

Preventing Weightlifting Injuries by Barbell Modifications

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Problem Statement

Weightlifting is the second most common form of exercise performed by Americans. Every year there are nearly a million emergency room trips due to a weightlifting accident [1,2]. In order to prevent more injuries, the team was tasked to create a marketable design that can inform the user of an imbalance in their lift in real time.

Physiology and Competing Designs

- Weightlifting has numerous physical/mental benefits [3]
- Barbell bench pressing accounts for 20-40% of weightlifting injuries [4]
- Injuries occur due to imbalances during the lift



Figure 1: Barbell bench press

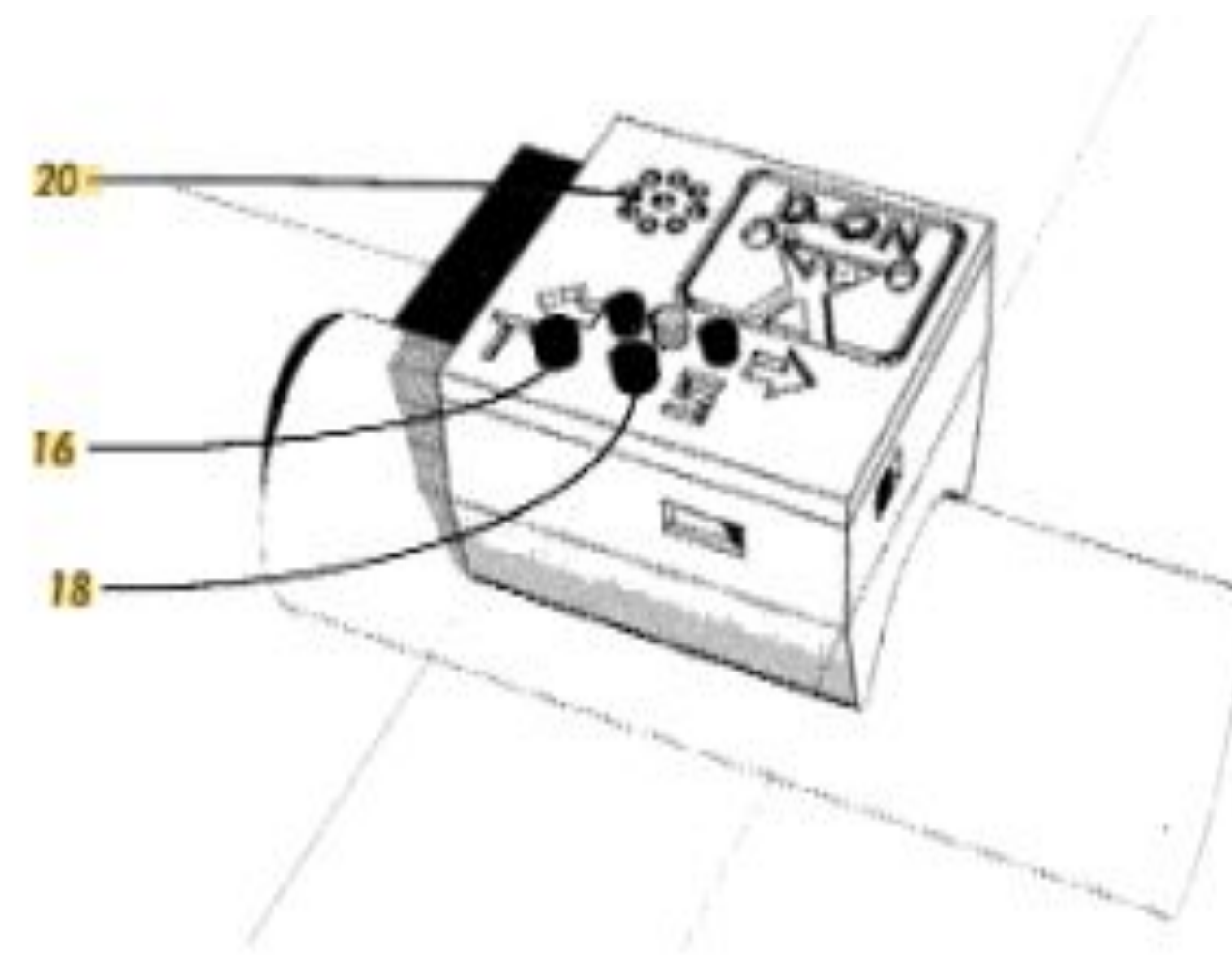


Figure 2: Barbell level indicator patent [5]



Figure 3: Bar Sensei speed tracker [6]

Design Criteria

Criteria	Specification
Safety	Correctly displays imbalance in bench press
Ease of Use	Intuitive to set up and use
Uniqueness	Novel technology and design
Marketability	Original and desirable to target audience
Accuracy	Within 5% error to real distance value
Reliability	Consistently measures and displays data
Cost	Within \$300 budget

Final Design and Prototype Fabrication

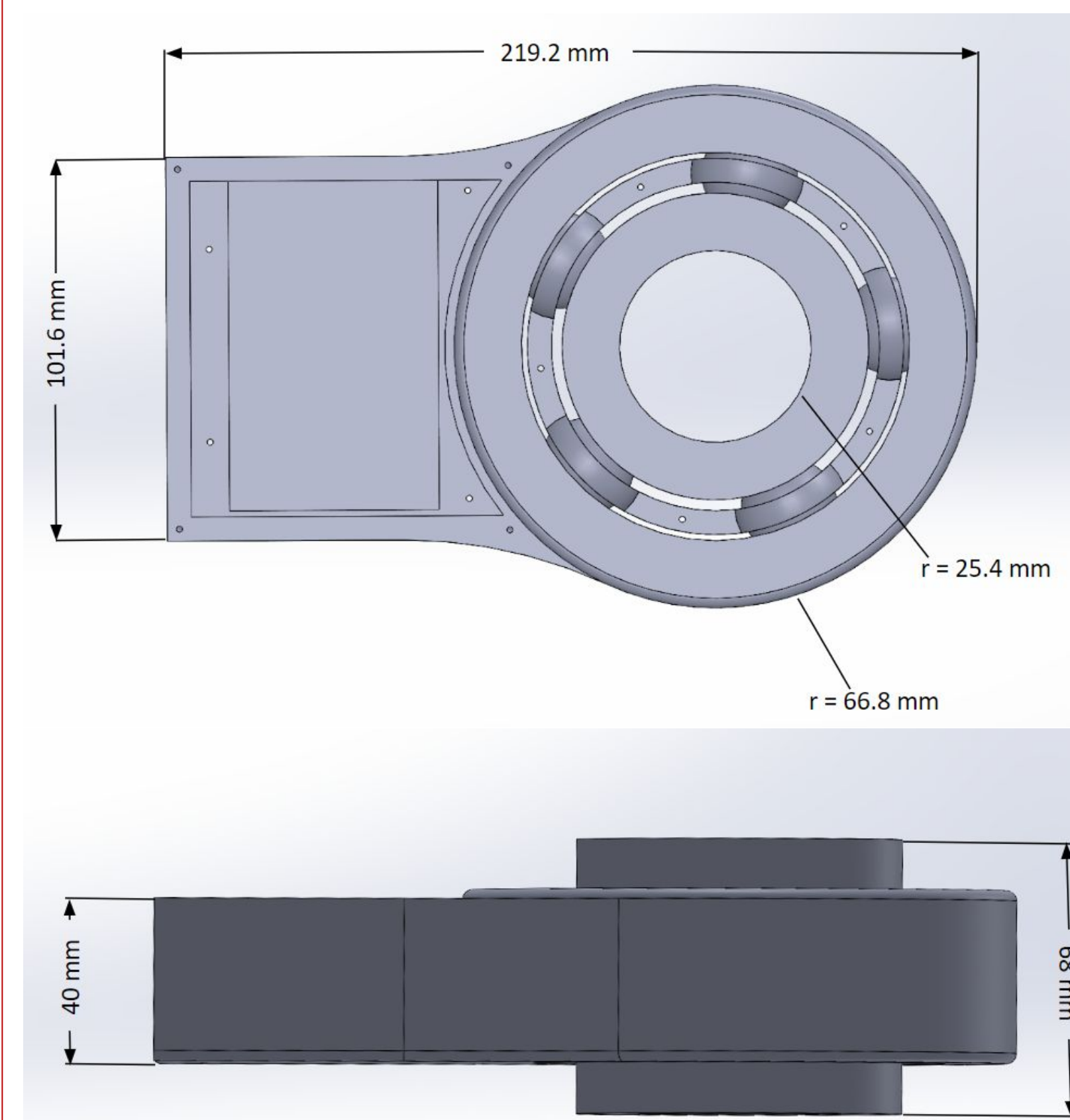


Figure 4: Solidworks assembly of final design with dimensions (mm), top and side views

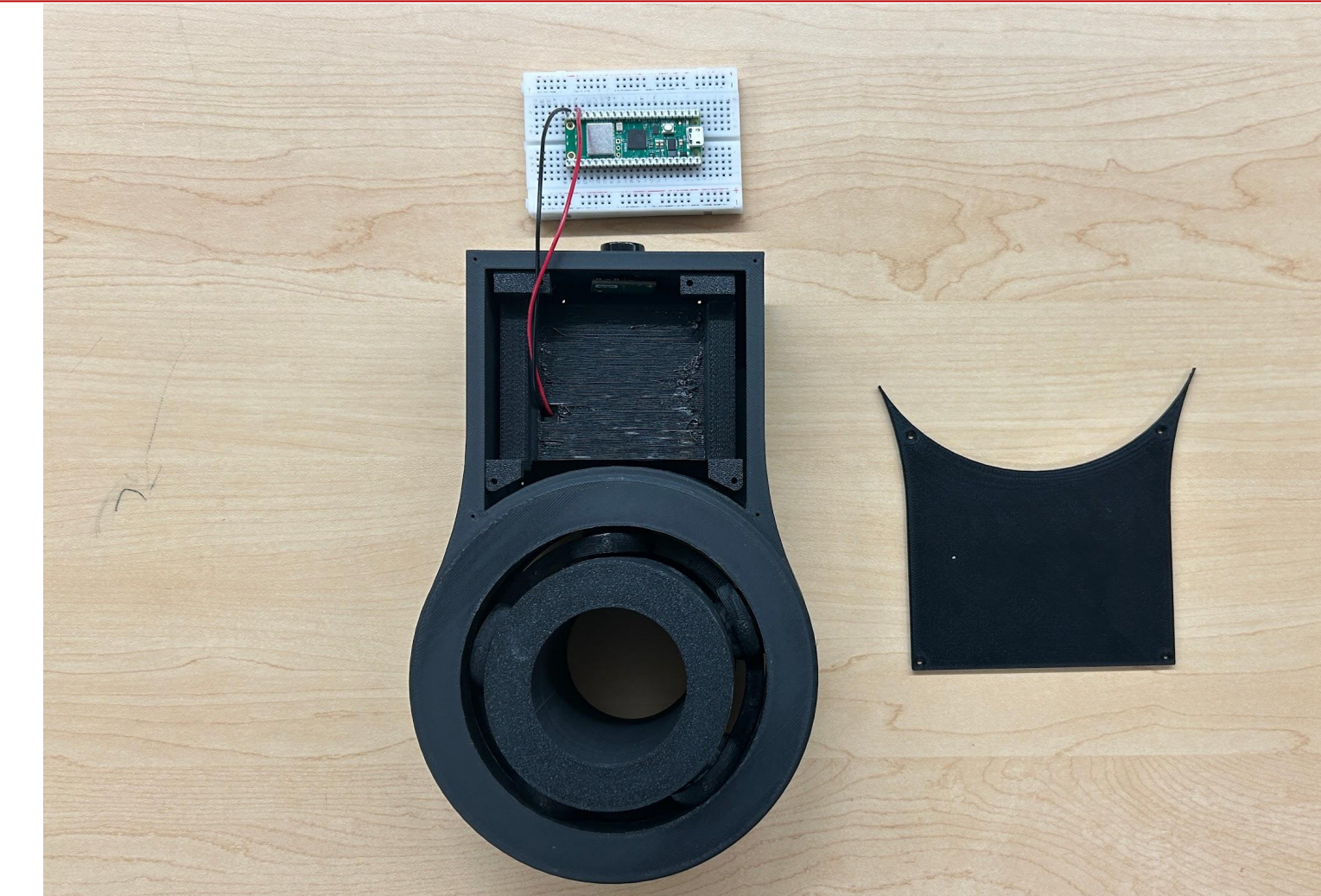


Figure 5: 3D Printed assembly of bearing attachment with internals open

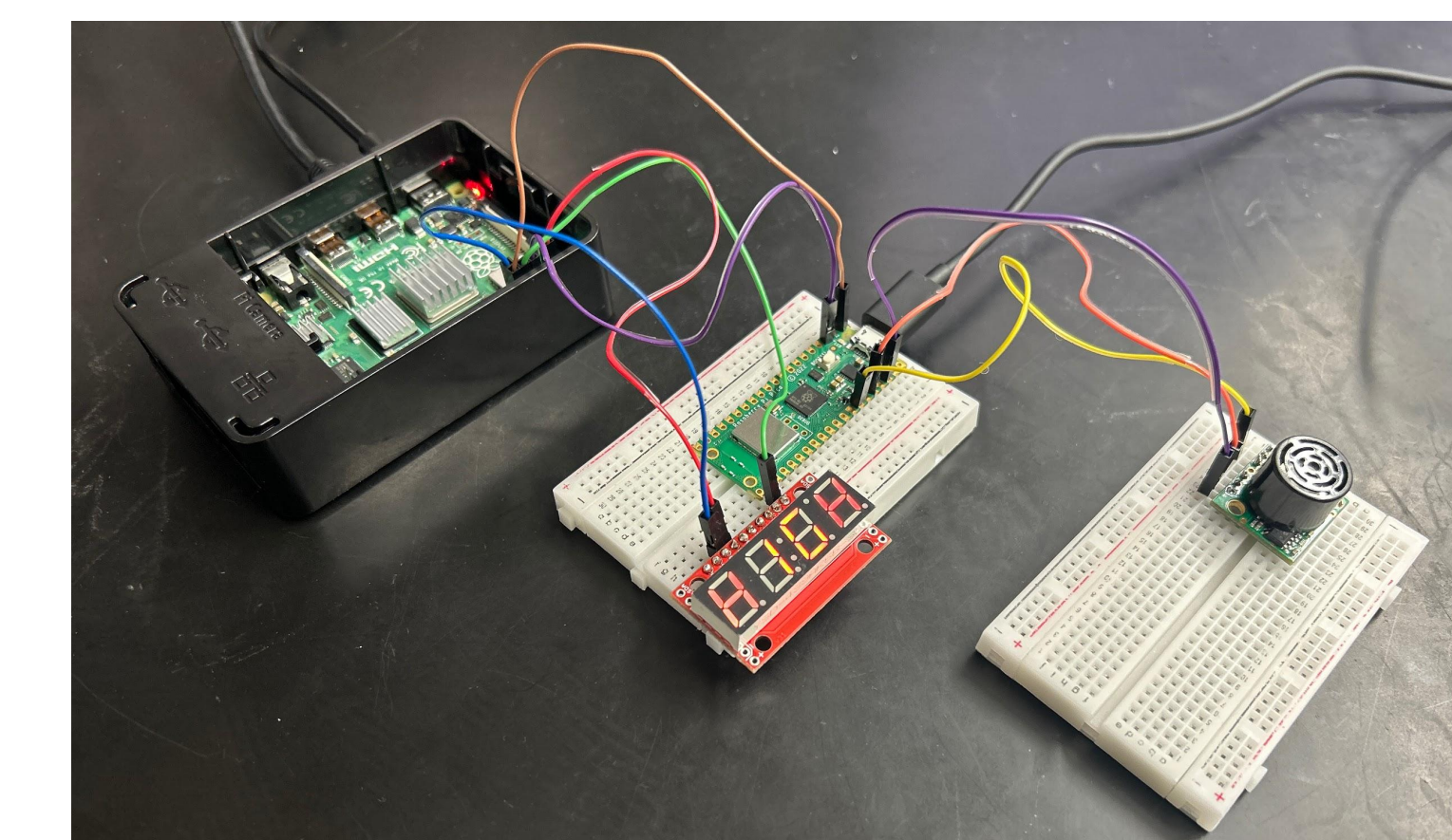


Figure 6: Functional wired version, includes digital display, Raspberry Pi 4, and ultrasonic sensor

Testing and Results

Sensor beam pattern testing

- Measured lateral distances of peripheral obstruction at varying distances from sensor

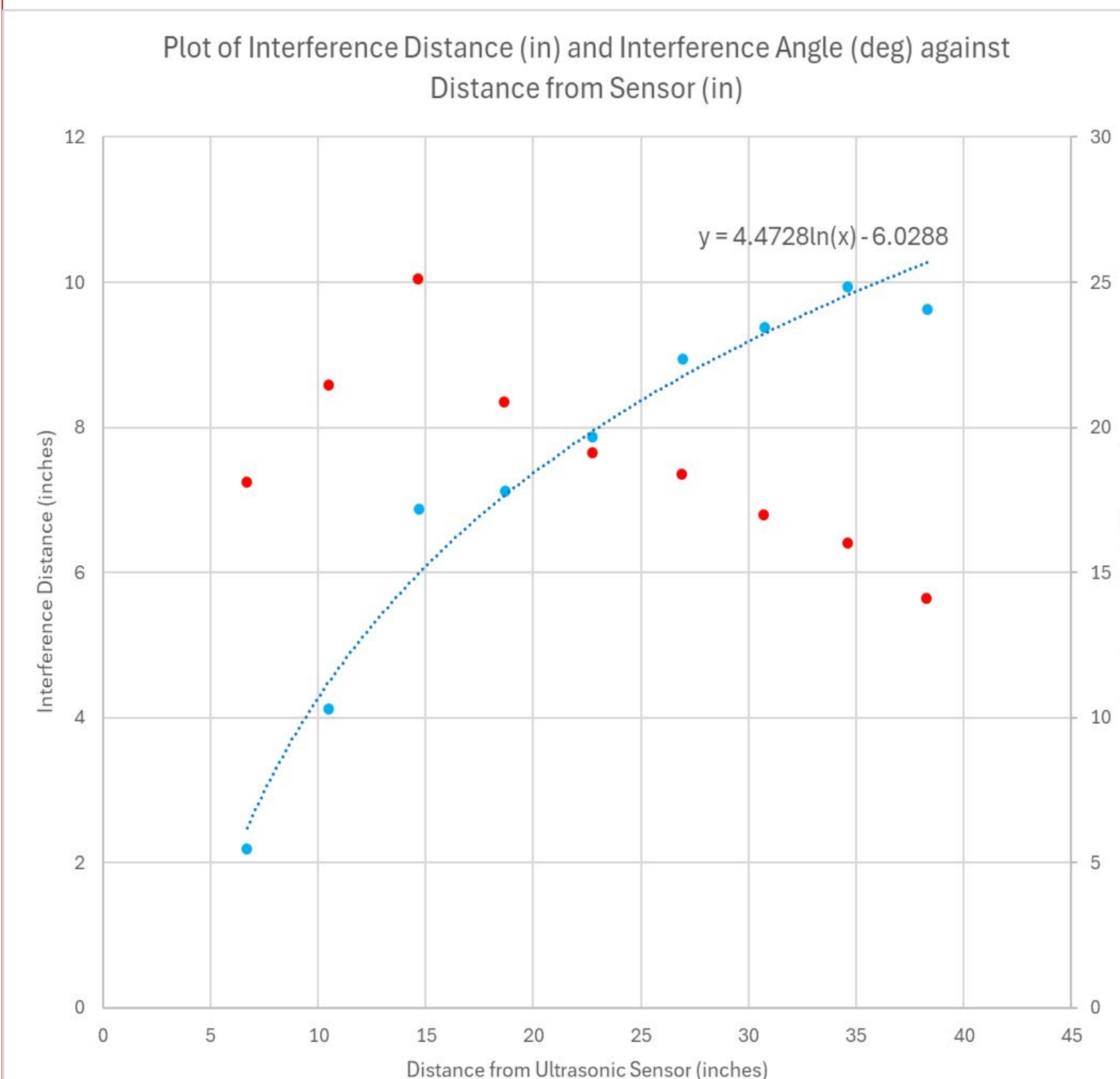


Figure 7: Plot of beam pattern width (blue) and angles (red) at varying distances from the sensor

Ultrasonic sensor error testing

- Measured distances at known heights for both ultrasonic sensors

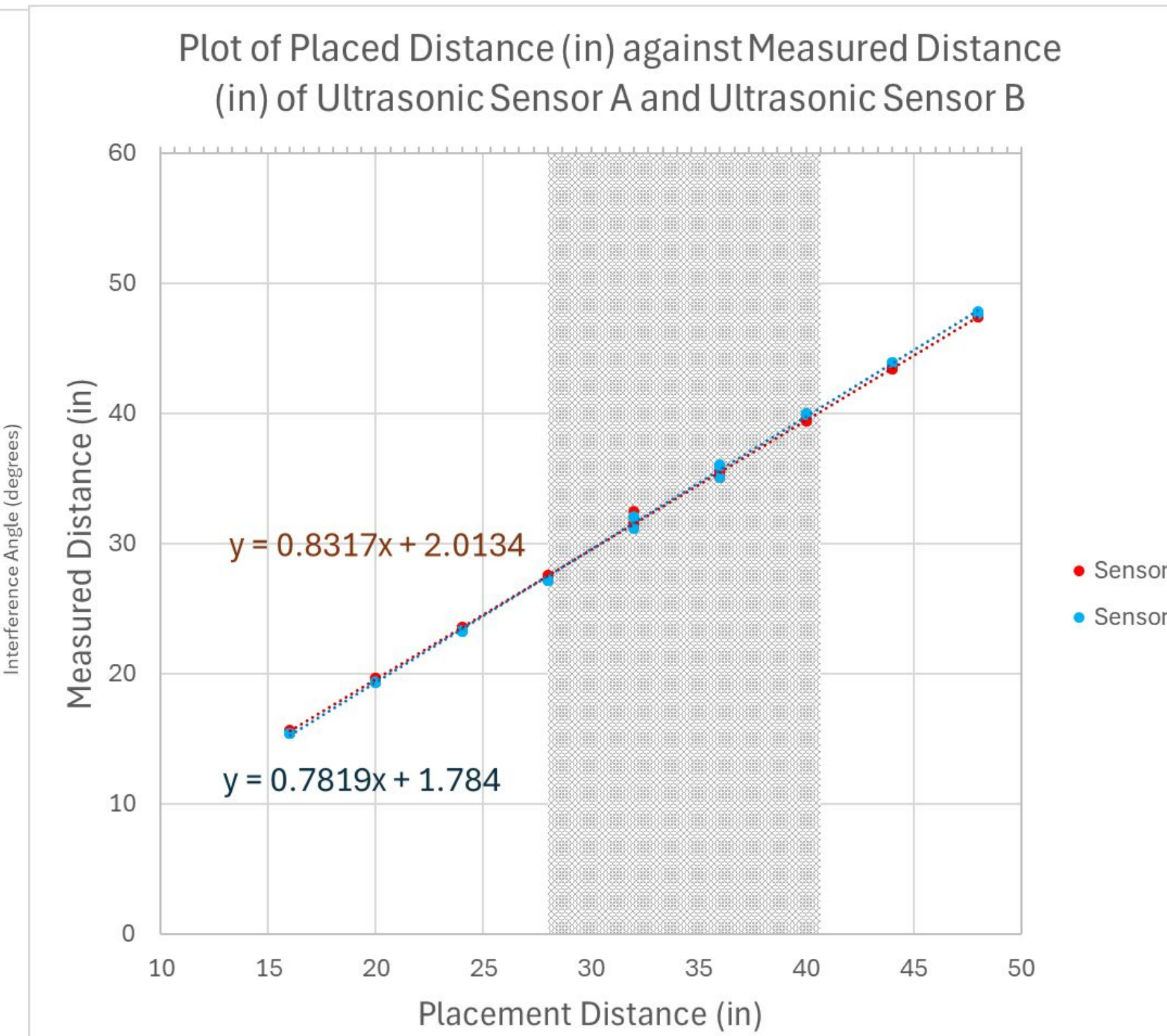


Figure 8: Plot of set distance (in) vs measured distance (in) of each sensor, with highlighted portion being the expected measured distance during a workout

Discussion

Testing Conclusions

- Ultrasonic sensors were able to measure within 5.0% of the actual distance on average (~1.5%)
- Ultrasonic sensors were precise (~1%)

Highlights of Design

- Successful implementation of novel technology to track barbell movement
- Easy to use and useful for assisting bench press

Future Work

- Design attachment for a display and complete wireless transmission code between microcontrollers
- Replace 3D printed bearings with better, less friction bearings (steel)
- Have exercise clamp integrated into bearing



Figure 9: Example of a barbell clamp

Acknowledgements

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References

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- [5] M. M. Ruiz, "Barbell Level Indicator," Apr. 18, 2017
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