Ergonomics in Agriculture

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Ergonomic and Biomechanical Evaluation of Mechanical and Robotic Strawberry Harvest-aids (WCAH Current Core Project)

Research Team: Victor Duraj, Tyler Hunter, Vicente Munguia, and Professor Stavros Vougioukas (Co-PI)
Traditional Strawberry Harvest

- Select/Pick/Pack load into a cart in furrows (300’ long)
- Walk to loading station at end of furrows (30-40% of the time)
Traditional vs. Harvest Aids

**Pros:**
- Low cost
- Walking = break = low back relief

**Cons:**
- Low productivity

**Pros:**
- Increased productivity
- Reduced transport time

**Cons:**
- High capital investment
- Difficult to transport
- Slow moving to accommodate slowest workers
- Worker continuous stooping
Multi-Person Harvest Aids

- Workers walk a short distance to unload fruit trays into the harvest aid.

- Potential labor savings of 30%-50% have been reported for these aids.
Collaborative Robot/Instrumented Carts

- Approach is developed to optimize worker’s productivity w/o compromising health effects
Project Goal

- Investigate the combined effects of operating speed and time breaks for multi-person machines and co-bot on productivity, biomechanical response, fatigue and symptoms of musculoskeletal disorders
Project Update

Completing development and building of harvest aid system to simulate various speeds and field configurations.
Project Update

- Piloting optimal worker’s biomechanical response
- Piloting symptom surveys
- Collaborating with the Strawberry Center at Cal Poly on biomechanical studies and access to strawberry growers
Adoptability of Orchard Ladders with Short Rung Spacing

Research Team: Victor Duraj, and Tyler Hunter
Preferred Ladder

PERCENTAGE PREFERRED LADDER

No one choose the 12" rungs.

PERCENTAGE PREFERRED LADDER BY HEIGHT AND ANGLE

No one chose the 72 degree angle.
The Relationship between MRI Parameters and Spinal Compressive Loading

Research Team: Jie (Victor) Zhou and Dr. Jeff Walton
METHODS

Specimens

- In-vitro study, functional spinal units (FSUs) from porcine cervical spines.
- Important similarities to the human lumbar spine. 17, 18, 19, 20
- Wrapped in PBS-soaked gauze, sealed in plastic bags.
- Frozen at -20° C then thawed for approximately 12 hours before testing. 18, 19

METHODS

Computer controlled loading apparatus

- Proportional control valve
- Pneumatic cylinder
- Position sensor (built-in)
- Pressure transducer (extend port)
- Pressure transducer (retract port)
- Laptop with LabView
- Multifunction DAQ - Analog & Digital I/O
- Lab Compressed Air supply hose
Experimental protocol

• Twenty-two specimens
• A repeated measures experiment design (263.25N for 60 minutes)
• Apparatus setup
• Procedure: Specimen preparation, imaging, compressive loading, imaging.
• Image analyses and parameter calculation
• Statistical analyses (paired t-tests)
RESULTS

<table>
<thead>
<tr>
<th></th>
<th>$T_{1\rho}$ (ms)</th>
<th>$T_2$ (ms)</th>
<th>ADC (mm$^2$/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>119.43 (6.22)</td>
<td>50.13 (4.70)</td>
<td>0.002887 (0.000054)</td>
</tr>
<tr>
<td>Compressed</td>
<td>89.03 (5.12)</td>
<td>33.10 (3.45)</td>
<td>0.002790 (0.000084)</td>
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- $T_{1\rho}$ significantly and $T_2$ significantly decreased
- Tension loading (e.g., inversion tables) returned values to baseline
- Implications as a diagnostic tool and effect of tensile loading as an intervention
Ongoing Study

Quantitative Morphometric and Immunohistochemical Evaluation of the Healing Rat Medial Collateral Ligament and Epiligament

Implications to Work in Stooped Posture and Intervention Effectiveness

Research Team: Amjad Ramahi and Professor Tom Jue
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- Tyler Hunter, Junior Research Specialist
- Jie Zhou, former PhD student
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