Development & Evaluation of a New Chest Deflection Measurement Sensor for the Large Omnidirectional Child (LODC) ATD

Mike Carlson, Brian Suntay
Transportation Research Center Inc.

Jason Stammen
NHTSA

SAE Government/Industry Meeting 2020
Background: HIII 10 YO vs. LODC

- Drawbacks of the HIII 10YO ATD led to the development of the LODC\(^1\)
  - Rigid spine caused improper head kinematics and neck loads
  - Pelvis / abdomen were not suitable for detecting abdominal loads
  - Head, neck, thorax and abdomen were not biofidelic according to latest data
  - Upright seating posture was not representative of actual child seating data

\(^1\)Stammen et al. “The Large Omnidirectional Child (LODC) ATD: Biofidelity Comparison with the Hybrid III 10 Year Old,” Stapp Car Crash Conference (2016).
Anthropometry matches actual seated child data

Head has inertial/mass properties matching pediatric data

Shoulders and thorax reflect pediatric anatomy and mimic pediatric response

Neck can elongate and allows for free Z axis rotation; response matching pediatric data

Flexible cervicothoracic & thoracic spine for more biofidelic head trajectory and neck loads

Biofidelic, instrumented abdomen to measure belt-induced loading

Docket NHTSA-2019-0110: NHTSA Crashworthiness Research - LODC Documentation
Motivation: Pediatric Thorax Injuries

• Thorax is an important body region to protect in motor vehicle crashes
• Injury data shows that the types of injuries are different in children than for adults (Arbogast et al. 2012)
  • Pulmonary contusions more common than rib fractures
• Need an accurate way to measure risk of these injuries
• Current method we are using in LODC is IR-TRACC
Motivation: Issues with IR-TRACC in LODC

- Reasons why we are pursuing a laser system instead of IR-TRACC
  - Because of internal space limitations and the flexibility of the dummy:
    - IR-TRACC has bottomed out in oblique and frontal tests causing loss of good data and damage to the sensor
    - No room for multiple sensors
Laser Triangulation To Measure Chest Deflection

Althen ADL 802-20/100
Range: 20 - 120mm
IR-TRACC vs. Laser System

- **IR-TRACC**
- **THORACIC SPINE**
- **RIBCAGE**
- **LASER TRIANGULATION SENSOR**
Objective

- Evaluate a new laser system to determine:
  - Measurement equivalency to IR-TRACC
  - Durability
  - Whether it solves the issues observed with IR-TRACC

- Conduct tests in four different conditions:
  - Static calibration
  - Quasi-static thorax compression
  - Thorax probe impact
  - Rear impact sled
Results: Static Calibration Test

Athen Laser 20/100 Calibration

Linearity = .17%

Calibration Fixture
Results: Quasi-static Thorax Tests
Results: Quasi-static Thorax Tests
Results: Thorax Probe Impacts

• Part 572 (HIII 10YO) Test Conditions
  • 6.89 kg probe @ 6.0 m/s
Results: Rear Impact Sled Tests

- High speed, 35 mph (56 kph)
- Seated on a backless booster
- Reclined 25° seatback
Summary

- Laser provides a linear response and good signal quality
- Signal matches known displacement
  - Quasi-statically and dynamically
- The sensor appears to be durable enough for crash testing
- Preliminary results show that the laser is an accurate and reasonable alternative to the IR-TRACC sensor
Future Work: Multi Point Laser Measurement

- More testing to examine dynamic performance
- Integration of multiple lasers into thorax
  - Multi-point laser measurement