RepXcel is a barbell velocity tracking system designed to help barbell users optimize their lifting performance. User’s simply attach their RepXcel device to their barbell and connect with the device through a mobile application. The application allows users to control the RepXcel device and provides a session history log for tracking progress. For each session, the rate of perceived exertion (RPE) value is provided as a quantifiable performance metric.

**Why RPE?**

RPE is a 0-10 number scale system that defines how exhaustive an exercise is; 0 no exhaustion and 10 full exhaustion. The RPE correlates with the velocity of the barbell since users approach maximal exhaustion their movement slows.

**How it Works**

For compound movements involving a barbell, vertical force is applied by the user accelerating the barbell upwards. RepXcel’s embedded application captures the vertical acceleration during the movement of the barbell and transforms it into velocity information. Bluetooth protocol transfers the velocity information to the user’s phone application, where it is transformed to performance metrics and displayed in digestible graphical formats. To save user’s session history, a cloud server is deployed and managed for users to access their history at any time.

**Mobile App**

The app is created using React Native with TypeScript. The back-end is hosted on AWS Amplify. The app offers many features such as user authentication, Bluetooth connectivity, RPE calculation, and data visualization and synchronization.

**Embedded Algorithms**

There are two algorithmic problems to solve to make this all work.

**How do we integrate acceleration?**

Acceleration in each cardinal axis is numerically integrated with Euler’s method:

\[ y_{n+1} = y_n + a \Delta t \]

**How do we track per-rep velocity?**

A state machine tracks the device state and determines when repetitions are tracked.

**Embedded Programming**

The embedded application is a Bluetooth peripheral device responsible for measuring, processing, and sending velocity data. The application takes measurements from an LIS2DH12 accelerometer and calculates the per-repetition velocity of a barbell. This velocity is then sent over BLE using our custom workout data service to our mobile application. The app then analyzes the set to calculate for RPE!

Under the hood, the following FreeRTOS architecture is used:

**System-on-Chip**

Power efficient nRF52 SoC containing Arm M4 processor, 2.4GHz transceiver, and additional important functional blocks.

**Bluetooth Antenna**

Chip antenna for minimizing space and a 502 impedance matching network for maximal power transfer.

**Motion Sensor**

3-axis accelerometer with serial interface and ultra-low power operation.

**Voltage Regulator**

5V voltage rail for digital system operation.

**Battery Charger**

USB micro USB 1-hour charging for single cell 110mAh Li-Po battery pack. Allows the device to be fully wireless for power on standby.

**Application User Experience**

The app is simple and easy to use. User can log into their account and start tracking their barbell. The app captures the data from the barbell and provides real-time feedback on their performance and progress.

**Try it Out!**

- Calibrate your benchmark velocity for maximum exertion and start a session to receive an RPE based on your benchmark!
- Your data is easily tracked and displayed in our app. Ask us to try it out!