# Preliminary Design Review

## Stride
## October 20, 2017

# Group Members

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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

# Problem Specifics

- Parkinson's Disease affects close to 10 million people worldwide and 1 million Americans[1]
- Gait training exercises require professional feedback to ensure proper form
- Insurance usually only covers 2-3 sessions a week

[1] http://www.pdf.org/parkinson_statistics

# Problem Specifics (Cont.)

- Many gait training exercises can be done in the home
  - No professional feedback
  - Development of bad habits

- Not enough therapy for patient to effectively progress in training

# Design Alternatives

## SafeGait

- Harness that allows 360 degree motion
- Therapist can alter settings to increase/decrease harness support given
- No data collected on walking form

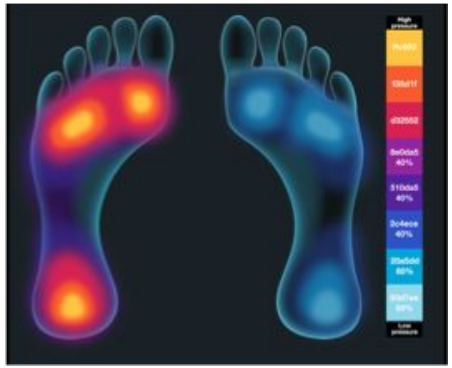
http://safegait.com/360-balance-mobility-trainer/

## EksoGT

- Robotic exoskeleton
- Assists patients who lack lower body strength to walk independently
- Costs $70,000

http://eksobionics.com/eksohealth/products/

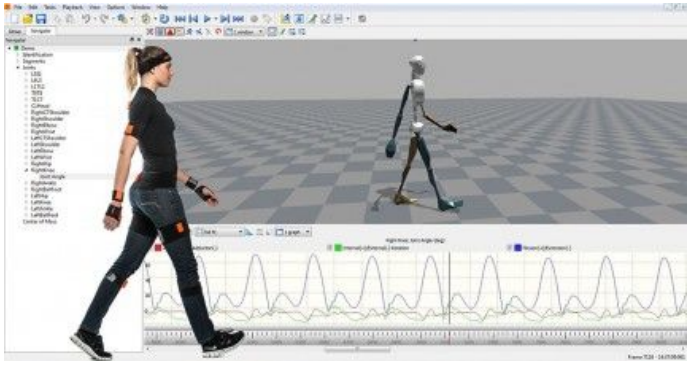
# Design Alternatives



## TrainRite

- Pressure sensitive shoe insole
- Measures weight distribution of the feet
- Provides no real-time feedback

http://www.ecs.umass.edu/ece/sdp/sdp16/team11/bobbobbob.my-free.website/index.html



## XSENS

- Wearable sensors that analyze walking form
- Relay information to software application
  - Displays 3D image of patient
- No real-time feedback to stimulate neuro training

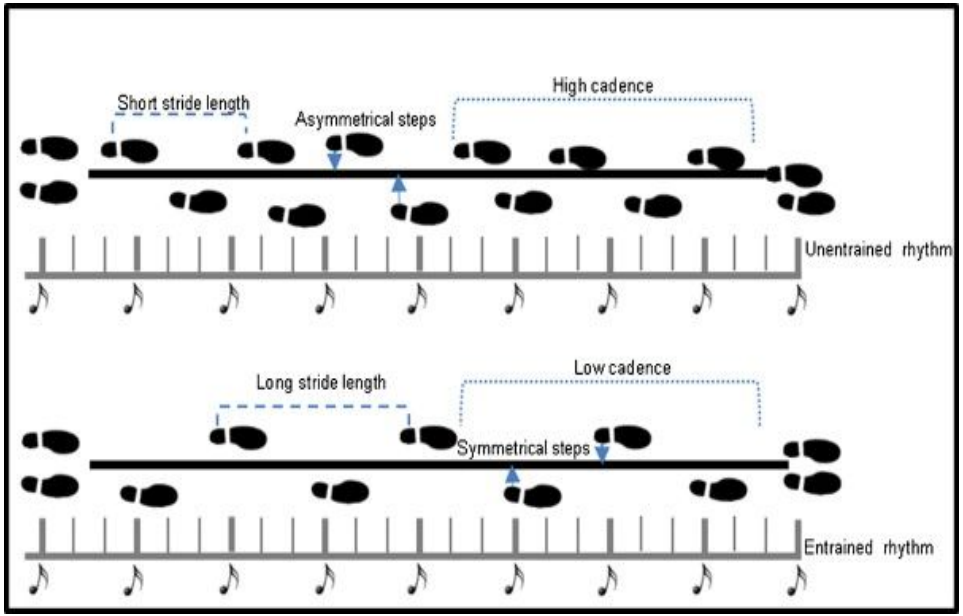
https://www.xsens.com/tags/gait-analysis/

# What is Stride?

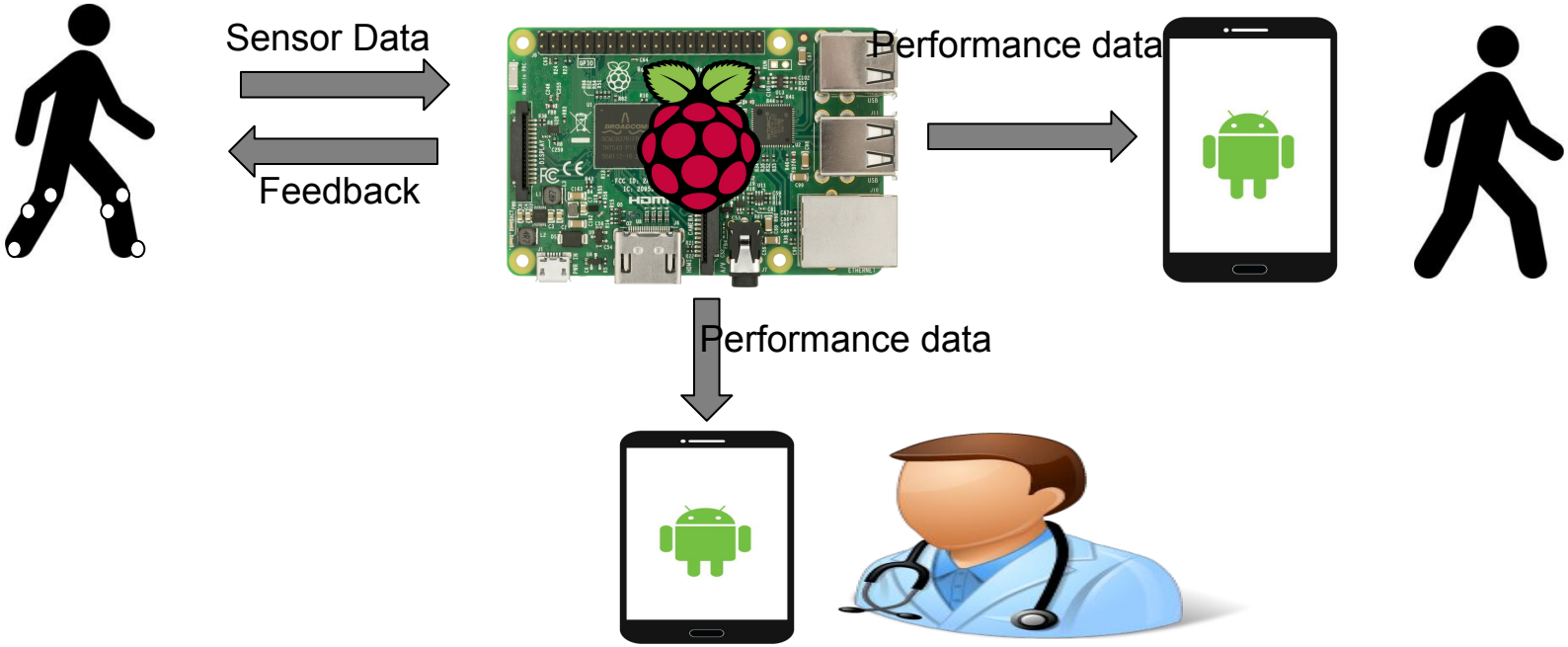
- Low cost array of wearable sensors that collects body movement information, designed for those with Parkinson's Disease
- Provide real-time feedback and track long term performance progress
- Used in home as well as in clinical environment

# Parkinson's and Gait

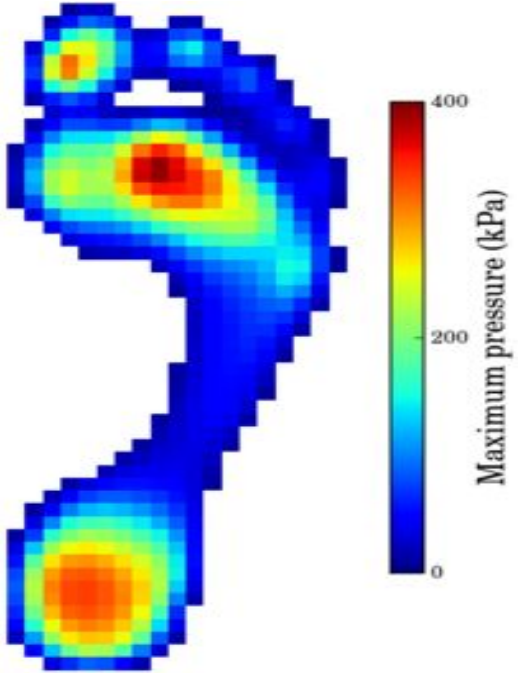
- Parkinsonian gait characteristics
  - "Shuffling"
  - High cadence
  - Flat-footed steps
  - Freezing



# How It Works



# Data Analysis




- Establish base cases
- Incorporate algorithms to convert sensor data to meaningful metrics
- Determine what data triggers feedback

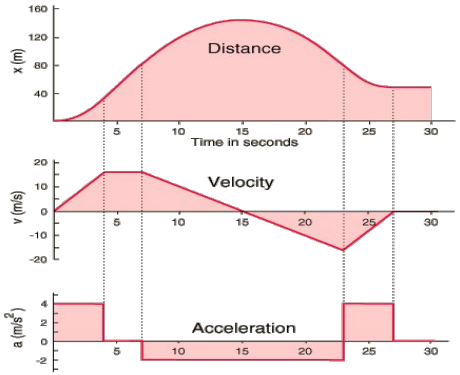
# Inputs and Outputs

## MEASUREMENTS

- Acceleration
- Angular Velocity
- Pressure Distribution

## METRICS

- Stride length
- Cadence
- Heel to toe weight transfer
- Freezes



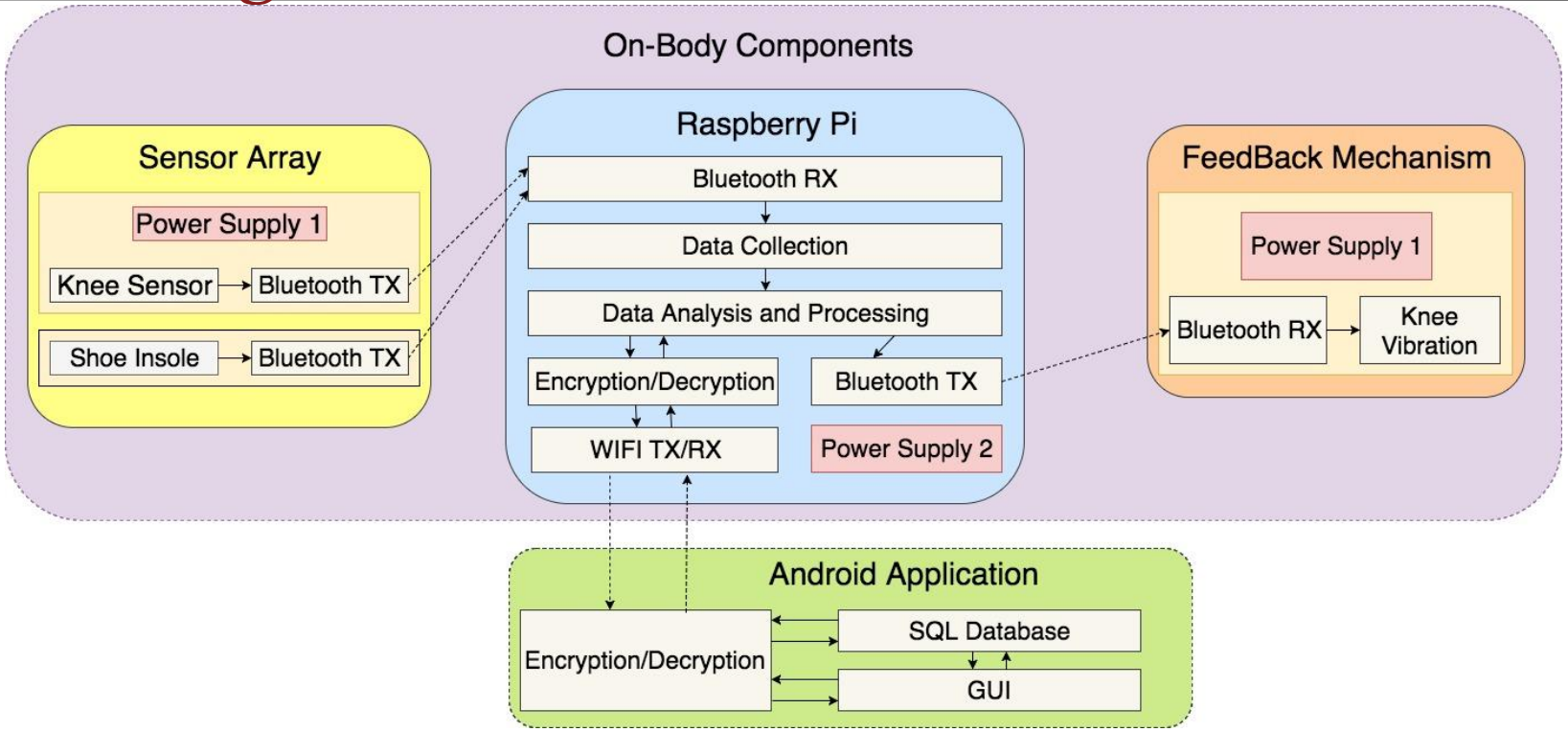

## OUTPUTS

- Performance tracking
- Real-time feedback

# Specifications

- Feedback
  - Real-time performance feedback < 10 ms
- Metric Calculations
  - Within 10% error of Qualisys Oqus Motion Capture System measurements (in UMass Human Motion Lab)
- Physical Specs
  - Knee sensor system < 1 pound
  - Waist clip (Raspberry pi + power supply) < 1 pound
- Battery Life
  - 2 hours

# Block Diagram

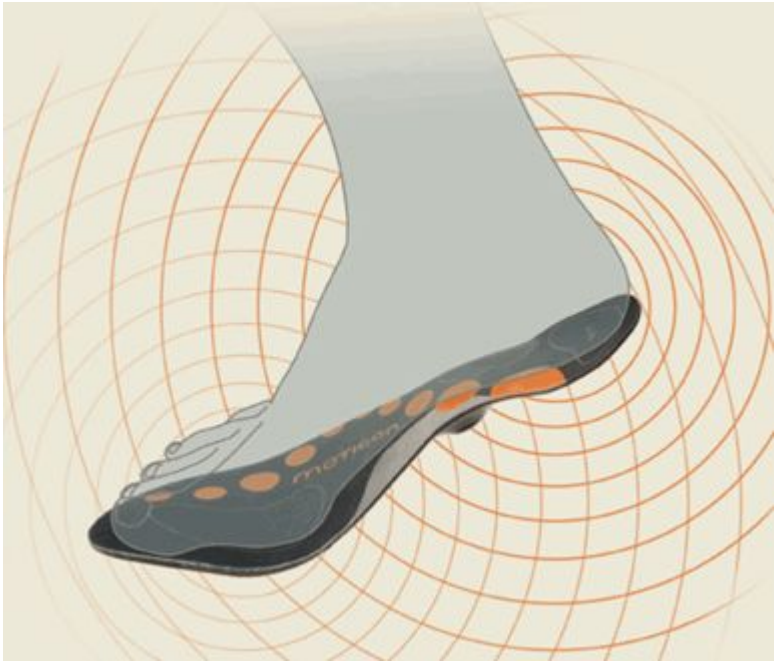


# Feedback Mechanism

- Real-time Feedback
  - Lets patient know when form is incorrect without physical therapist
  - Form can be corrected on spot during home therapy
- Neuro training
  - Muscle monitoring/muscle checking solution
  - Benign vibrations on each leg
  - Help train patient to walk with correct form
- Three Vibration settings
  - No vibration, form is within proper range
  - Slight vibration, form is just outside of proper range
  - Full vibration, form is outside of proper range

# Insole Specifications

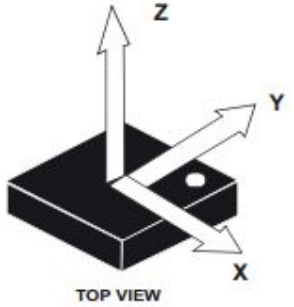
- Sensor based insole
  - Measure heel to toe motion of individual feet
  - Measure individual's weight distribution between feet
- Data collected by Insole:
  - Heel to toe to prevent patient from becoming flat footed
  - Weight distribution to detect “freezing”

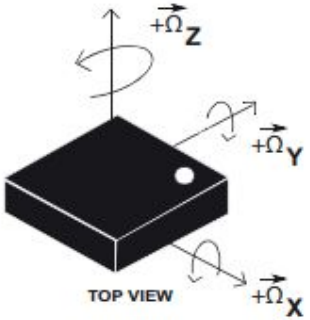



# Body Sensors Specifications

- Sensors worn on knees
  - Measure acceleration of limbs
  - Measure angle at which the joints bend to correct form

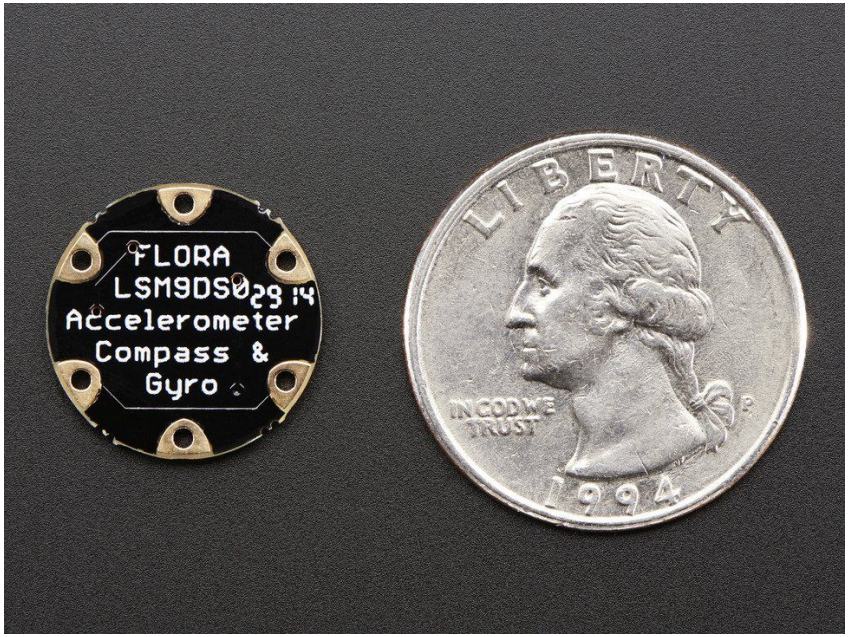
- Inertial Measurement Unit (IMU) Sensor System used to determine data
  - Accelerometer and Gyroscope used to determine cadence and stride length



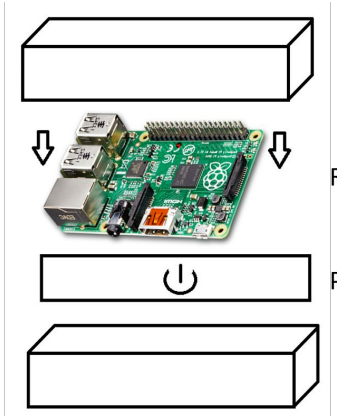
# FLORA 9-DOF

- VDD range (2.4-3.6 V)
- 9 DOF IMU
  - 3D Accelerometer
  - 3D Gyroscope
  - 3D Magnetometer
- 16-bit data output
- Small size and weight
  - 16 mm diameter
  - .8 mm thickness
- Easily mounted



# Mechanical Design

- Knee Sleeve
  - Sensor will be on front
  - Wired to small pcb in pocket on back
  - Rechargeable power supply also in back pocket
  - Feedback vibrator on inside of knee




- Waist Clip Box containing:
  - Raspberry Pi
  - Power Supply

# User Interface

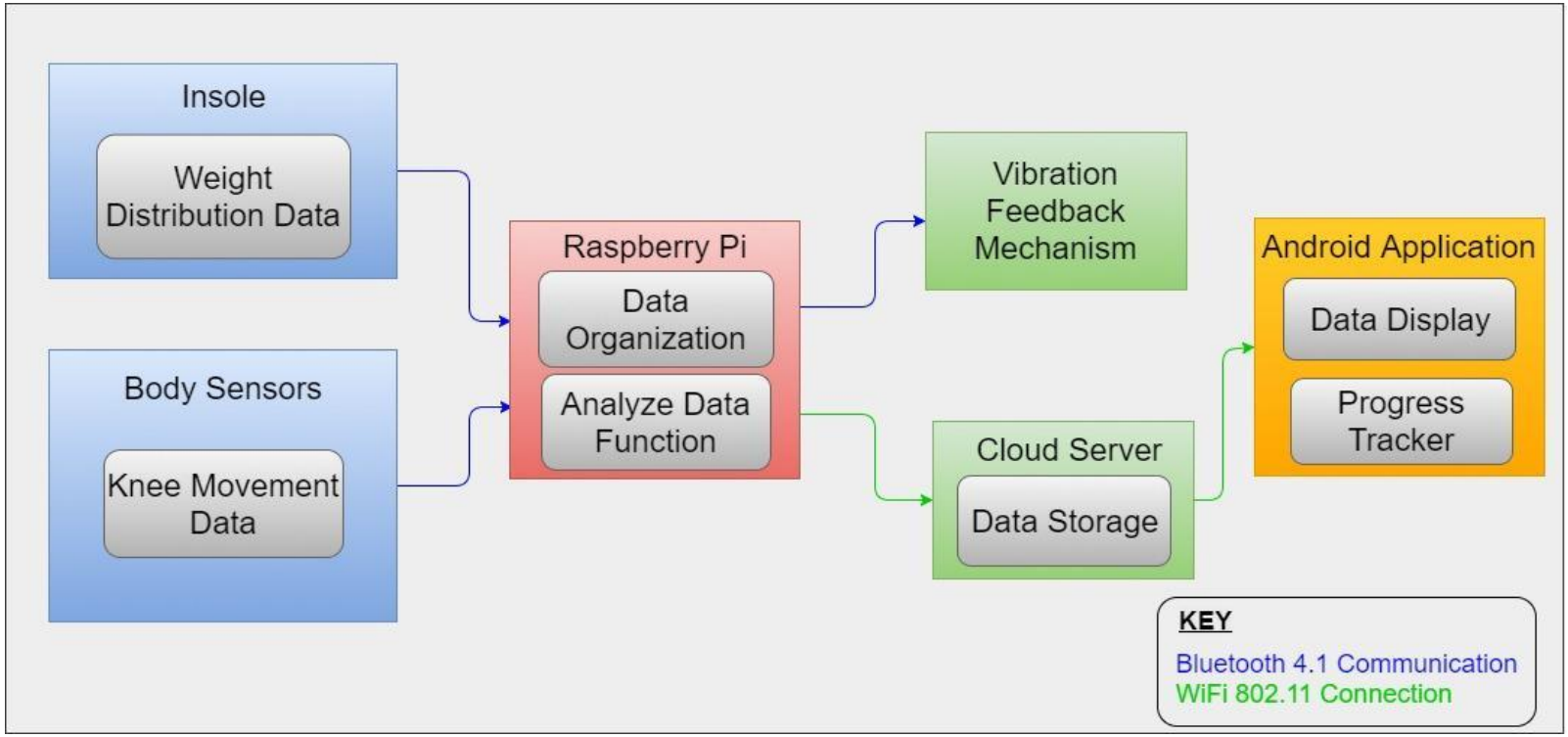

- Android Application for phone and tablet
- Display and track statistical information
- Separate types of accounts
- Allows for in-home monitoring
- Program/Assign Simple Workouts

# Data Processing and Storage

Processing
- Sensors
- Raspberry Pi
- Bluetooth 4.1
- ARM v8 Processor

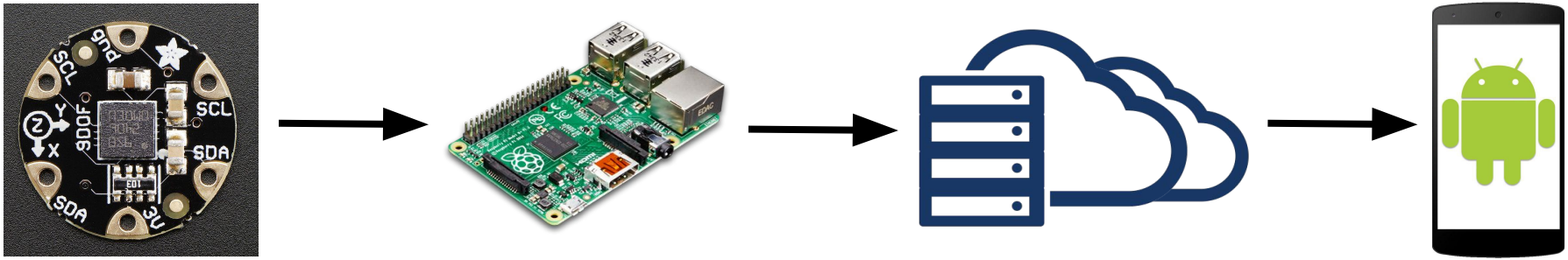
Storage
- SQL database
- Cloud Server

# Data Processing and Storage Diagram



# Proposed MDR Deliverables

- Knee sensor
- Cloud Server
- Raspberry Pi
- Android Application



# Individual Roles Moving Forward

- Richie - Team Leader, Software Application, Data Storage
- Joe - Hardware/Software Interfacing
- Jack - Mechanical Design and PCB Design
- Jarred - Data Processing and Analysis, Sensor Programming

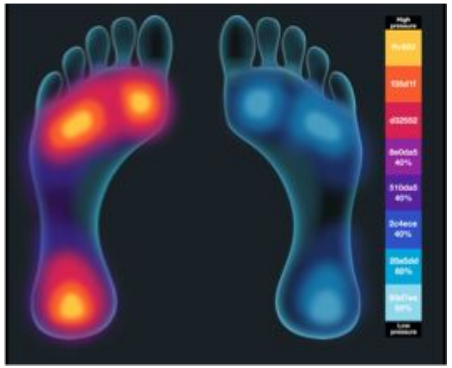
# Thank You

Questions?

# Former SDP Projects

## TrainRite

- Pressure sensitive shoe insole
- Measures weight distribution of the foot
- Monitors form when weight lifting to avoid injury



## SWAG

- Pressure sensitive shoe insole
- Measures weight distribution of the foot
- Monitors walking form to assist with gait training