion system. Platform movements and vibration (data derived from

University of Iowa Media Event Introducing the New ATV Simulator

The Office of Strategic Communication hosted a media event at the Center for Computer-Aided Design in June 2016 to introduce the new ATV simulator, largely funded by a SAFER-SIM grant.

Legislators in the Lab

The new ATV simulator was included in the "Legislators in the Lab" event hosted by the U of I Office of the Vice President for Research and Economic Development in November 2016. During the annual event, Iowa legislators have the opportunity to witness U of I research innovations.

"Our simulator provides a unique and powerful methodology to investigate ATV crashes. Future studies will allow us to investigate a number of known risk factors for ATV-related injuries and how they impact active riding and increase the risk of loss of vehicle control."

instrumented field vehicles) are computer generated. Motion-capture technology and accelerometers are used to measure the speed and extent to which subjects shift their bodies in response to vehicle angle change, shocks, and vibration, and also to calculate forces on the operator's body. Collected data are analyzed with 3D modeling software (see Figure 1).

Despite successful studies,[4] our previous ATV simulator had multiple limitations. With the funding provided by our SAFER-SIM grant, we were able to address a number of these issues and create a significantly more versatile and sophisticated simulator. Some of these improvements included:

Force sensors were added to the handle grips, seat, fuel tank, and footrests in order to measure the forces generated by the operator that maintain ATV stability.

An improved vehicle-platform configuration was developed that allows turning of the handlebars and tires, but prevents overturning or sliding of the vehicle on the platform and allows the tires to lose contact with the platform when a potential rollover might occur during simulated rides.

ATV ride simulation was further enhanced using Unreal Engine 4.9 (UE4) with the creation of virtual test course environments. An Oculus Rift virtual reality headset was purchased that allows immersion of subjects in the simulator world.

The programming for the platform table was updated to allow real-time control and movement matching that of the simulated environment and operation of the ATV by the subject. The ATV controls, including throttle, brakes, handle bars, and suspension, were tuned to create true-to-life responses in the virtual reality environment.

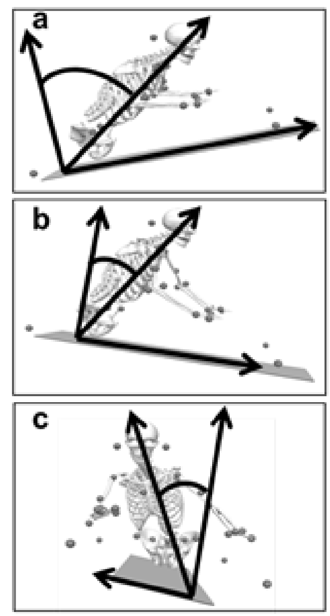

Figure 1 - Torso shift. Computer representations of a subject's torso shift in response to changes in vehicle angle are shown for upward pitch (Fig. 1a), downward pitch (Fig. 1b), and roll (Fig. 1c).

Six subjects were studied using the new simulator, and the results provided proof of principle for the use of our new ATV simulator to study active riding and potential thresholds for loss of vehicle control.

References

1. US Consumer Product Safety Commission. (2014). Annual report of ATV-related deaths and injuries. Accessed January 9, 2017, from http://www.cpsc.gov/s3fs-public/pdfs/2014atvannualreport.pdf.
2. Helmkamp, J.C., Aitken, M.E., & Lawrence, B.A. (2009). ATV and bicycle deaths and associated costs in the United States, 2000-2005. *Public Health Rep*, 124(3):409-418.
3. Helmkamp, J.C., Furbee, P.M., Coben, J.H., & Tadros, A. (2008). All-terrain vehicle-related hospitalizations in the United States, 2000-2004. *Am J Prev Med*, 34(1):39-45.
4. Jennissen, C., DeShaw, J., Meusch, J., Denning, G., McGehee, D., & Rahmatalla, S. (2014). Responses of experienced all-terrain vehicle operators to simulated unexpected terrain changes. In *Proceedings of the Human Factors and Ergonomics 2014 Annual Meeting*. Chicago, IL, October 27-31, 2014.

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