# Happy Hands

Berkeley | EECS
Electrical Engineering and Computer Sciences

EECS 149/249A - 2018

Neha Godbole | Meghna Mandava | Henry Muller

## Project Goals

Happy Hands was designed to be full-featured, customizable, and playable through hand movement alone.

### Musical features

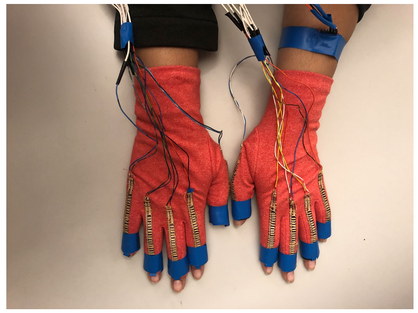
- All 12 major keys available for selection
- Pitch bending for extra flats and sharps within a key
- Can play any number of notes at once, enabling complex chords

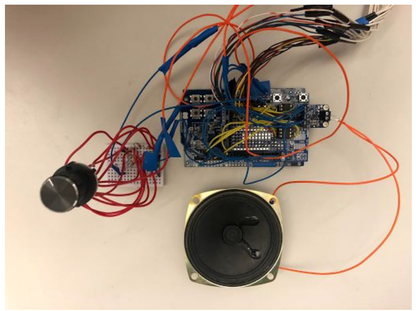
### Controls

- 8 fingers for playing scales or chords and 2 thumbs for pitch bending
- Wrist-mounted accelerometer changes volume level with a shake

### Customization

- Several different instrument soundboards are included (piano, cello, oboe), as well as software to easily generate even more





## Implementation

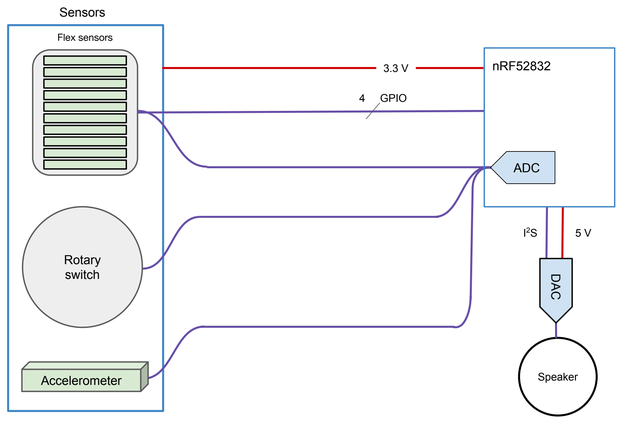
### Hardware

- Nordic nRF52832 Development Kit
- Resistive flex sensors used to send variable voltages to ADC
- 12-position rotary switch
- TI 3-axis accelerometer development board
- $I^2S$ DAC + audio amplifier development board
- 8Ω speaker

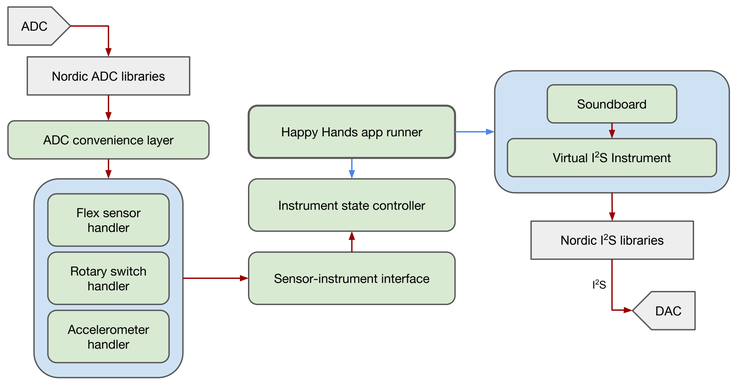
### Software

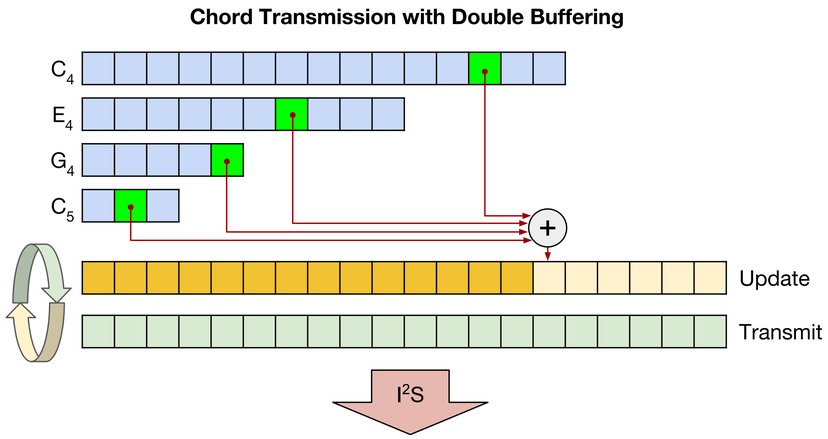
- Musical notes implemented as ring buffers
  - ($I^2S$ clock frequency) / (ring buffer length) = output note frequency
- Note combinations calculated in real time and streamed over $I^2S$, using a double-buffering strategy to avoid audio corruption
  - Precomputing chord combinations is unreasonable
  - C4 ring buffer contains 368 16-bit integers; E4, 276; G4, 232; C5, 174. LCM(368, 276, 232, 174) = 5,554,776 → 11.1 GB to precompute a single C major chord with a high C on top

## Hardware Architecture




## Software Architecture




## Connections to Course Topics

1. Sensors
   a. Flex sensors, accelerometer, rotary switch
2. Input/Output
   a. Analog inputs for sensor readings, GPIO ports to control multiplexers
   b. $I^2S$ protocol for sound output
3. Type Equivalence
   a. Instruments and soundboards can be swapped in and out
4. Interrupts and Polling
   a. Accelerometer volume adjustment triggered by ADC high/low limit interrupts
   b. Flex sensors are polled to determine which notes should be played

## Evaluation

1. Instrument is usable and customizable
2. Arbitrary note combinations possible with new waveforms calculated in real time
3. Sound character preserved between low and high frequencies (see below)
4. Volume levels are distinguishable