JAM'D: All Lifts

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Introduction

Powerlifters are constantly looking to improve their form, but it is often hard for the human eye to notice the correction necessary in the time it takes to complete a lift. Products on the market are often overpriced and lack a visual representation of the lift instead focussing on its statistics. Our competitors all have the same idea to create a product that is low weight and easy for a customer to use, but most affordable products on the market will only provide you with velocity and acceleration data. Normally it takes thousands of dollars to obtain a product/service that will provide position data.

Product Design Specifications

Overall:

Basic Functions of the Product:

- Measure acceleration, Velocity, and rotation.
- Transmit data to user device.
- Ingest and process data into a format that the user can easily gain access to and evaluate.

Special Features of the Product:

- Display path of barbell with comparison to the "perfect" form

Key Performance Targets:

- Accuracy, Durability, Ease of use, Low weight

User Training Required:

- In App-Training, when first used the user will be prompted to learn how the barbell sensor works.

Electrical Design

Electrical:

- Requirements
  - Small
  - Low Power
  - Wireless

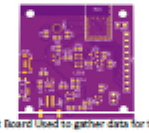

Fig 1: Printed Circuit Board Used to gather data for the virtual coach.

In order to accomplish these goals a custom PCB was designed Figure 1 using surface mount components to reduce size and power consumption. A BLE module from Laird Connectivity was chosen to account for the wireless aspect as well as its integrated microcontroller to reduce size and power consumption. During the design process multiple errors were discovered and rectified such as mismatched footprints, improper circuits, and the inclusion of test point.

Software Design

Software:

- Requirements
  - Provide the tracking the motion of the barbel and providing that position as Shown in Figure 2.
  - Provide Acceleration, Velocity and Direction of the user.

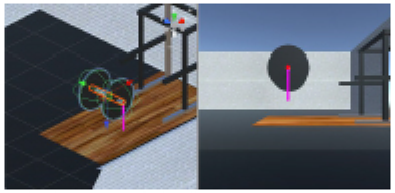

Fig 2: Software Computer Interface used for the virtual coach.

Mechanical Design

Mechanical:

- Requirements
  - Lightweight
  - Small in Size

Overall in this project we have had five different designs as shown in Figure 3, which have changed overtime due to testing and electrical components dimension changes. The goal was to make a lightweight small design that would not hinder the lifter in any way. The first design idea was a sensor that would slide onto or clamp onto the barbell. But through testing a strap attachment design was made so the sensor would not slide or move during the lift. The final circular design was made to decrease weight and material use. It was also made to avoid any pointy edges while also having a more appealing look to the design.

Fig 3: The iterations of the barbel sensor.

Build

Electrical:

- Due to the use of surface mount components reflow was the best option to assemble the PCB. However the lack of a commercial oven required the conversion of a toaster oven.
- A few error in the design led to multiple iterations being manufactured.

Software:

- The 3D simulation was designed based on a weight room in the HPE.
- The sizing was designed to a one to one ratio to the real world
- Red tracking dot to provide a tracking line.

Mechanical:

- 3D printers were used to rapid prototype a case to safely house the electronics.
- After multiple adjustments an finalized circular design was made in solidworks and 3D printed.
- Screws, fasteners, and dampiners were used to place all the electrics in the housing as shown in Figure 4. Also to fix the lid over the electronics components.
- Multiple prints had to be made to adjust for different tolerances caused by the 3D printers.

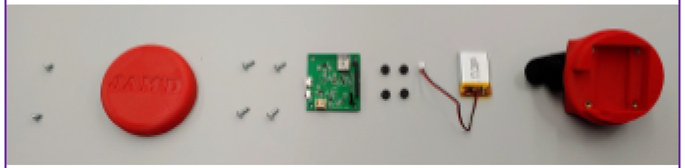

Fig 4: Exploded View of our prototype

Testing

Electrical:

- Accuracy of the virtual sensor:
- Real Time 30 frames/s
- Power Consumption
- Current draw of the board is measured at several working voltages in order to calculate wattage.

Mechanical:

- As shown in Figure 5, a sensor was attached to the barbell and dropped multiple times with weight on the bar to test durability
- A strap design had to be made when it was discovered during testing that the sensor was moving around and would not stay fixed to the barbell.
- Cracking in casing during drop test also led to more material needed to be added to certain weak spots in design.

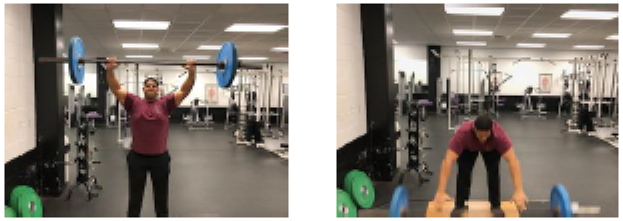

Fig 5: Durability Testing of 3D printed prototype

Conclusion

After a 8 months of development, we are on the verge of mass producing our training sensor. To mass produce we plan to use injection molding to construct the housing of the electronics. This will allow JAM'D to order by the thousands which will decrease manufacturing costs. ABS plastic will replace the current housing material, PLA. This material change drastically increases the overall strength of our product. The last hurdle will be perfecting the electronics and reducing/removing debugging features. As of now there are still a few bug dealing with communication both on the PCB and from it, but the bugs have been found and documented.

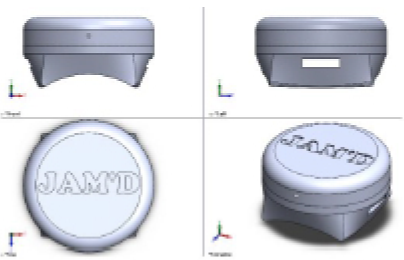

Fig 6: The Final Model