Final Project Review

Stride
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What is the Problem?

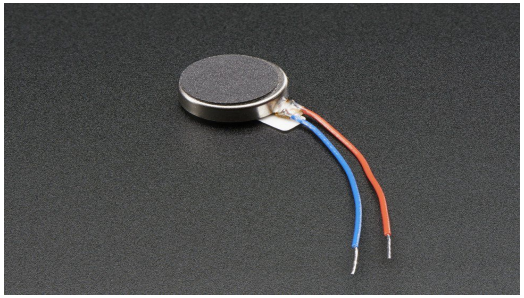
- Parkinson's Disease (PD) makes walking challenging
- Physical therapy and other treatments are expensive
- Limited inexpensive methods of monitoring exercises outside of clinical environment

What is Stride?

- Low cost array of wearable sensors that collects body movement information, designed for those with Parkinson's Disease
- Provide real-time feedback and track long term performance progress
- Used in home as well as in clinical environment

Neuro Training

- Vibrations on knee to indicate stride length error
  - Patient-specific stride length threshold
  - Two levels of vibrations depending on severity of error (both benign)

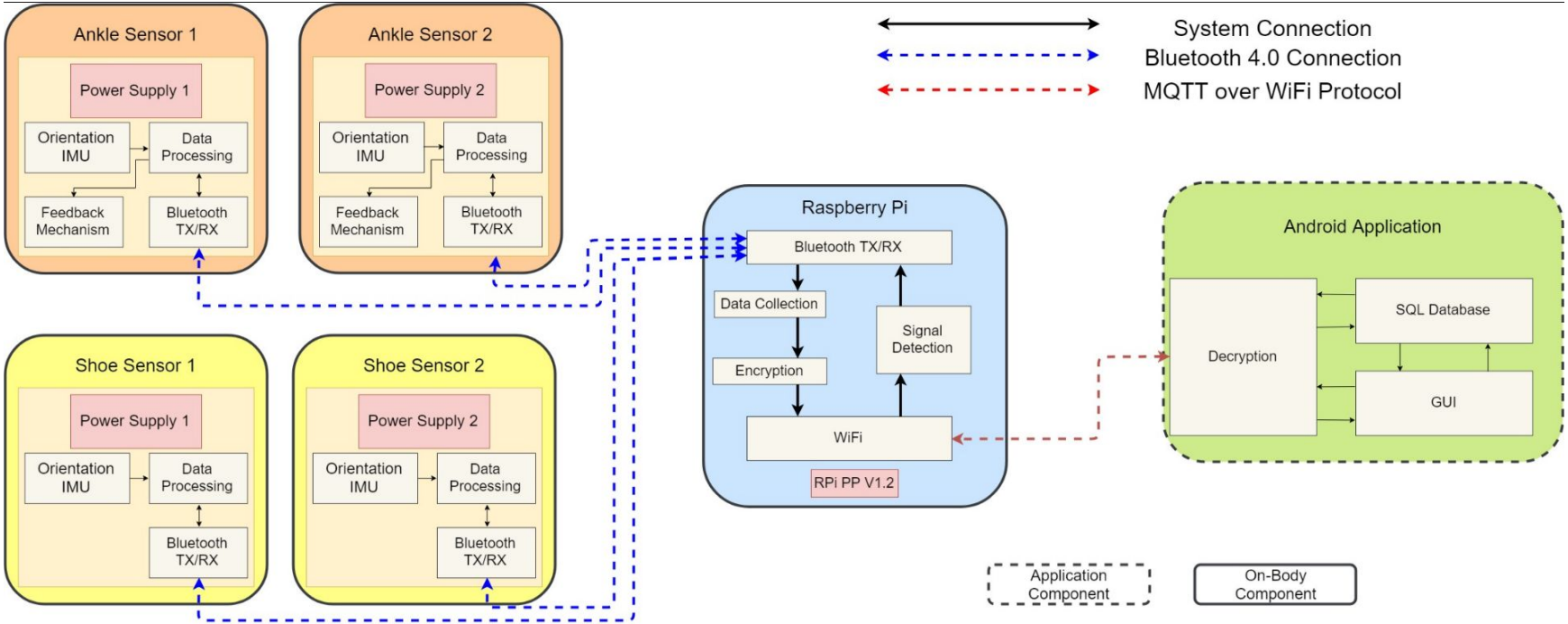


- Auditory Cueing
  - Rhythms played via app to stimulate proper cadence
  - Recommended by a Neurological PT

System Requirements

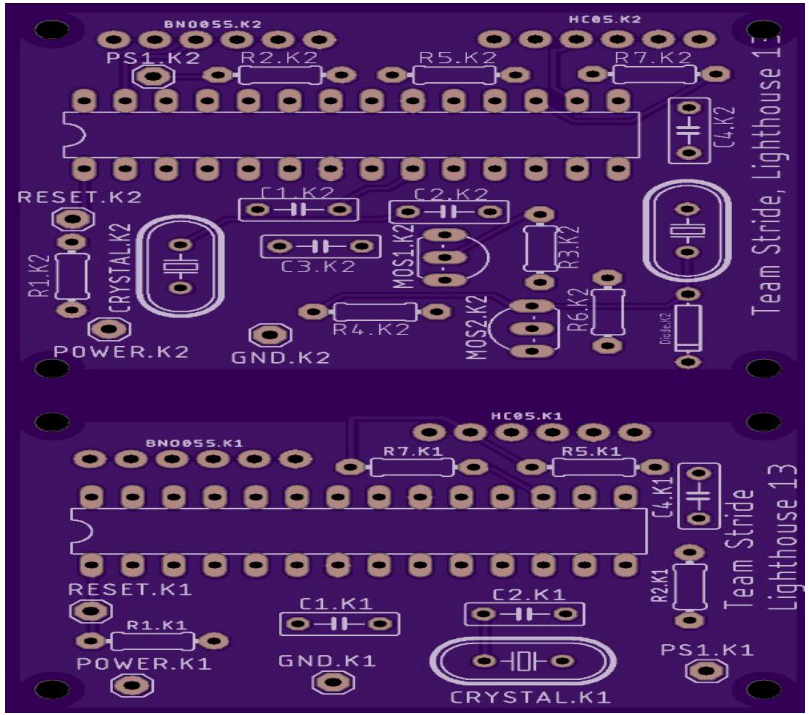
- Accurately collect movement data to appropriately monitor an individual's:
  - Stride length
  - Cadence
  - Heel-to-toe motion
  - Freezing
- Provide real-time feedback to correct stride length during exercise (less than 100ms)
- Store and display data Android application to track long term patient progress
- Lightweight product that is easy for patient to put on
  - Sensor systems < 1 pound each
  - Waist clip (Raspberry Pi + power supply) < 1 pound
- Sensor systems and Raspberry Pi will have battery life of greater than 2 hours

FPR Block Diagram



Hardware Components (Sensor Systems)

Hardware Component	Shoe (x2)	Knee Sleeve (x2)
PCB	Yes	Yes
Processor	Atmega328p	Atmega328p
Wifi	No	No
Bluetooth	HC-05	HC-05
Battery	Lithium Polymer	Lithium Polymer
Feedback Circuit	No	Yes
IMU	BNO055	BNO055



Hardware Components (Waist Clip Pouch)

Waist Clip Pouch

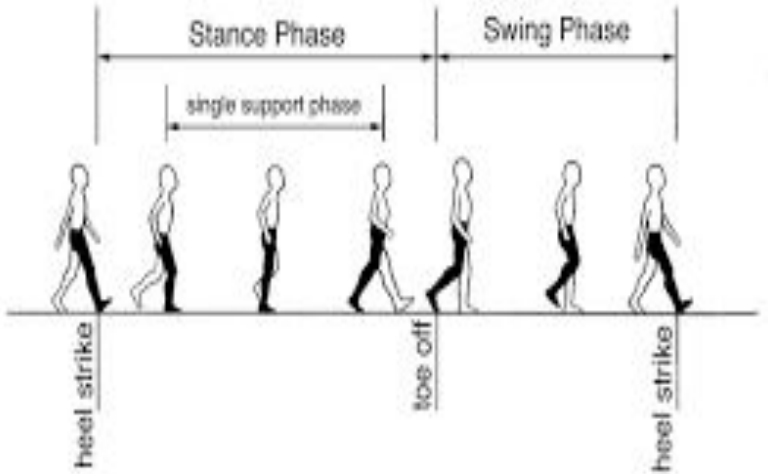
- Raspberry Pi
  - Processor
  - Bluetooth
  - Wifi
- Lithium Ion Battery

Data Analysis-Ankle

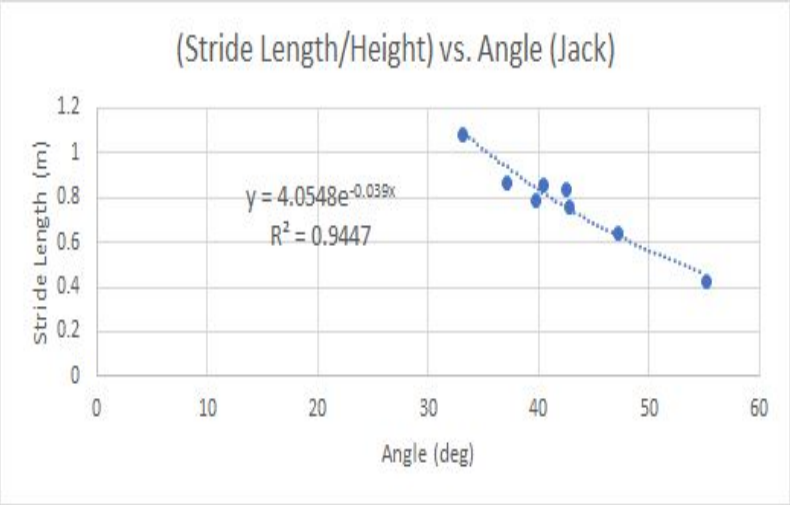
- Outputs: stride length and cadence
- How it works:
  - Determine step by examining sensor orientation
  - Capture smallest angle in step = θ
  - Stride Length (theoretical) = L*cos(θ), where L is length of leg
  - Stride Length (after experimentation) = L*(K)*e^(-M*θ)

(L = leg length; K,M = calibration constants; θ = angular extent of swing phase)

  - Cadence = steps/time



Data Analysis-Ankle (Cont'd)



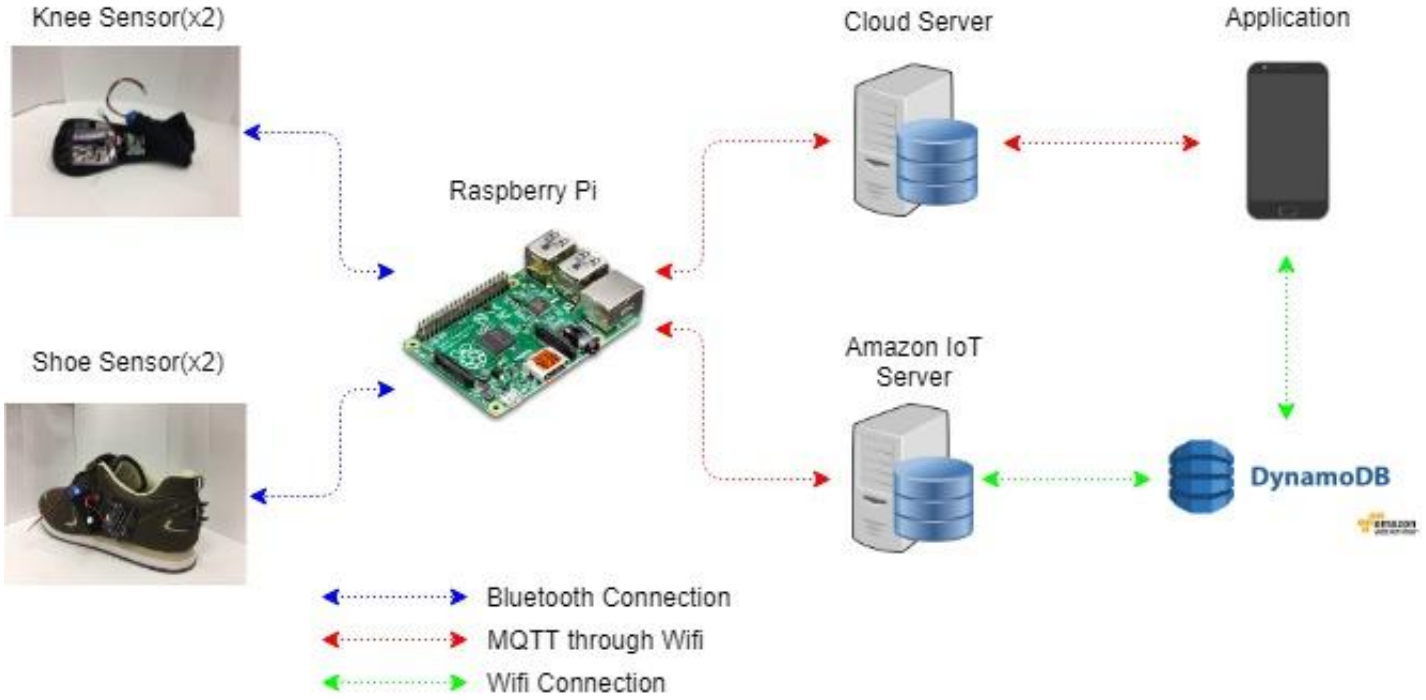
Trendline of measured vs. calculated stride length

- Stride length equation and feedback work best when calibrated to the specific user
- Can set feedback thresholds based on severity of disease; therapist's discretion
- Use progressive values or standardized values

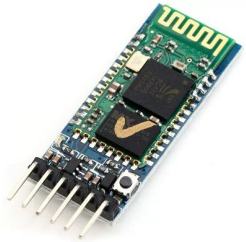
Data Analysis-Shoe

- Outputs: heel-to-toe weight transfer and freezes
- How it works:
  - Utilize orientation data to determine range of angles in steps
  - Greater range of angle = better heel-to-toe weight transfer
  - Freeze recorded if angle does not change above 5° threshold

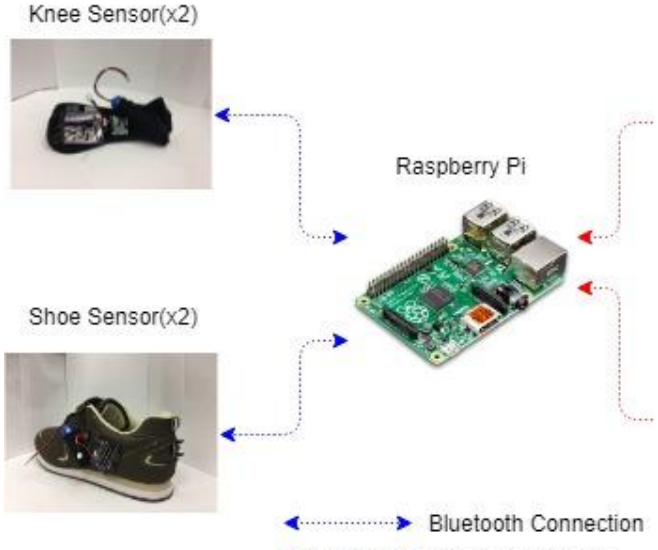
Visual System Communication Overview



System Communication: Bluetooth Connections



- HC-05
- Start and Stop signals
- Synchronous intake



System Communication: MQTT Connections

- Publish/Subscribe Messaging
- App commands
- Amazon IoT Topic

dataTopic Dec 8, 2017 10:41:44 AM -0500 Export Hide


```
{
  "sessionID": "1_49",
  "magnetometerz": "0.66",
  "accelerometer x": "-3.18",
  "user": "rhartnett",
  "accelerometer z": "8.61",
  "magnetometer x": "0.26",
  "magnetometer y": "1.03",
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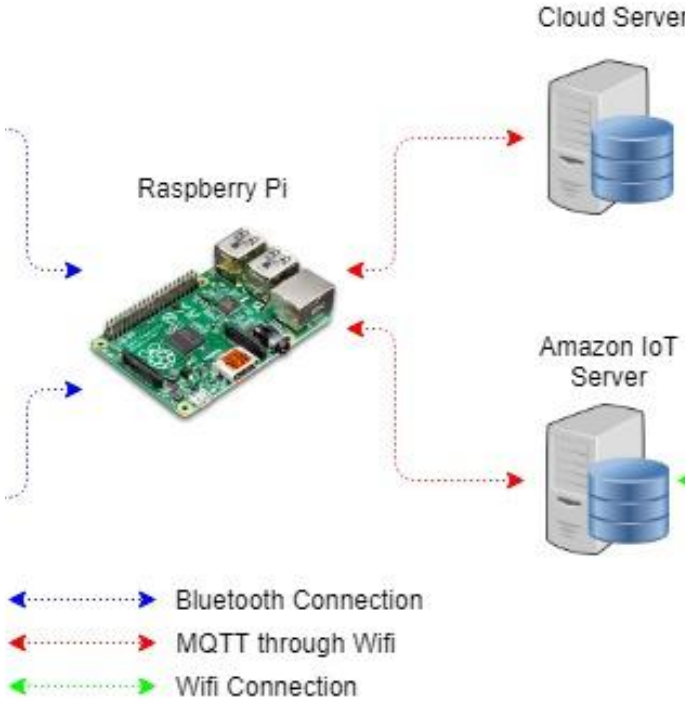
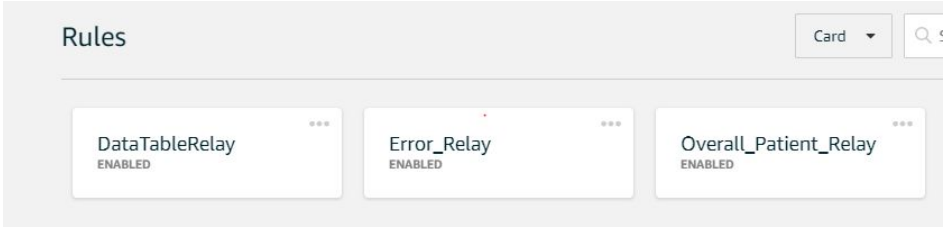


System Communication: Other Wifi Connections

- Application
- Rules are used to relay information



Application Backend

- Used AWS Mobile Hub to integrate backend with Android Application

- Created multiple NoSQL database tables to store application data

- Database consists of 6 tables
  - User Information
  - Patient List for Therapist
  - Patient Workout List
  - Overall Workout Performance
  - Session Workout Performance
  - Session Error Check

Application

- Android application designed in Android Studio
- Functionality:
  - Patient/Therapist Login
  - Therapist can program workouts for specific patient
  - Therapist can view patients session performance
  - Patient can view session performance
  - Patient can view and perform programmed workouts
  - Patient workout auditory queuing

Proposed FDR Deliverables

- Fully functional knee and shoe sensor with data analysis
- Breadboard → PCB
- Real-time feedback incorporated into data analysis
- Fully functional and polished application
  - Be able to start workout from application

Goals of Demo

- Show basic data analysis using knee sensor system and view data received by the Raspberry Pi over BlueTooth
- Show data movement through all systems
  - BNO055 → Atmega328 → HC-05 → Raspberry Pi → AWS backend → Android Application
- Show simultaneous sensor data transfer
- Show feedback system functionality
- Show application design and functionality
  - login/create account
  - Therapist side
  - Patient side

Thank You

Questions?