Forearm Fracture Model

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Outline

- Client
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- Background
- Design Specifications
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  - Testing
- Budget

Client

- . Matt Halanski
- rthopedic Surgeon
- inical Medicine
- rthopedic Research
- sociate Professor

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Problem Statement

o develop a pediatric forearm fracture
nodel that provides temperature, skin
urface pressure and bone alignment
eedback for use by medical school
esidents in order to practice and learn
afe, effective casting techniques.

Background

- 40% of all pediatric fractures occur on the forearm
- 75% pediatric forearm fractures are distal
- Both bones or only radius
- Caused by fall on outstretched hand
- May include wrist fracture

Distal Radius Fracture
http://en.wikipedia.org/wiki/Distal_radius_fracture

Background

- Common in pediatrics causes major public health problem
- No current teaching model
- Residents learn to apply and remove casts in situ
- Complications during casting from inexperience
  - Compartment Syndrome
  - Thermal injuries
  - Skin breakdown

Thermal injury from casting
http://www.psychologytoday.com/blog/the-red-l
district/201401/penile-fracture-and-9-other-painful

esign Specifications

imary Focus:

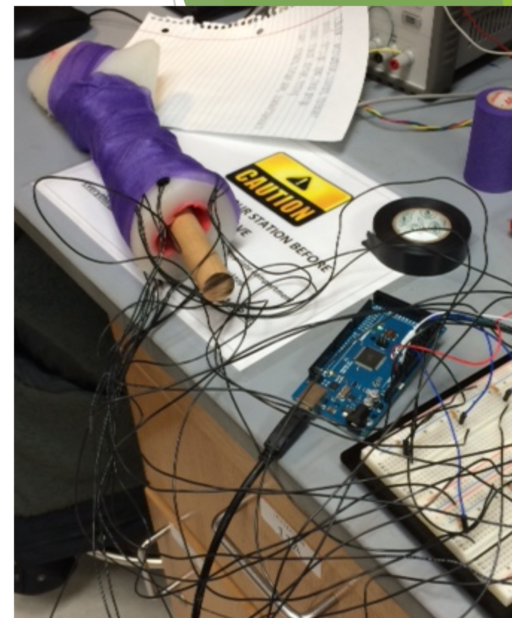
- Increased usability for residents
- Applied force output-make portable
- Visual map of forearm and corresponding pressure
- Improved computer interface

condary Focus:

- Temperature detection
- Protection for sensors
- Representation of skin tissue
- Alignment detection

Final Design

Testing setup with circuit, arduino, and hinge inserted in Platsil mold



Force Data Collection

- 10 Force Sensitive Resistors
- Arduino
- Processing

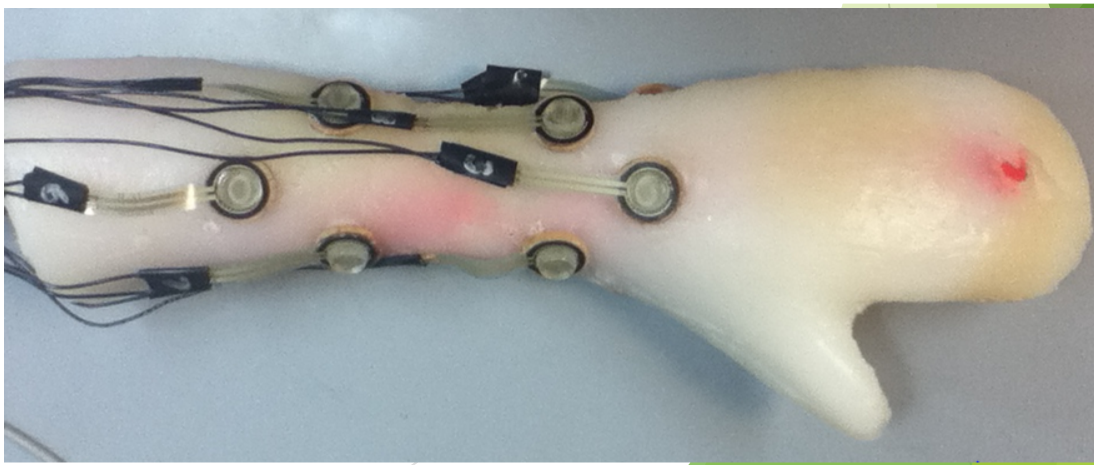
Computer display with force readings for each of the 10 sensors, live data with color

Final Design

- Fracture Representation
  - "Hinge" system
  - Wooden dowel
- Tissue Representation
  - Platsil (silicone mold rubber)
  - Mold from a 9 year old female

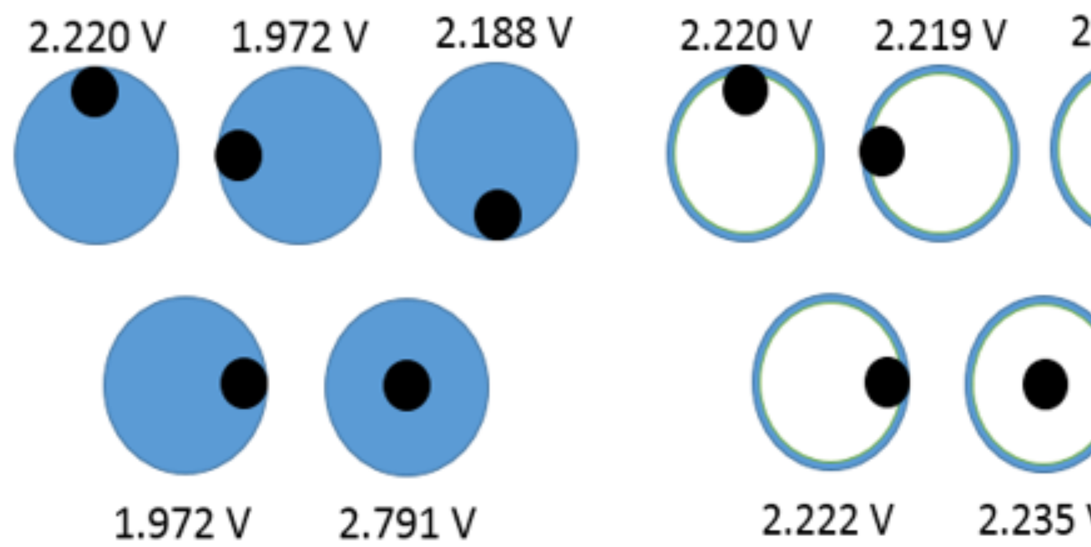
Platsil mold and hinge fracture model made of wooden dowel

Platsil mold with 10 sensors (with bumpers) attached clustered around wrist

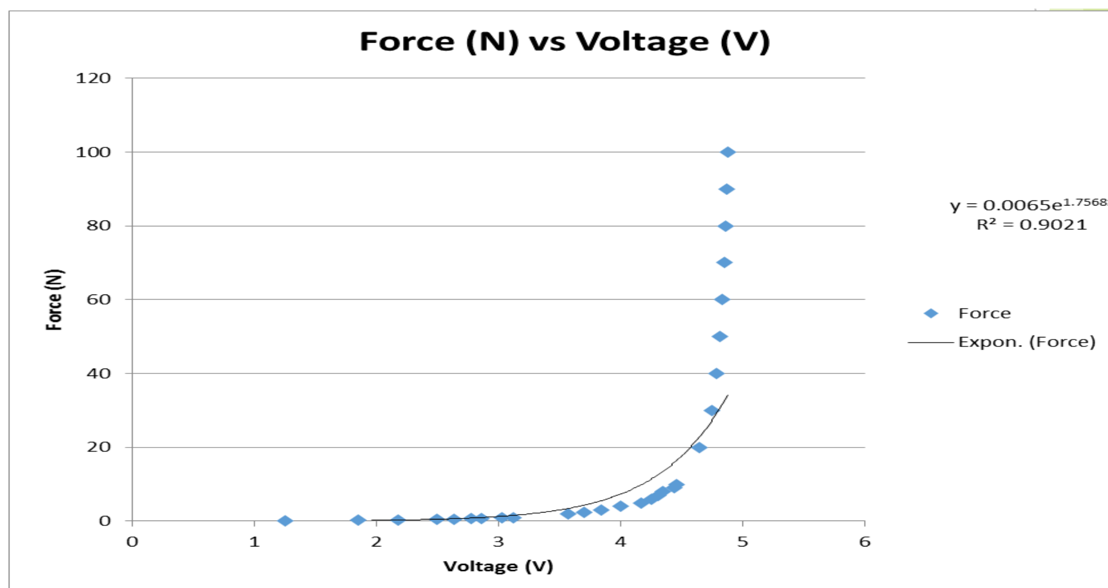


Testing

- Point load comparison
  - Place weight on FSR (no bumper) on small CSA
  - Place weight on FSR with bumper
- Calibration of FSRs
  - Weight from 1-2000g
  - Measured voltage output
  - Calibration curve to convert V_{out} to force



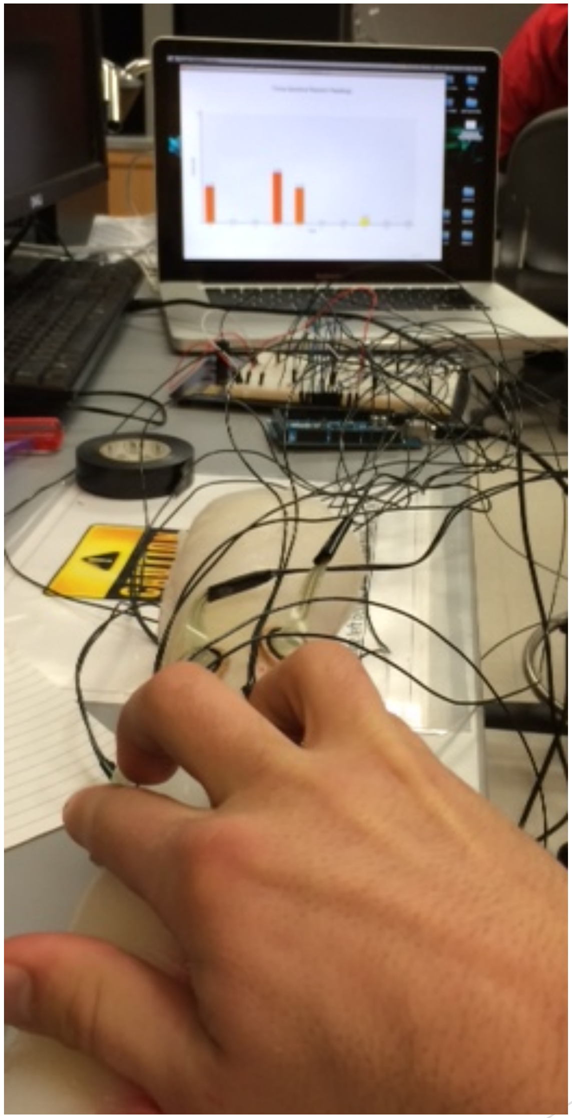
Force data collected when applied at 5 different locations on FSR sensors with and without b
distribute the force equally



Calibration curve

Testing

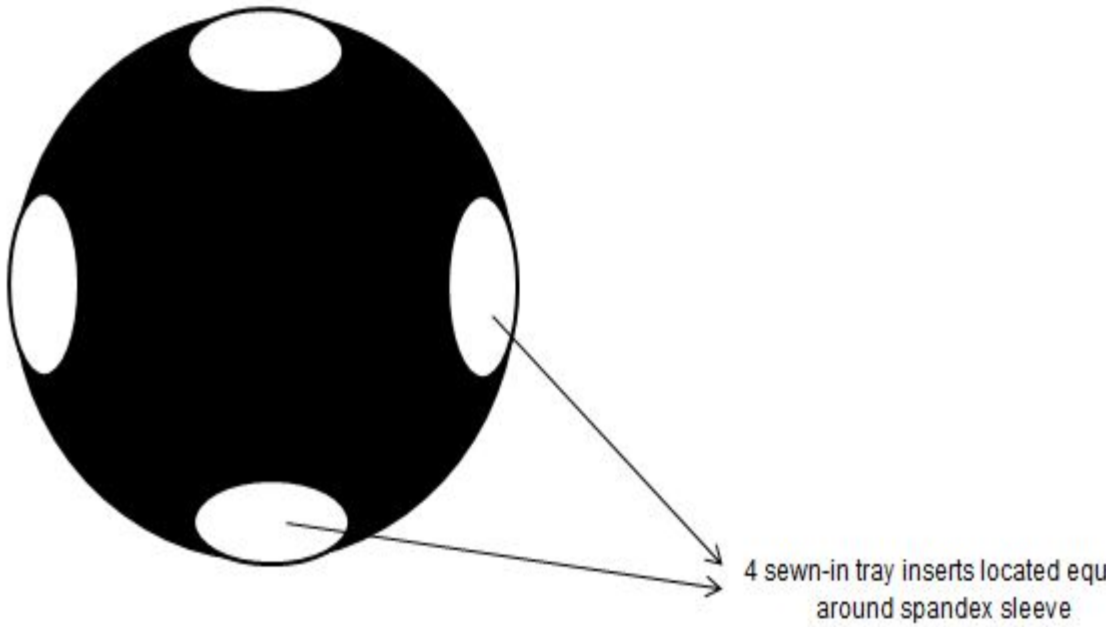
- Consistency of FSR readings
  - Vary resistance of hinge and correct ‘fracture’
  - Record force necessary for each trial
  - Compare force values at different resistances



Testing setup with computer and fracture model

Goals-Fabrication

- 32 smaller FSR
- Attach sensors on tray
- Spandex sleeve
- 4 pockets for inserts
- Tray inserted into fitted pocket



Tray insert with 8 sensors, most coverage on distal and proximal ends due to hand placement during reduction

Goals-Fabrication

- Transportable pressure system
- Develop wireless system
- Display range of standardization of pressure on screen
- Color display of arm
  - Pressure data corresponds to location on arm
- Strategic placement of sensors around a typical grip

Dr. Halanski's hand placement during fracture reduction

Goals-Testing

- Prove precision
- Use device with multiple orthopedic surgeons
- 10 trials per doctor and minimum of 3 doctors
- Sample mean and standard deviation shows variability
- T-test to verify subjects do not reject null hypothesis: $u_1=u_2=u_3\ldots$ ($\alpha=0.05$)
- Confidence intervals to obtain proper range
- Range of standardization of pressure on each sensor

Budget

rchased Materials	Cost
shers/Screws/Nuts	$4.72
oden Dowel (7/8" x 48")	$3.38
nyl Bumpers	$3.96
duino MEGA 2560	$40.01
eadboard w/ wires	$8.86
nductive Rubber Cord	$13.77
und FSRs (15)	$102.25
tal	$176.95

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References

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