Prevention of Weightlifting Injuries by Barbell Modifications

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Background

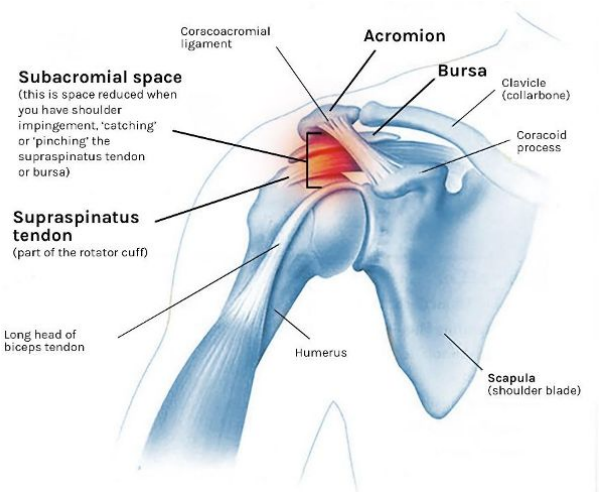


Figure [1] Shoulder muscle diagram [2]

- Thousands of weightlifting injuries occur every year [3]
- How do injuries occur while lifting?
- What injuries are most common?
- What is the best way to prevent injuries from occurring?
- Fix the Form

Problem Statement

- Thousands of weightlifting injuries occur every year
- Injuries are often caused by an uneven distribution of load on the barbell, leading to the weight lifter favoring one arm over the other. [3]
- The team has been tasked with designing a biomedical device that can prevent weight lifting injuries by targeting, identifying, and correcting improper form.

Design Criteria and Specifications

- Primary function is to tell the user when they are at risk of injury because of bad form.
  - Detect when the barbell is uneven vertically or not parallel to the shoulders
  - Track barbell path and compare it to the ideal path
  - Let the user know when the barbell path isn't ideal and how to change it, and when the barbell is uneven. [4]

Competing Designs

- WL Analysis - bar path tracker
  - App
- FLEX by Gym Aware
  - Laser optic sensors
- Bar Sensei
  - Accelerometer

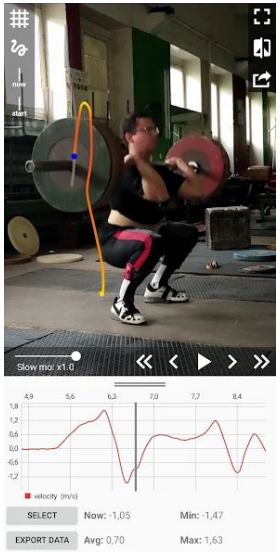


Figure 2. App interface for WL Analysis - bar path tracker [5]

Figures 3 and 4. Flex barbell attachment and Bar Sensei barbell attachment [6][7]

Weightlifting Injury Prevention Designs

Figure 5. Motion System sketch

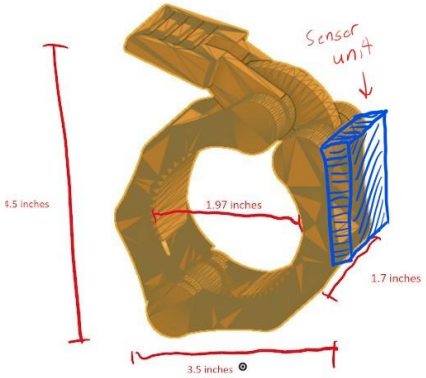


Figure 6. Clip sketch

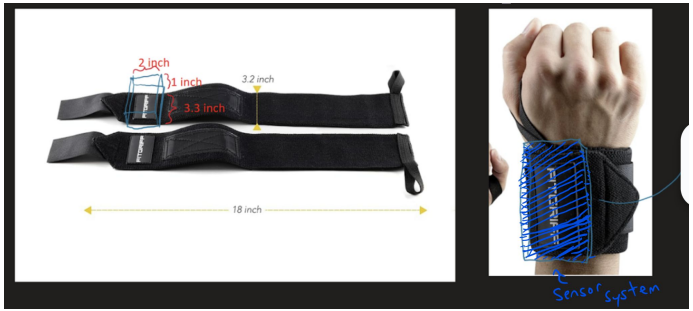


Figure 7. Strap sketch

Motion Capture System

- Camera-based system
- Computations from elbow position

Weight Clip Sensor

- Motion sensor system
- Replaces weight clips
- tracks bar path

Wrist Strap Sensor

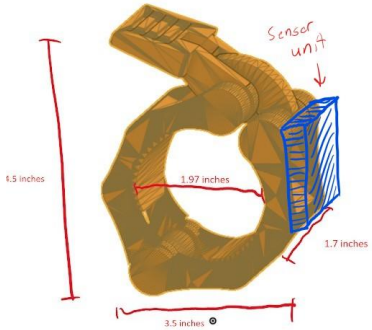
- Motion sensor system
- Embedded into wrist straps
- Tracks wrist path - translates to elbow

Weightlifting Injury Prevention Design Matrix

Design Categories (Weight/100)	**Motion System**		**Barbell Weight Clips**		**Wrist Straps**	
Precision (30)	5/5	30	4/5	24	4/5	24
User Comfort (25)	5/5	25	5/5	25	3/5	15
Ease of Use (20)	2/5	8	5/5	20	4/5	16
Maintenance (10)	3/5	6	5/5	10	4/5	8
Ease of Fabrication (10)	2/5	4	4/5	8	3/5	6
Cost (5)	1/5	1	3/5	3	4/5	5
Total Points:	74		90		74	

Final Design

- Weightlifting Clips
- Arduino Nano [8]
- MPU6050 Accelerometer and Gyroscope [9]
- Breadboard



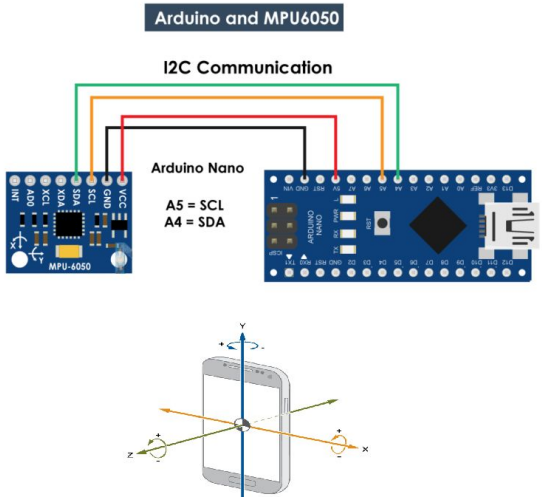


Figure 6,8. Weight Lifting clip with Technology Housing, Arduino and MPU6050 [7]

Future Work

Fabrication Process

- 3D Printing
- Arduino, MPU6050

Post Repetition Feedback System

- App
  - Displays barbell path
  - Offers correction to prevent injury

Testing

- Functionality of 3D Printed Weightlifting Clip
- Weight Distribution Accuracy
- Bar path line of best fit Accuracy

Acknowledgements

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References

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