GAITKEEP

BMES MAKE-A-THON TRACK B

TEAM 2
MATTHEW LO, CHRISTINE LY, DEREK NUTZ,
ADRIAN ORNELAS, VIETBAO TRAN

THE PROBLEM

- Patients with gait disorders have problems with neurological components that relate to the inner ear, vision, brain, peripheral nerves, muscles, and spinal cord [1]
- Gait disorders are associated with cognitive dysfunction, depressed mood, and compromised quality of life [2]
- Approximately 4 in 1000 adolescents suffer from cerebral palsy, the most common motor disability in children [3]
- What affects gait:
    - Neurological disorders
        - Parkinson's disease, cerebral palsy, muscular dystrophy [4]
    - Gait abnormalities
        - Intoeing, outtoeing [5]
- Accurate diagnosis and quantification of these movement disorders over time are important in order to determine patient outcome and treatment [6]

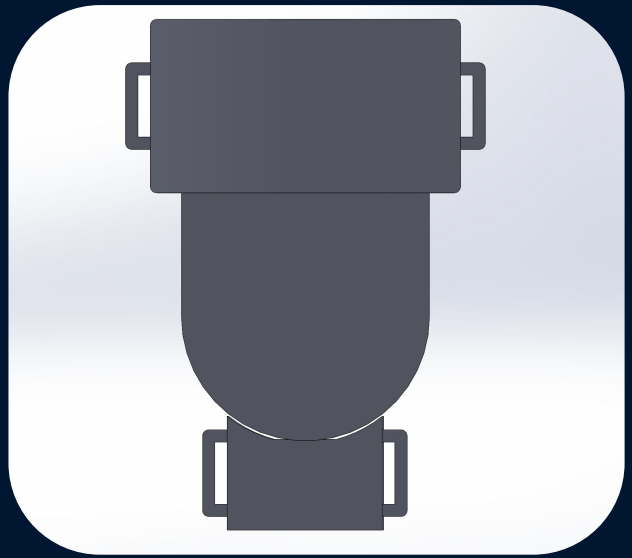
OUR SOLUTION

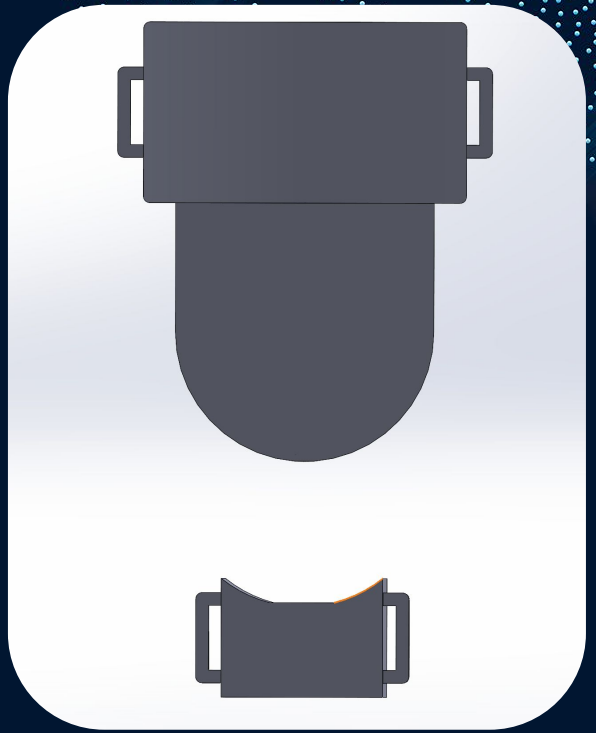
- Four accelerometers (one on each ankle, one around each knee)
  - Measure relative position of patient's legs
  - Provide physical therapists more quantitative information used to diagnose and treat disorders
- Our customers are patients who suffer from gait and balance disorders
- Non-wearable gait monitors require patients to be in the same location as the sensors, which are on a track on on the ground [7]
  - Not practical for everyday monitoring
- Newer gait monitors focus on placing the sensor in the insole of the shoe
  - They use force and kinematics to map the distance between each steps and only have accelerometers in the feet [8]
  - Our device would use accelerometers at two different points on the legs which could help give more data
- Our mobile application and device will allow children with gait disorders and their physicians to monitor their state and progress to make healthcare information more accessible and smooth the transition between pediatric and adult healthcare

USABILITY

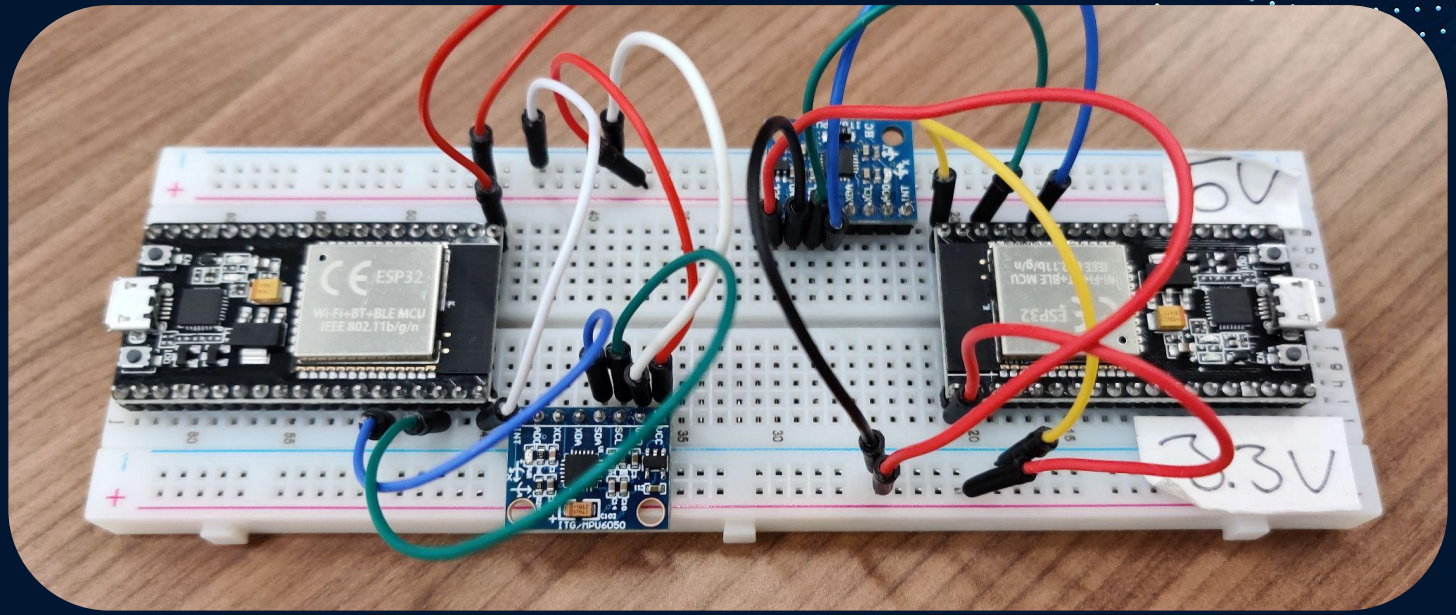
- The patient straps the main body of the device, which houses one of the accelerometers, to their knee with the velcro straps
- The second accelerometer will be below the main body of the device and is pulled down to the ankle; it will also be attached using velcro straps
    - The second accelerometer will be connected to a mechanism that uses a torsional spring to bring the two pieces together when the device is released from the ankle
- The main device is then connected to a mobile app via Bluetooth and will display the data collected from the accelerometers
- There will be a charging port on the side of the main device that will connect to the battery

SOLIDWORKS MODEL





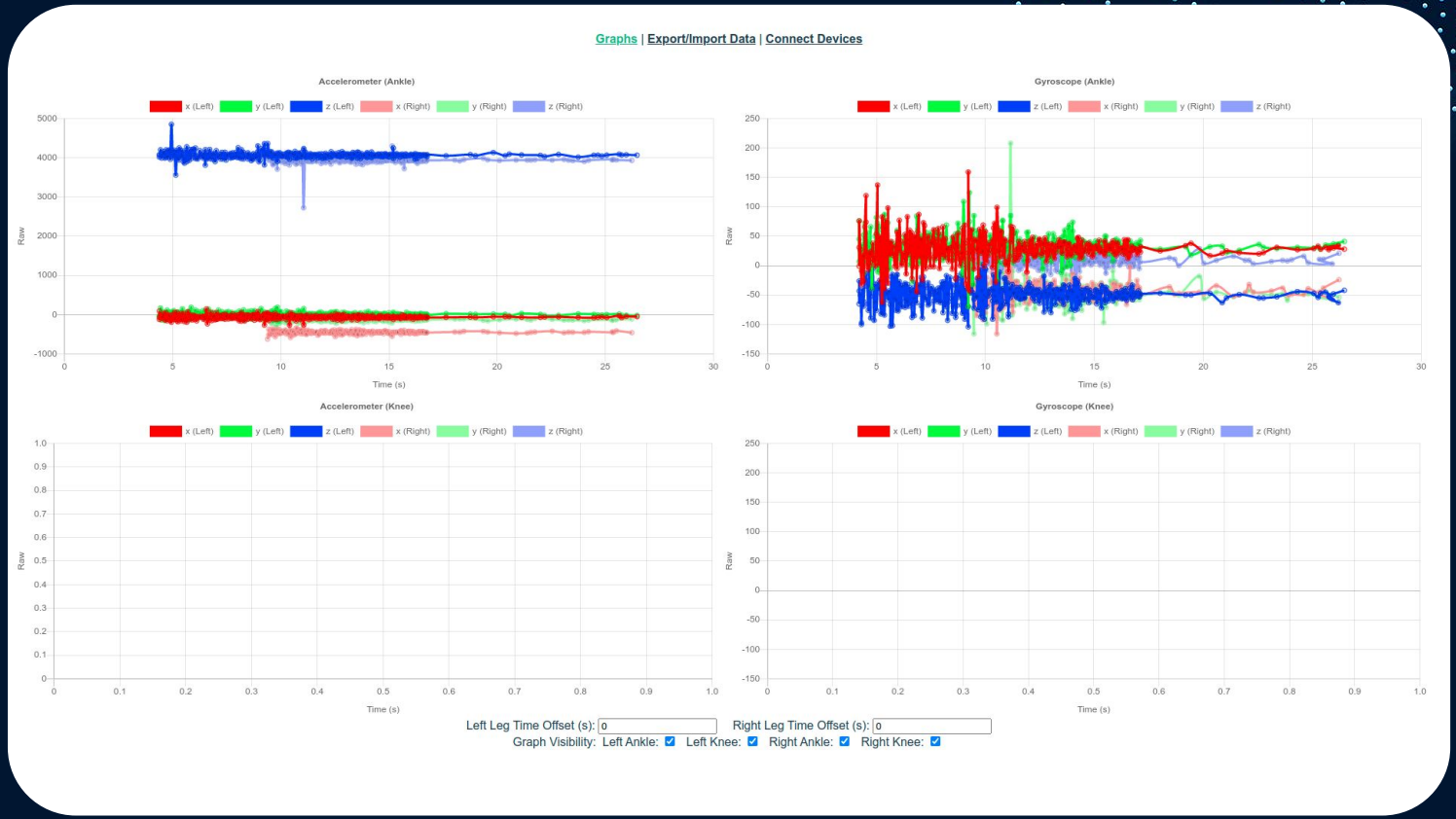
HARDWARE



SOFTWARE

- Webapp
  - Vue.js
  - Web Bluetooth (BLE) for communication with ESP32
    - Compatible across most major platforms
  - Chart.js for graphs
  - CSV export and import
- ESP32
  - Arduino framework running on of Esspressif's IDF
  - I2C for communication with dual MPU6050 sensors (accelerometer and gyroscope sensing accurate up to 2 g's of acceleration)
  - BLE for communication with webapp
  - 10 hour run time on a compact 1000 mAh battery
    - Can be optimized to 35 hour run time with a more conservative implementation of BLE
- Code is open source with MIT license

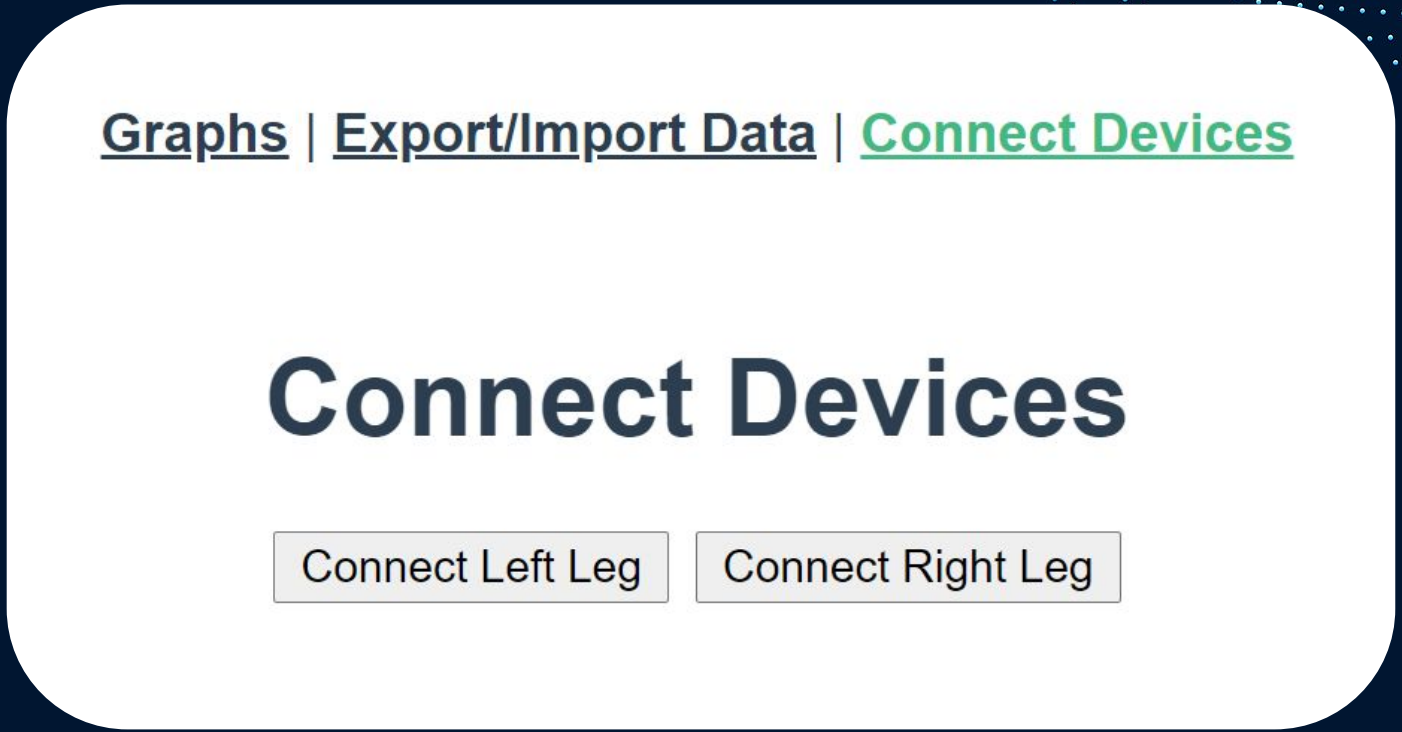
SOFTWARE


Graphs | Export/Import Data | Connect Devices
Accelerometer (Ankle)
Gyroscope (Ankle)
Accelerometer (Knee)
Gyroscope (Knee)
x (Left)
y (Left)
z (Left)
x (Right)
y (Right)
z (Right)
Raw
Time (s)
Left Leg Time Offset (s): 0
Right Leg Time Offset (s): 0
Graph Visibility: Left Ankle: Left Knee: Right Ankle: Right Knee:

SOFTWARE


Graphs | Export/Import Data | Connect Devices
Export Data
Export CSV
Import Data
Import CSV

SOFTWARE


Graphs | Export/Import Data | Connect Devices
Connect Devices
Connect Left Leg
Connect Right Leg

LIMITATIONS AND FUTURE WORK

- Accuracy of accelerometers
- Comfort
  - Requires convenient and unobtrusive attachment
  - Needs padding to make device less hard
- Mobile app
  - Currently uses a web app; need to create an engaging mobile app to keep patients engaged and encouraged for long term independent use
  - To improve transfer of data to healthcare providers, app can use App Orchard APIs from Epic Systems, the most widely used EHR, to seamlessly integrate patient data into their medical record for review by their physician
  - Should add a training module to acclimate the user to the app and how to use it
- Needs to be able to dynamically compare the real time data with saved past data in order to track changes in gait over a period of time
- Current data is shown in graphs, which can be hard to read for users. Making 3D visual animations corresponding to the recorded data could resolve this problem
  - Implementing an inverse kinematic model of a patient's gait pattern could aid visualizations of their unique gait patterns
- Data acquired can be used as inputs to neural networks to analyze the data and track gait progression

DEMONSTRATION

Source: https://github.com/TapuCosmo/BMES-2021-Gait-Monitor

CITATIONS

1. Pediatric disorders of gait and movement – Children's health. Children's Health . (n.d.). Retrieved December 3, 2021, from https://www.childrens.com/specialties-services/conditions/disorders-of-gait-and-movement.
2. Mahlknecht, Philipp, et.al. “Prevalence and burden of gait disorders in elderly men and women aged 60-97 years: a population-based study.” PLoS One vol. 8, (2013): e69627.
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7. Muro-de-la-Herran, Alvaro, et.al., “Gait Analysis Methods: An Overview of Wearable and Non-Wearable Systems, Highlighting Clinical Applications.” Sensors (Basel), vol. 14, (2013): 3362-3394.
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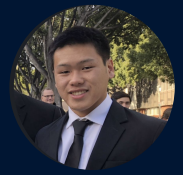
THANK YOU



Matthew Lo lomk2@uci.edu

Christine Ly cly13@uci.edu

Derek Nutz dnutz@uci.edu

Adrian Ornelas afornela@uci.edu

Vietbao Tran vietbaot@uci.edu