Introduction

- We present the design of the HABits necklace, a neck-worn device that estimates behavior.
- This neck-worn device is continuously evolving to provide researchers with the ability to use it in multiple applications including eating, gesture, and activity recognition.

Eating Related Behavior

**Chewing**

The proximity sensor signal shows 3 bites and 2 chewing sequences between the bites with a chew count of 22.

**Gesture**

The three dips in the ambient light sensor signal correspond to 3 feeding gestures as the participant places his/her hand close to the mouth.

**Lean Forward**

The animation on top shows the posture estimated from the IMU. The lean-forward motion often corresponds with a feeding activity, while the lean-back motion corresponds with a drinking activity.

System

**Sensor Design**

- Proximity Sensor (VCNL4010)
  a) points towards the user’s chin.
  b) captures the changes of the distance between the chin and the necklace when the user chews.
- Ambient Light Sensor (VCNL4010)
  a) Placed around each subject’s neck.
- Inertial Measurement Unit (BNO055)
  a) calculate the amount the user leans forward and back.
- Real-time Clock
- Bluetooth Module

Example of signals

Activity Intensity

Activity intensity, calculated from IMU data, can inform us when users are moving and at what intensity level, to offset calorie need.

Conclusion

- We present a demo of a necklace that is equipped with four sensing modalities (proximity, ambient, and inertial sensing).
- We show the feasibility of the necklace in characterizing chews, feeding gestures, posture, and activity during an eating episode.
- The necklace also streams data in real-time to an app for processing and visualization.