

Final Presentation

Group 4

Lower Limb Amputation - Overview

- Lower limb amputation (LLA) due to several causes- most commonly diabetes
- More than one million individuals living with LLA in the United States

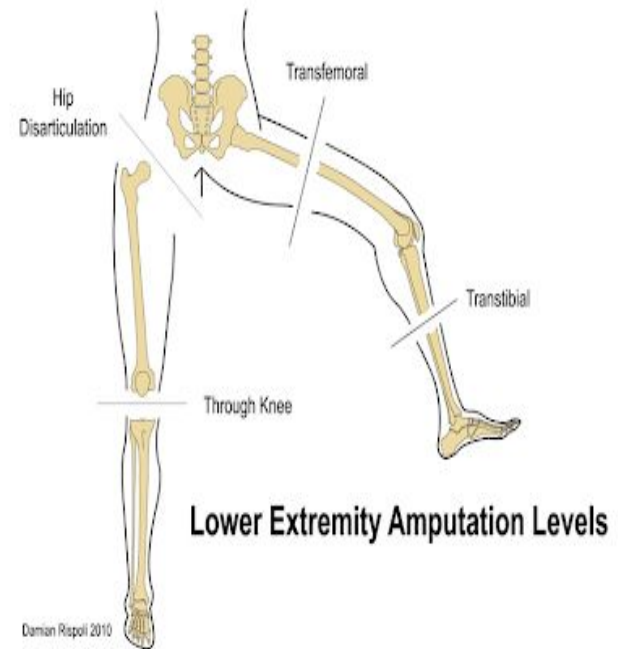


Figure 4. Lower extremity amputation levels.

Gait Problems in Lower limb amputees

- Gait asymmetry is most common problem, due to patients not trusting their prosthetics.
- Uneven weight distribution
→ lower back pain, knee osteoarthritis, and hip osteoarthritis



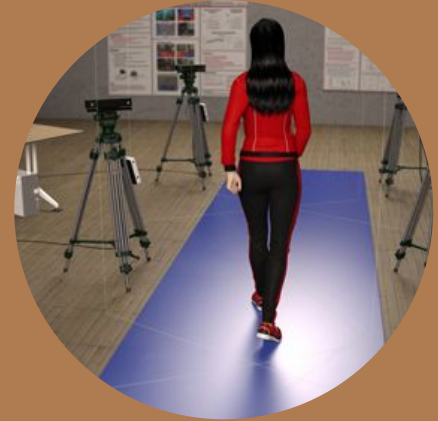
Methods for Gait Data Collection



Inertial Measurement
Units

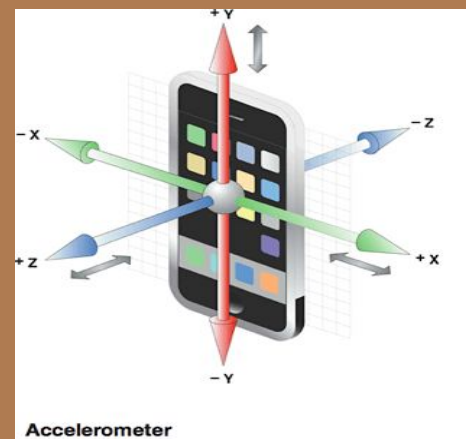
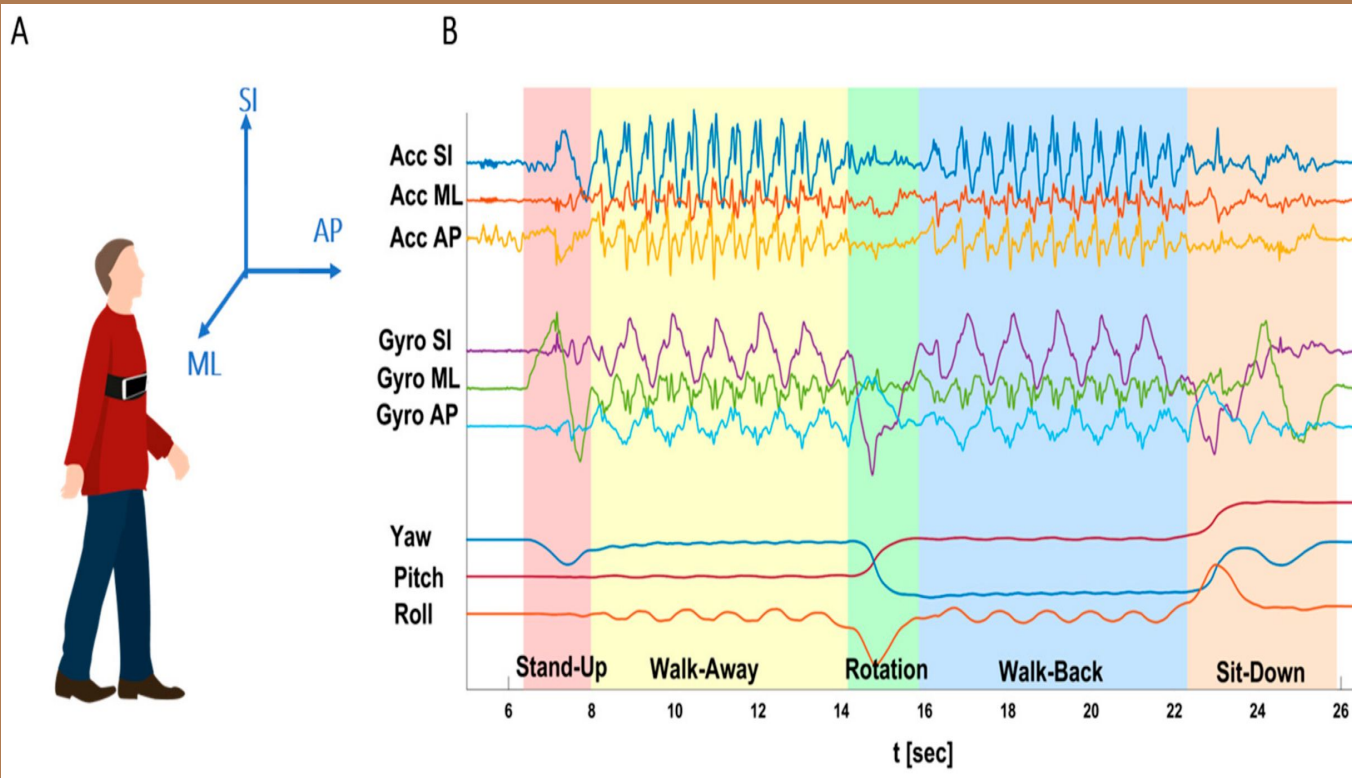


Motion Capture



Force Plates

Sensor Data



Clinicians lack device to
objectively assess and
track uneven gait in
patients

← Problem

assess gait by
eye only

Patients
unaware of
uneven weight
distribution at
home

No way to
track recovery

Clinicians lack device
to objectively assess
and track uneven gait
in patients

A cheap, portable
device that detects
objective changes in
gait pattern and
asymmetry

Solution

Objective, and
consistent analysis

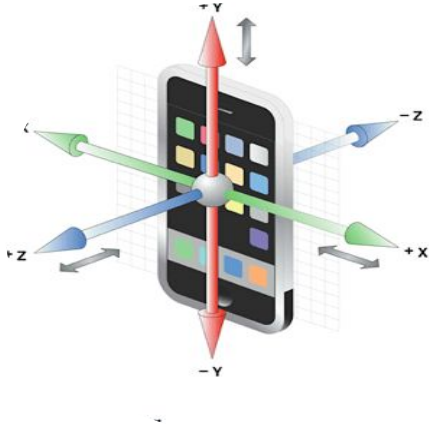
Can be 'prescribed' to
patients to use at home

track patient's
recovery progress over
weeks etc....

Final Design Ready2Walk App



Three Components of App



Gather Sensor Data

Data Collection



Process Data

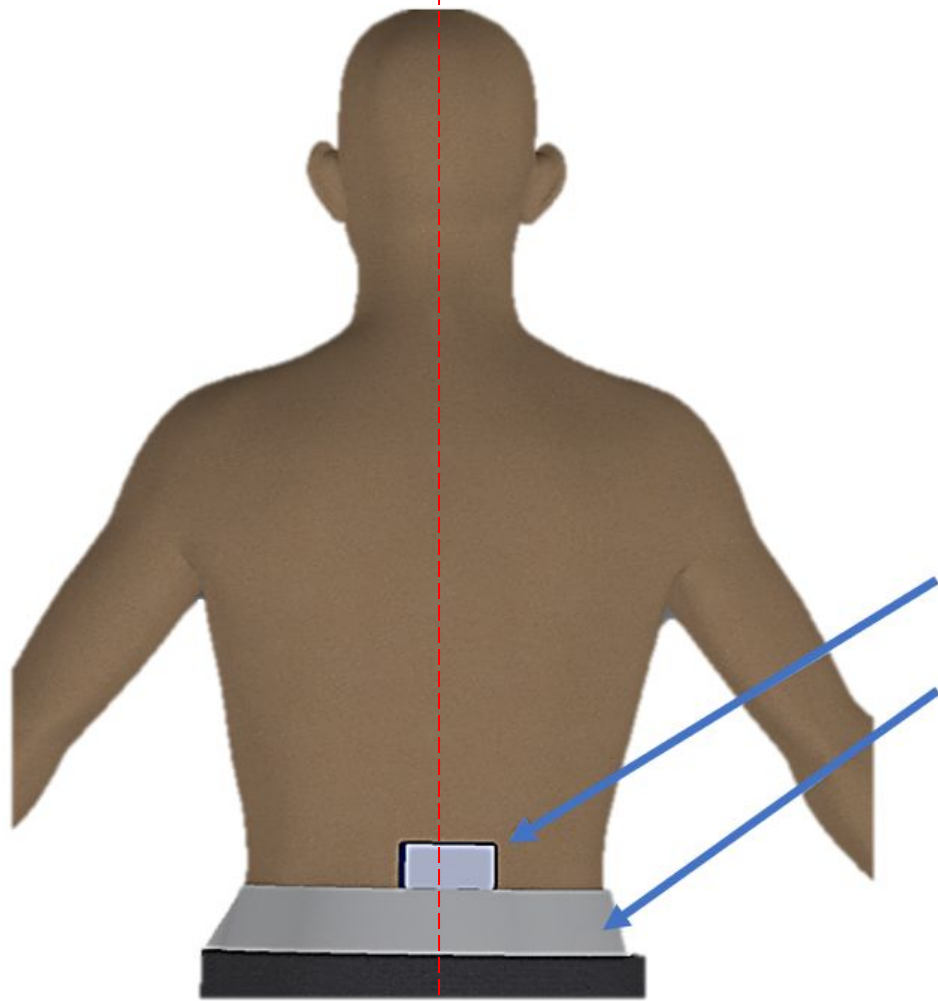
Algorithms



Display Data

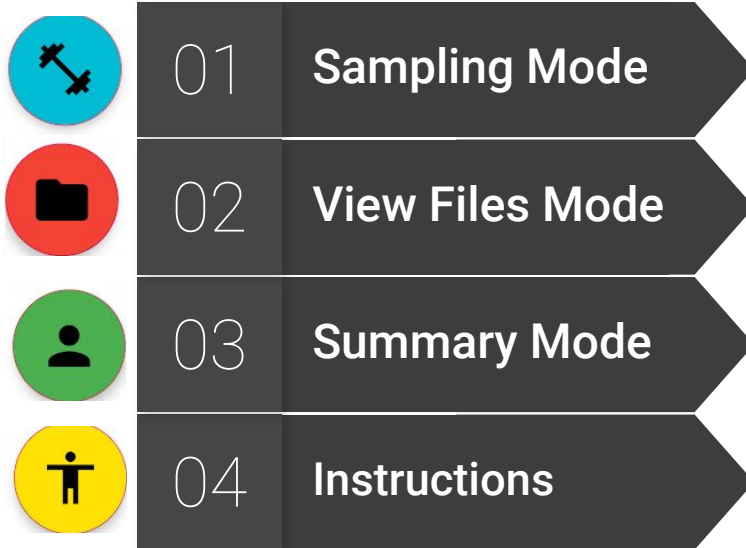
Graphs, UI

Hardware



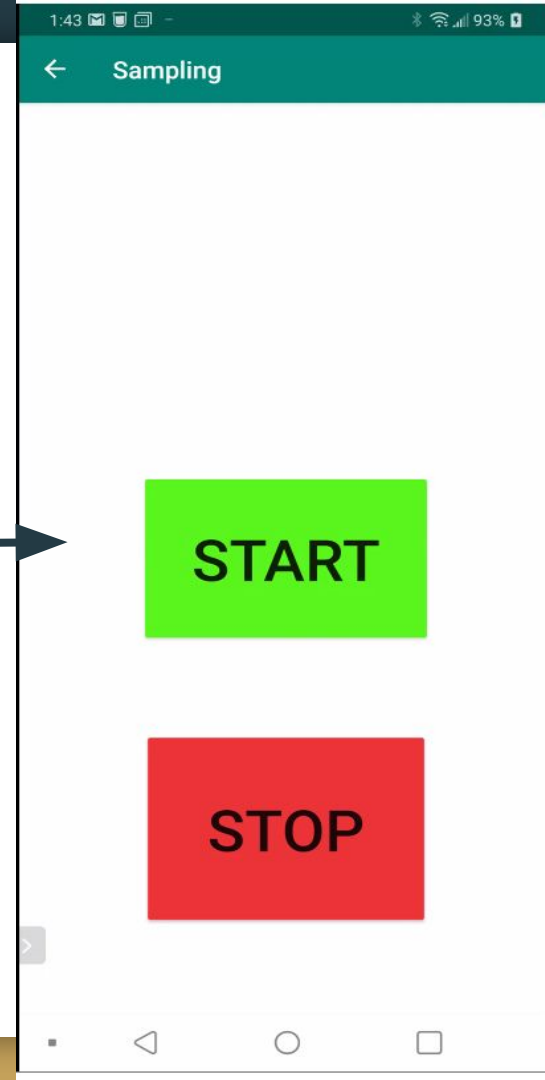
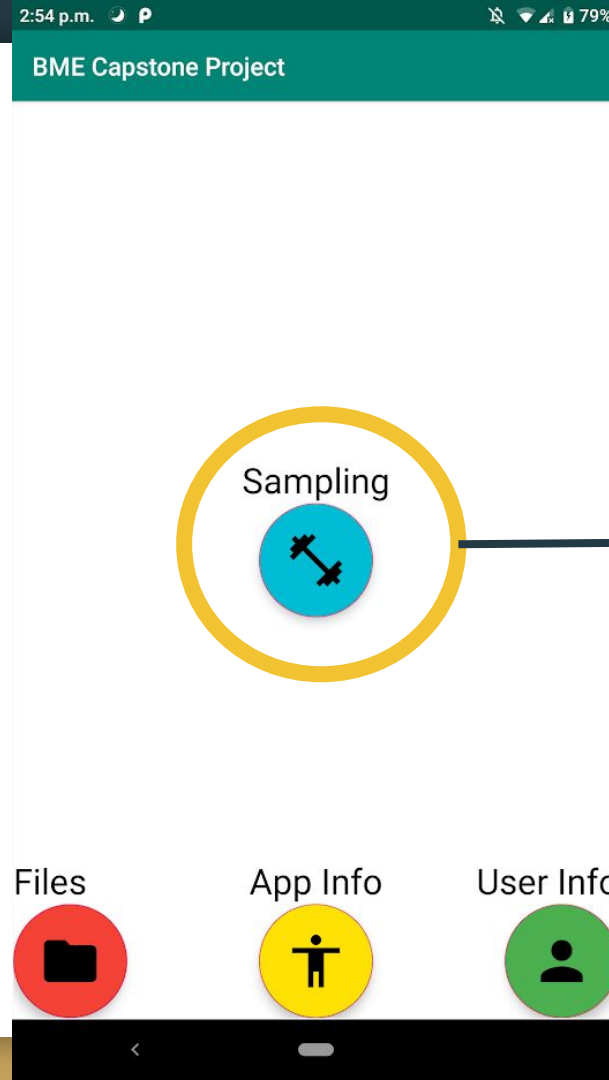
- Smart Phone
- Securing Belt

User Interface



Training Mode (Sampling)

- User(Patient) clicks Start and then attaches the phone to lower back/belt
- Device will start collecting data when it detects steps



View Files Mode

Mediolateral
Acceleration
(side to side)

Trunk Angle
(side to side)

Steps
Autocorrelation
(Step
symmetry)

2:54 p.m. P
BME Capstone Project

Sampling



Files



App Info



User Info



← Sampling Files

Session Date:

Tue Mar 24 00:24:18 EDT 2020

Session Date:

Tue Mar 24 00:17:25 EDT 2020

Session Date:

Tue Mar 24 00:16:17 EDT 2020

Session Date:

Tue Mar 24 00:09:48 EDT 2020

Session Date:

Mon Mar 23 23:58:16 EDT 2020

Session Date:

Mon Mar 23 23:43:41 EDT 2020

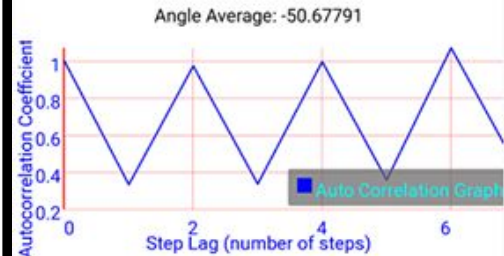
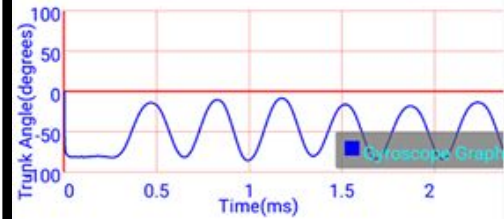
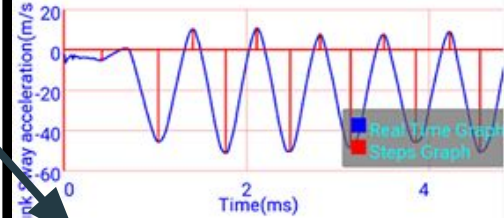
Session Date:

Mon Mar 23 23:39:00 EDT 2020

Session Date:

Mon Mar 23 23:30:16 EDT 2020

← fragment_session_view



Step Symmetry 0.6813402360916128

SEND DATA

User Info



Sampling



Files



App Info

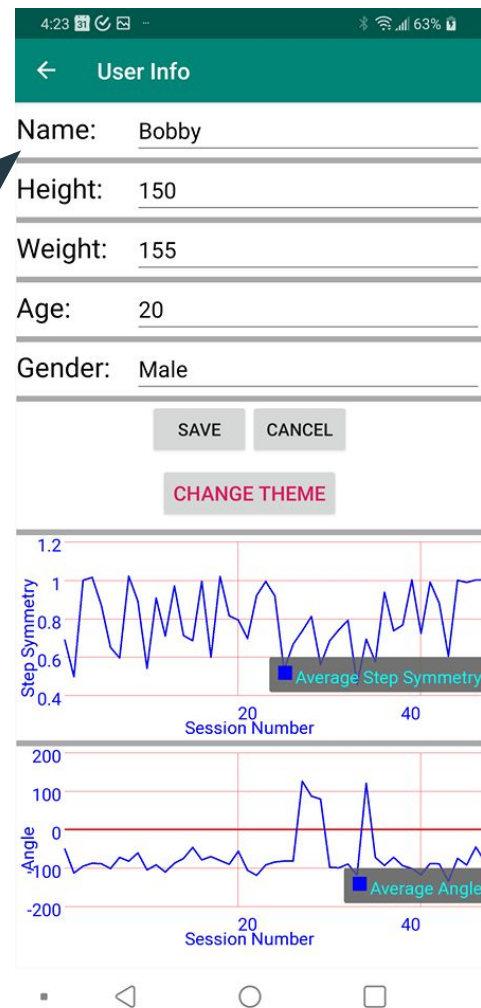


User Info

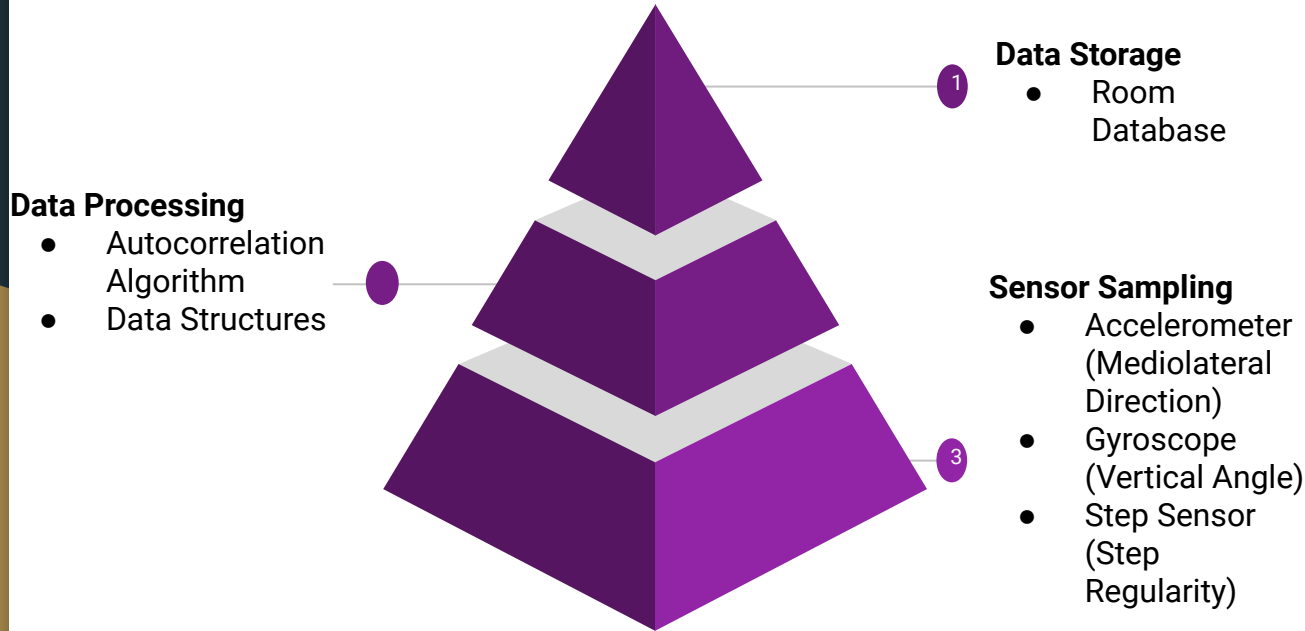


Step symmetry
over sessions

Average trunk angle
over sessions



Training Mode (Sampling)



Sampling

START

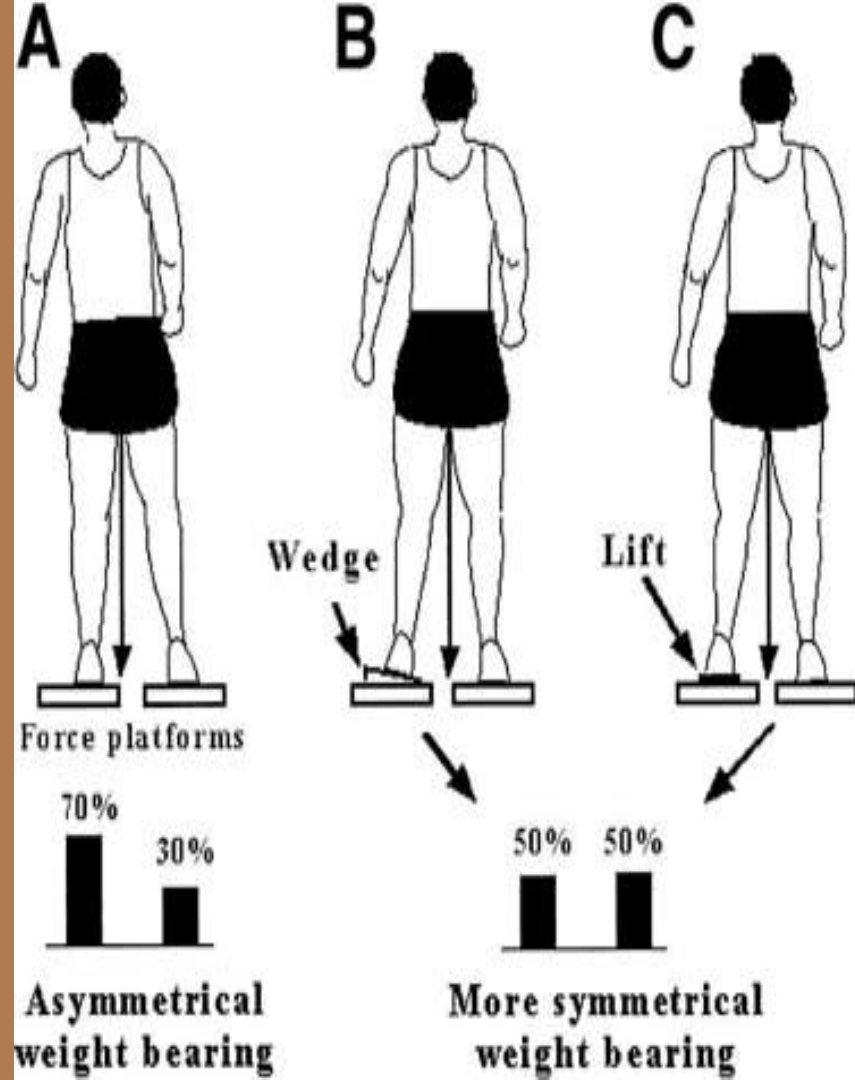
STOP

Weight distribution metrics

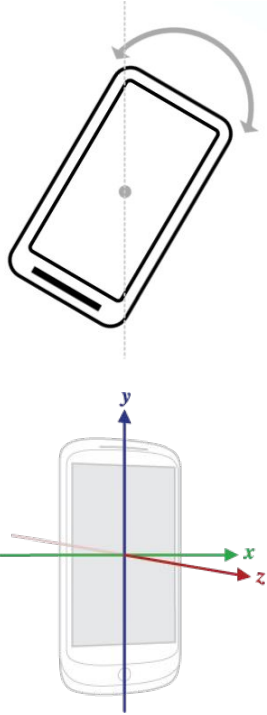
Step
Symmetry

+

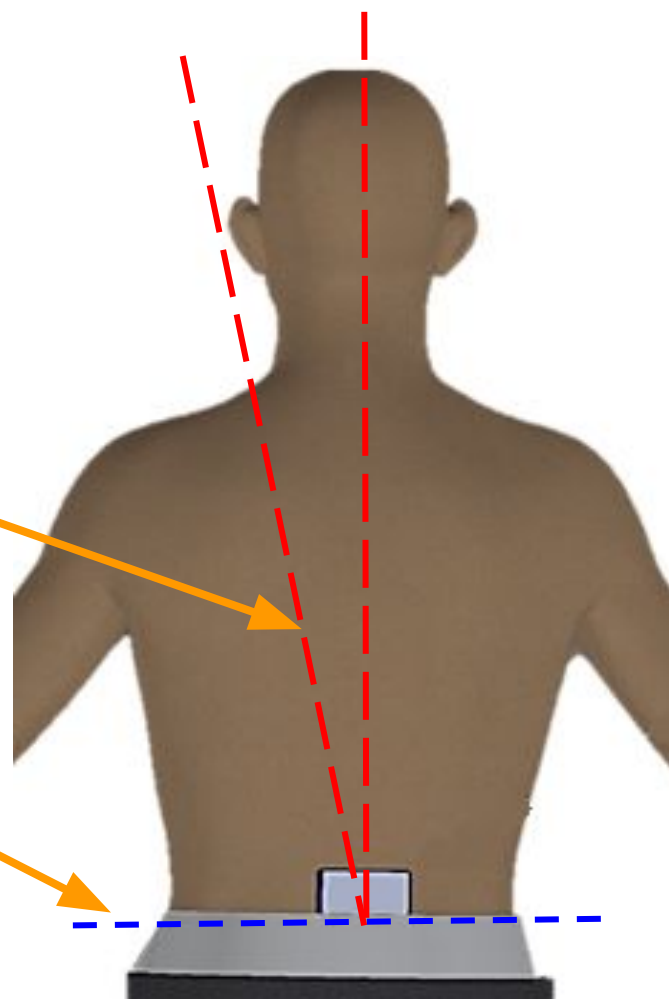
Average Trunk
Inclination



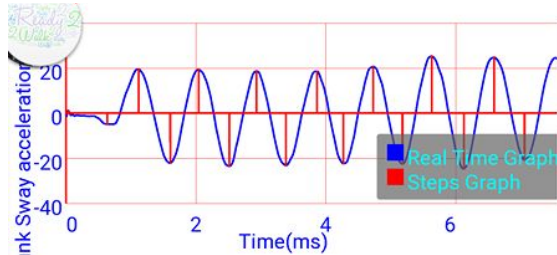
Phone Motion Sensors



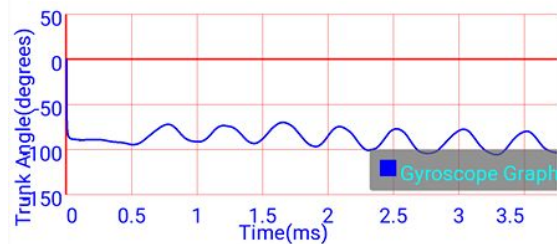
- Tilt Angle
(Azimuth angle)
- Accelerometer
(Mediolateral
Direction)



Normal Walking Data

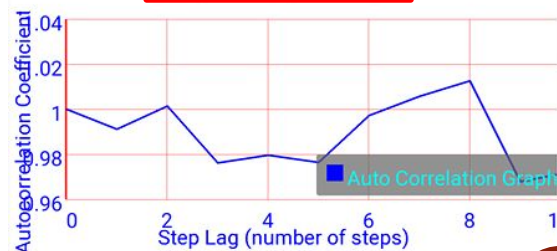


**Ideal Peaks:
symmetrical**



Angle Average: -88.1364

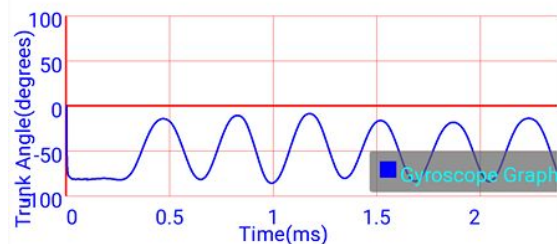
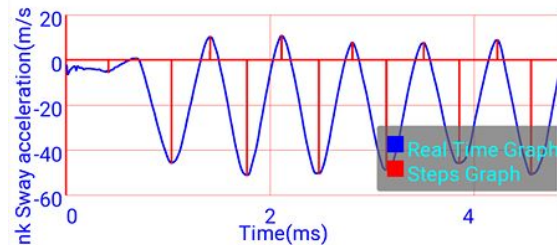
**Ideal Average
angle: about -
90 degrees**



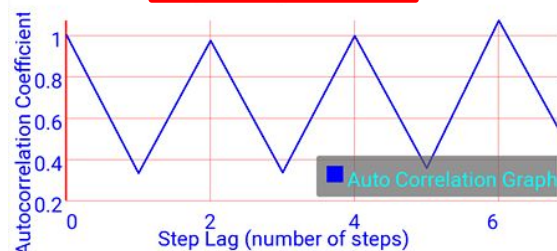
Step Symmetry 0.9952657747508207

**Ideal Step
Symmetry:
about 1**

Abnormal Walking

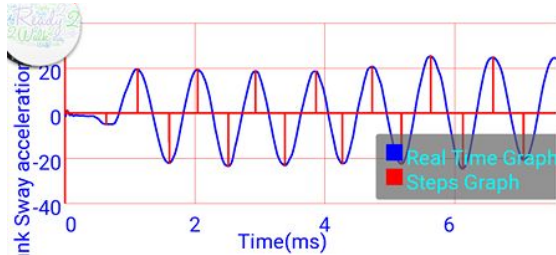


Angle Average: -50.67791

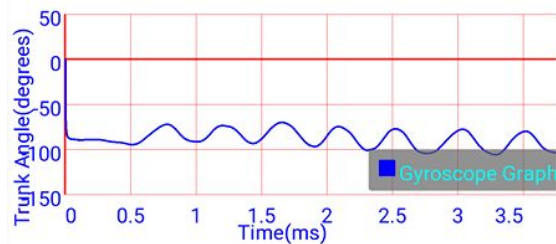


Step Symmetry 0.6813402360916128

Normal Walking

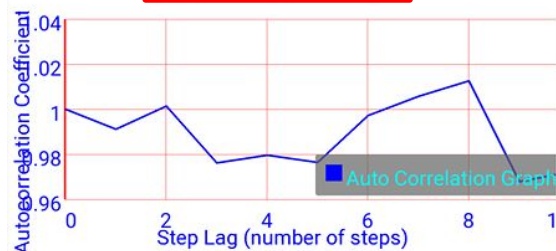


**Ideal Peaks:
symmetrical**



Angle Average: -88.1364

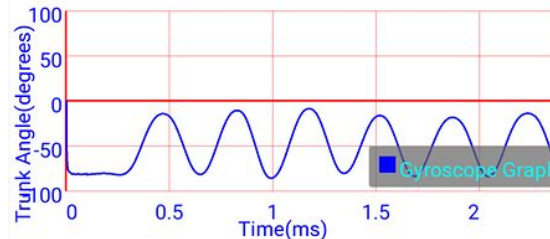
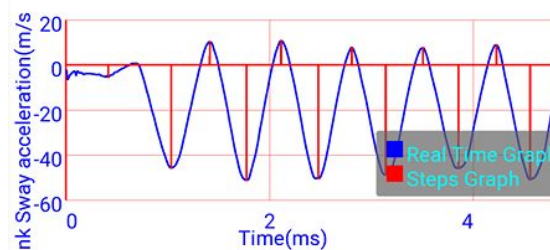
**Ideal Average
angle: about
- 90 degrees**



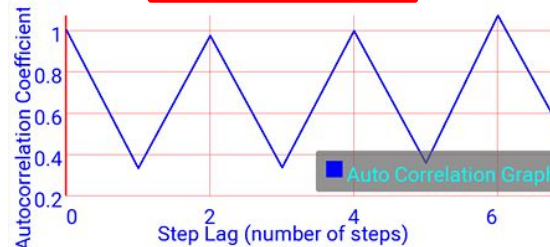
Step Symmetry 0.9952657747508207

**Ideal Step
Symmetry:
about 1**

Abnormal Walking

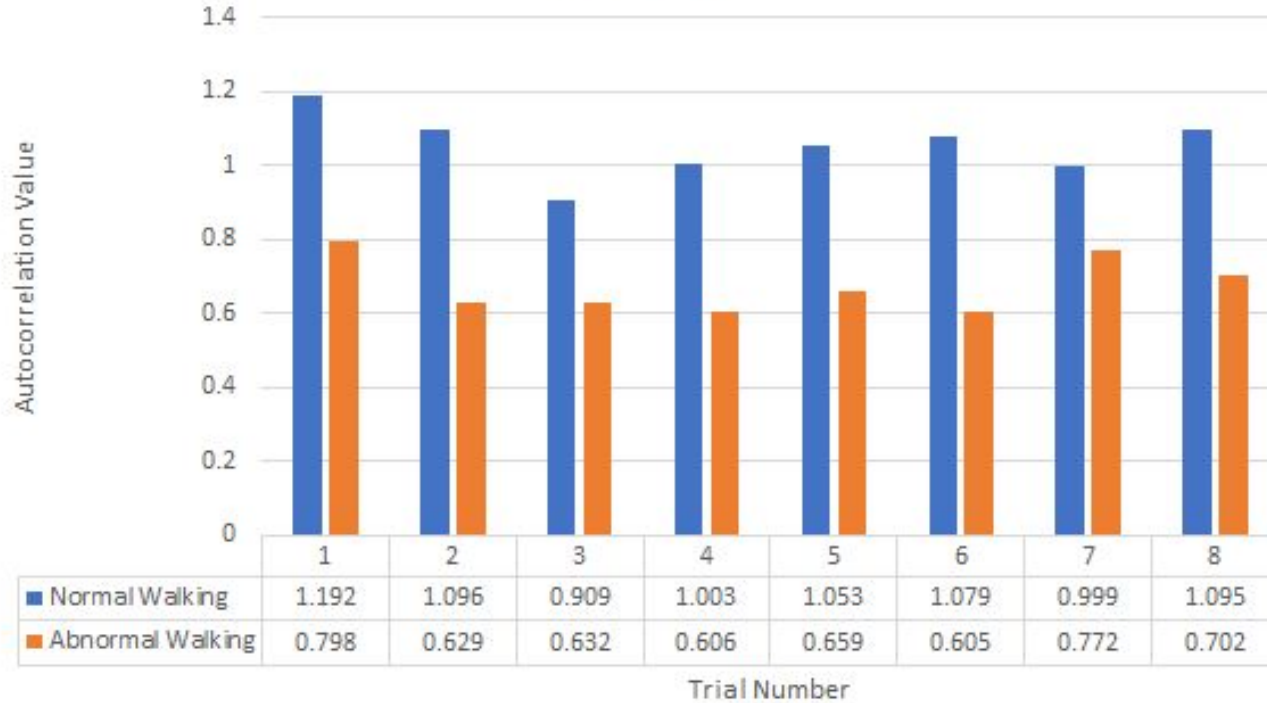


Angle Average: -50.67791



Step Symmetry 0.6813402360916128

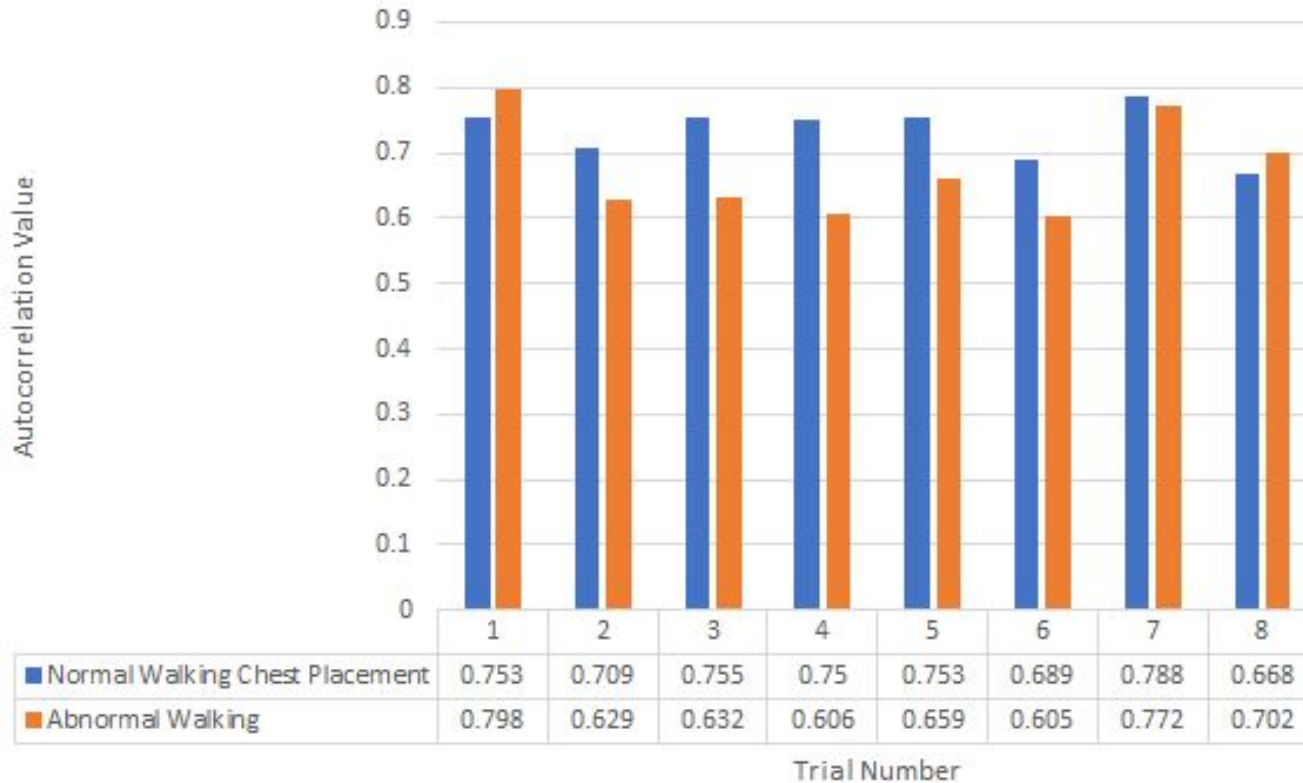
Autocorrelation Values for Normal Walking - Lower Back Placement



Test Result

- Results consistent between trials
- Device can detect change in normal vs abnormal gait

Sensitivity Significantly Reduced with Chest Placement



Conclusion:
Lower back
placement
most ideal

Project Requirement Summary and Limitations

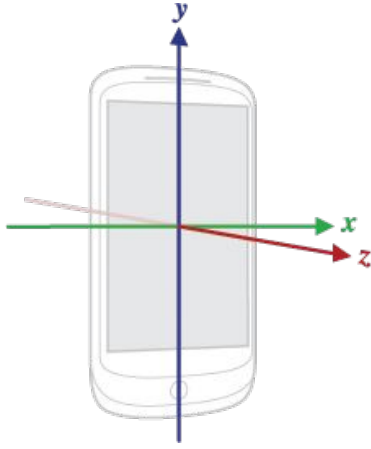
- Should record accurate information
- Should be consistent between tests
- Should be intuitive
- Should be inexpensive (under \$1000)
- Should increase speed of recovery



Questions?

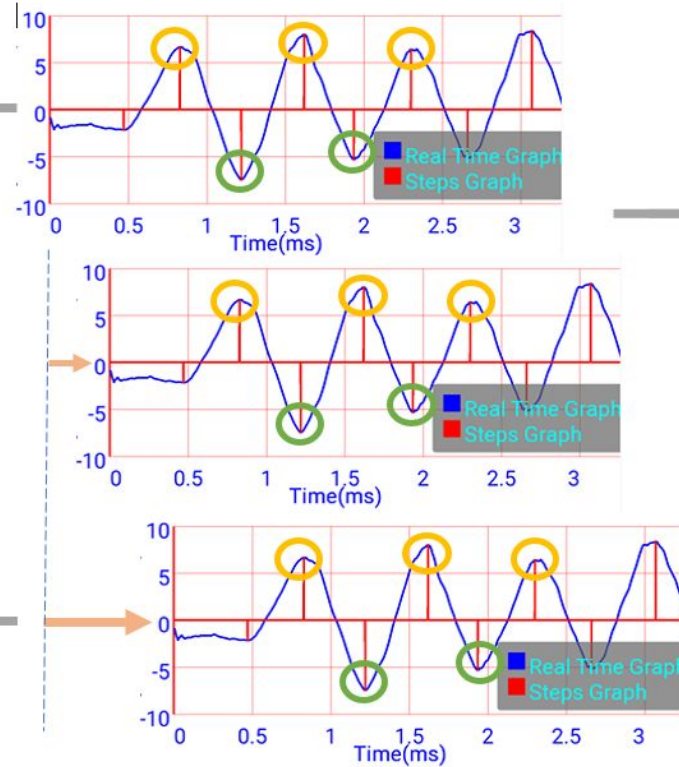


Autocorrelation Algorithm (Shift and multiply)



$$\text{Step Symmetry} = \text{AD2} / \text{AD1}$$

AD2



AD1