Design and Development of a Surrogate Bruising Detection System to Describe Bruising Patterns in Children

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Background

- An estimated 1,760 children die and approximately 150,000 are permanently disabled each year in association with child abuse
- Missed cases of child abuse have been shown to be as high as 71% where children were presented to hospitals for their injuries and not evaluated for abuse
- Bruising is an early sign of abuse, and can be an effective indicator of child abuse
  - Bruising patterns provide a "roadmap" documenting a child's exposure to impact
- However, the ability to predict bruising patterns occurring in association with falsely reported events in child abuse does not exist
- This improved understanding could prove extremely beneficial to clinicians and child protective services in distinguishing between abusive and accidental injuries

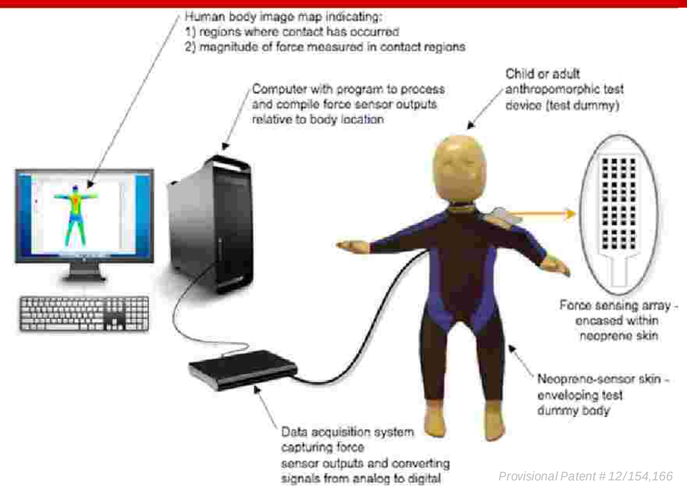
Objective

- To modify an existing pediatric test dummy to allow for the prediction of potential bruising location, size and patterns
  - Ultimately use the surrogate bruising system to study accidental/abusive events

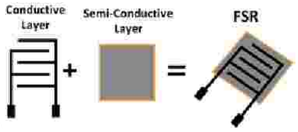
Methods

- Developed specifically for 12 month old CRABI ATD
  - Weight = 22 lbs, Height approx. 30 in
- The surrogate bruising detection system's conceptual model consists of the following components:
  - A pressure sensor integrated sensing skin
  - A data acquisition system
  - A computerized body mapping image system

Methods



- The ATD was divided into seven regions requiring sensor coverage
  - Custom sensor array/matrix containing a varying number of sensor sizes and shapes designed for each region
- Force sensing resistor (FSR)



  - Consist of two layers
  - Sensors protected in neoprene
  - Change in physical pressure applied to the sensor generates a proportional change in the sensor's electrical resistance
- The multifunctional input/output data acquisition cards (NI, PCI-6225) used to acquire, condition and digitize the sensor output signals
- Using Labview ™ software (NI), a Virtual Instrument (VI) was developed to create an active 3D body map image representing the ATD
  - Sensors on the ATD were mapped to the body image to show real-time recordings of the sensors

Results

For illustrative purposes, we will primarily describe the development of the sensors for one of the seven regions of the ATD - The forearm

- Custom sensor design patterns generated on copper clad laminate to create conductive layer of the FSR
- Custom semi-conductive material (Sensitronics ™)
- The FSR was sandwiched between two layers of neoprene, cut in a pattern to conform to the forearm

- Sensors were dynamically calibrated using a load cell
- Sensor data was represented on a 3D image of the ATD, to provide visual details of location and active sensor value readings
  - Varying color intensities described the level of force the sensors were subjected to

Conclusions

- Use of our device is expected to provide clinicians, child protective services, law enforcement personnel and judiciary personnel with objective data as to the bruising patterns that can be expected in common household accidents that are often provided as false histories in an effort to conceal child abuse.

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