VIDGA: A Visualization Interface for Detecting Gait Abnormalities in Humans

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Final presentation CPSC547
Soheil Kianzad

Introduction

Photo courtesy: http://www.manitobaphysio.com/

- Physiotherapists use observation to find gait disorders
- Support their diagnosis with:
  - Good historical data of patient
  - Detailed physical tests (e.g. muscle strength)
- Problem: Growing number of patients and limitation of medical resources

Motivation

- Wearable sensors generate large dataset of human gaits
- Solution: Computational algorithm for recognition and classification
- Large individual differences
  - Weight
  - Limb length
  - Habitual posture
  - Type of stroke or injury
  - Rehabilitation stage

The efficacy of these systems is not high

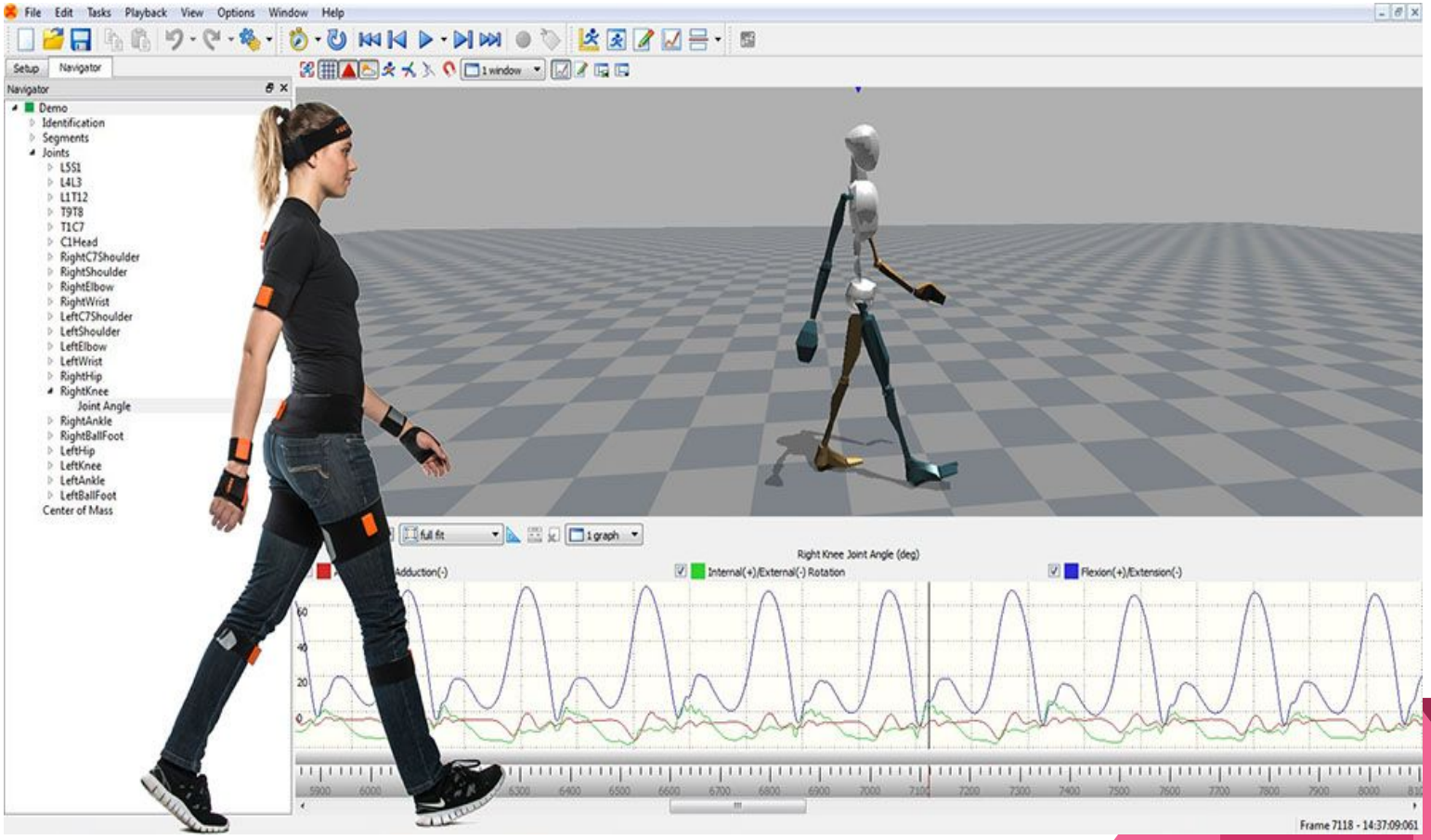
Motivation

- Case specific diagnosis and treatment
  - Physiotherapists still rely on direct observation
  - They often dismiss the rich sensors dataset

I propose VIDGA:

- Connect the observational cues to sensors data
- Facilitate analysis of the whole therapy session

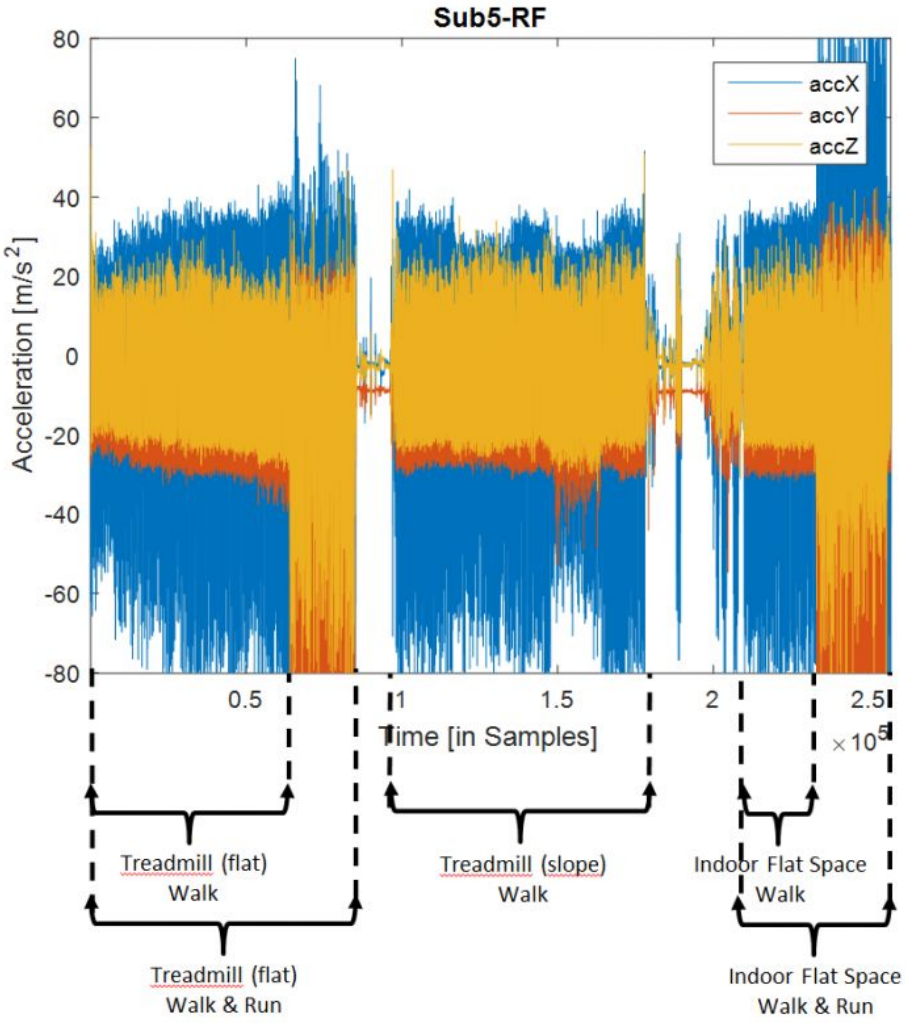
Kinematic and kinetic analysis of locomotion



www.xsens.com

MAREA Gait Database

(Movement Analysis in Real-world Environments using Accelerometers)



http://islab.hh.se/mediawiki/Gait_database

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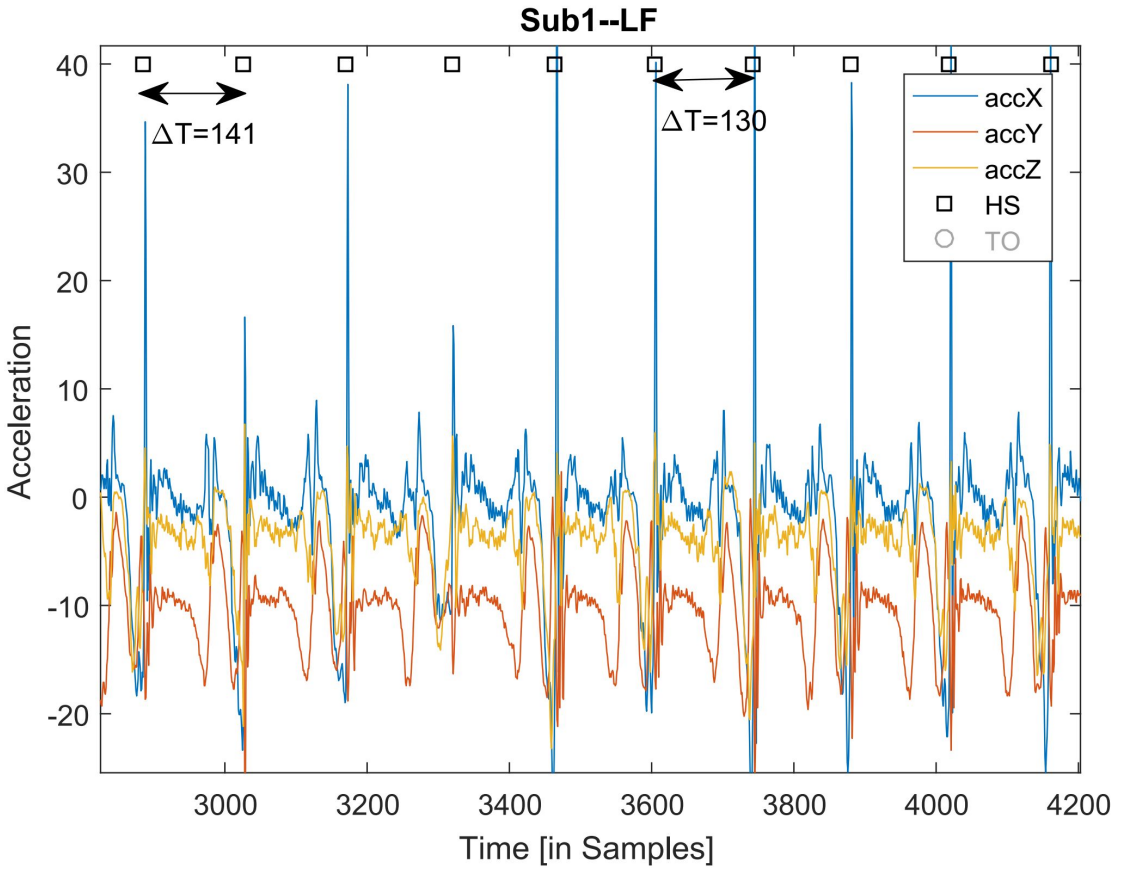
Data abstraction

- Quasi periodic time series data with bounded frequency (speed)
- Quantitative attributes of X, Y, and Z acceleration
- Key ground truth attribute for the heel strike and toe-off events



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Task abstraction

- Discover and locate a normal or abnormal pattern in gait dataset (Search/locate, browse)
- Annotate similar patterns (Analysis/Produce)
- Support predictive analysis and summarizes the results (Query/Summarize)
- Filter the result of query so that user can drive a subset of interest (Analysis/Drive)

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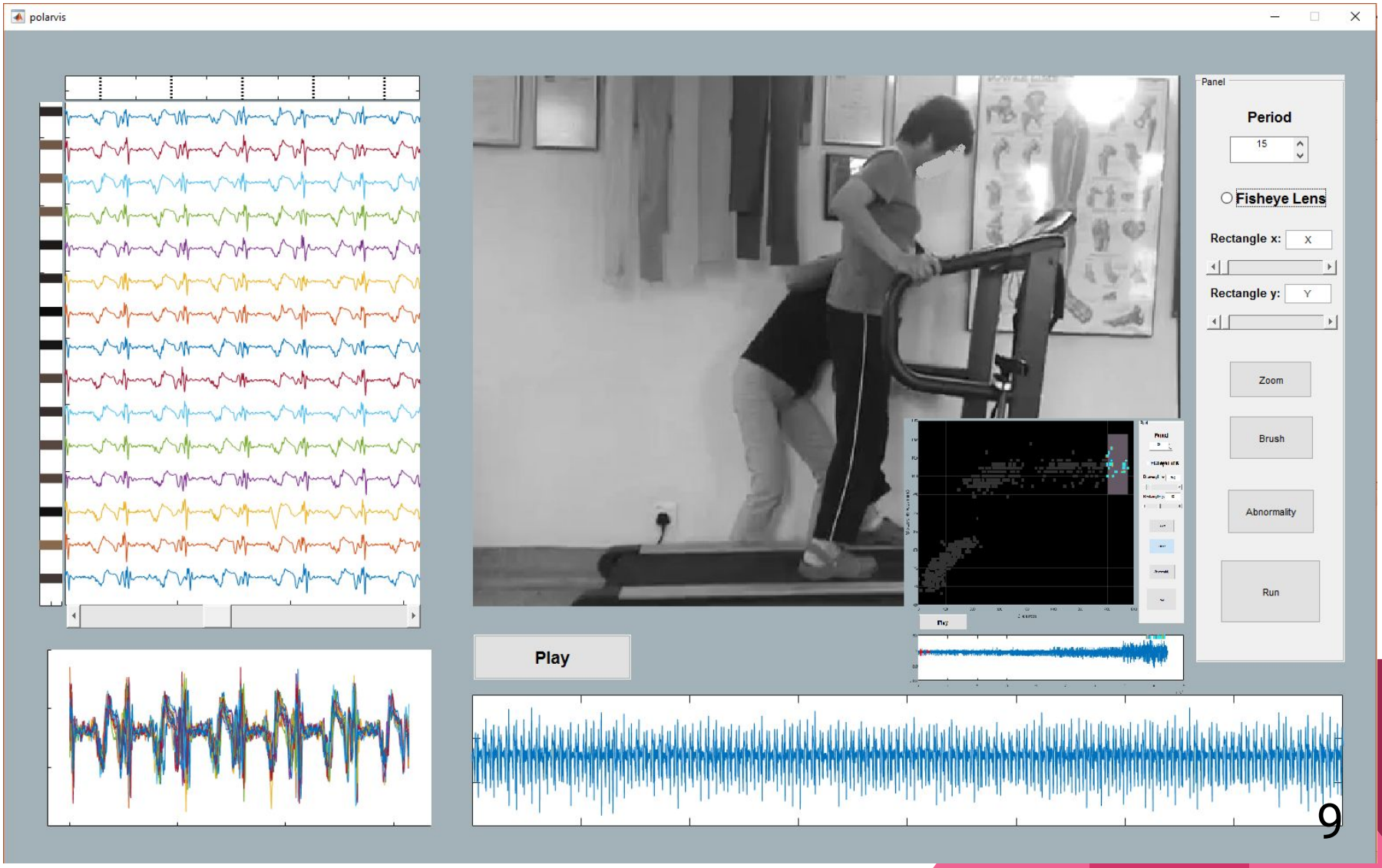
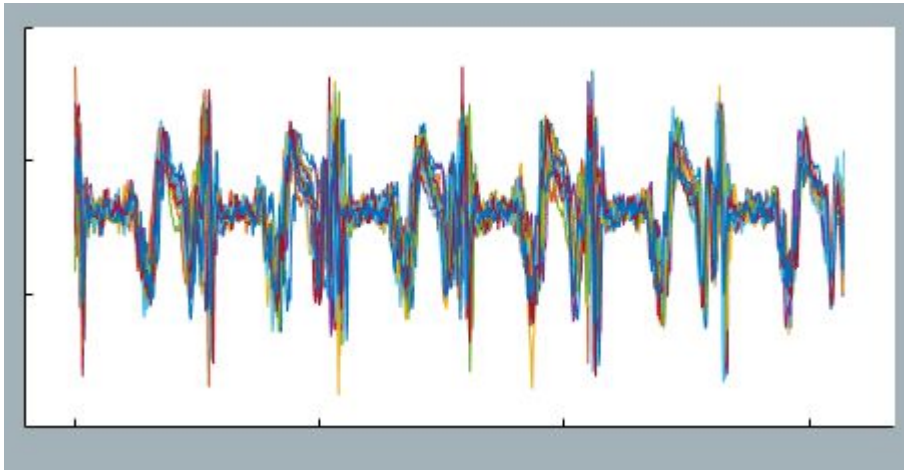
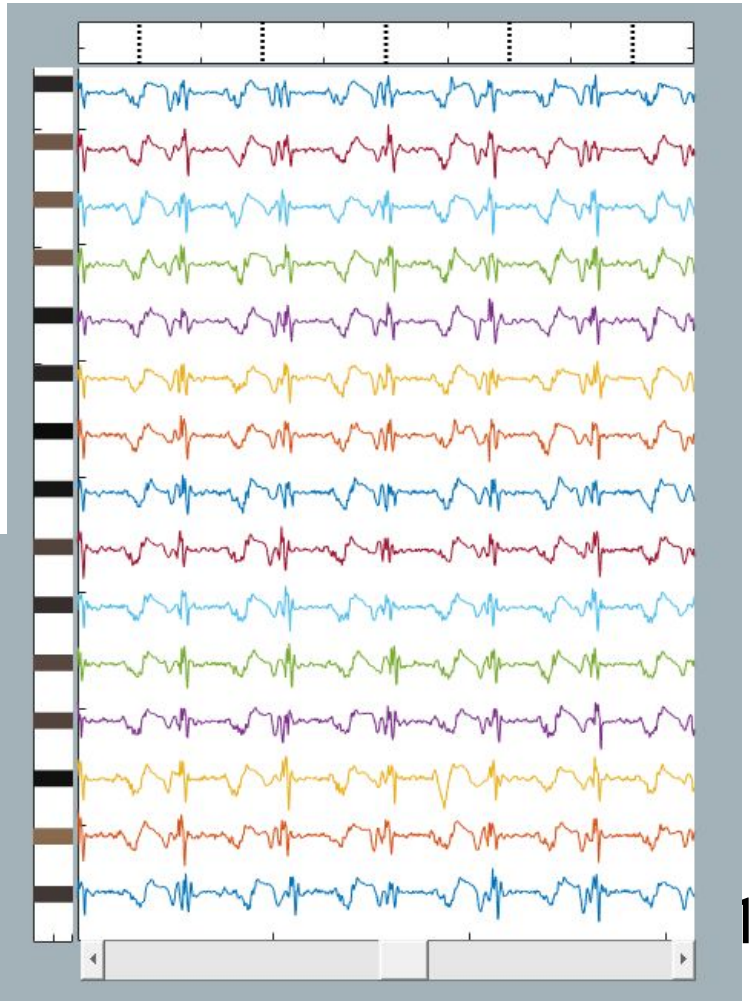
VIDGA interface



Faceting data into multiple views

- Partitioning and superimposing
- Partitioning based on number of sequences (heel strikes)
- Color hues to encode different partitions
- Limited up to few dozen line charts
- Color saturation to encode speed





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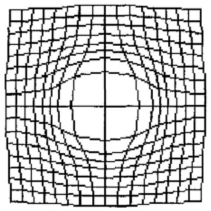
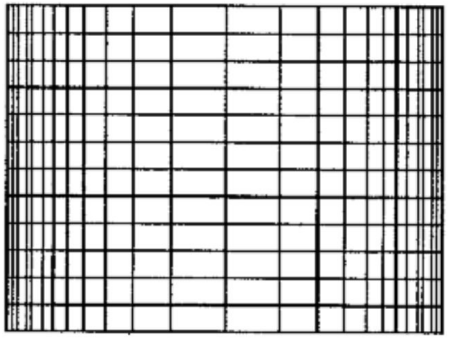
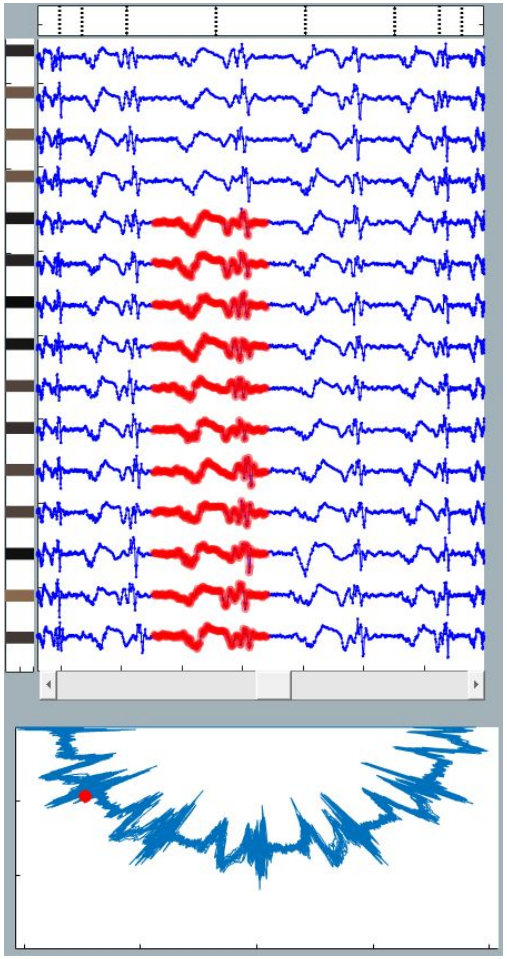
1D Fisheye lens

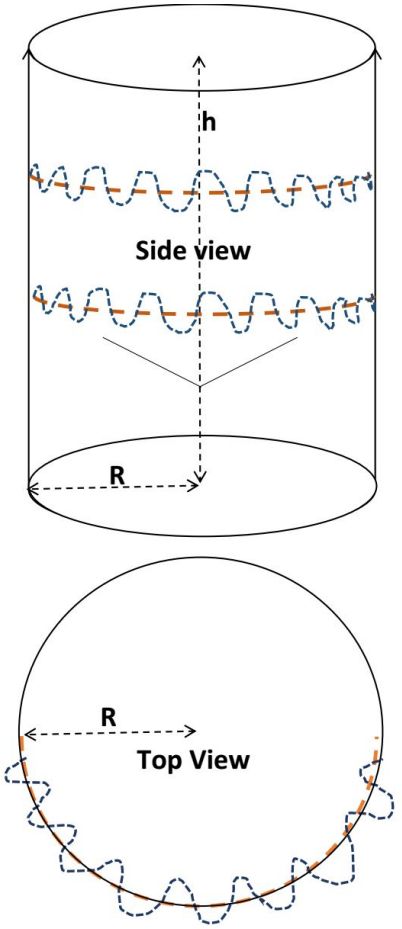


2D Polyfocal

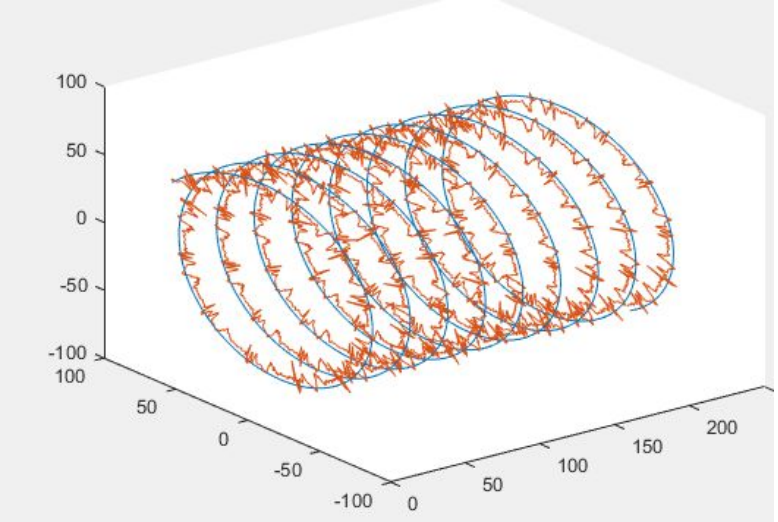


1D Fisheye



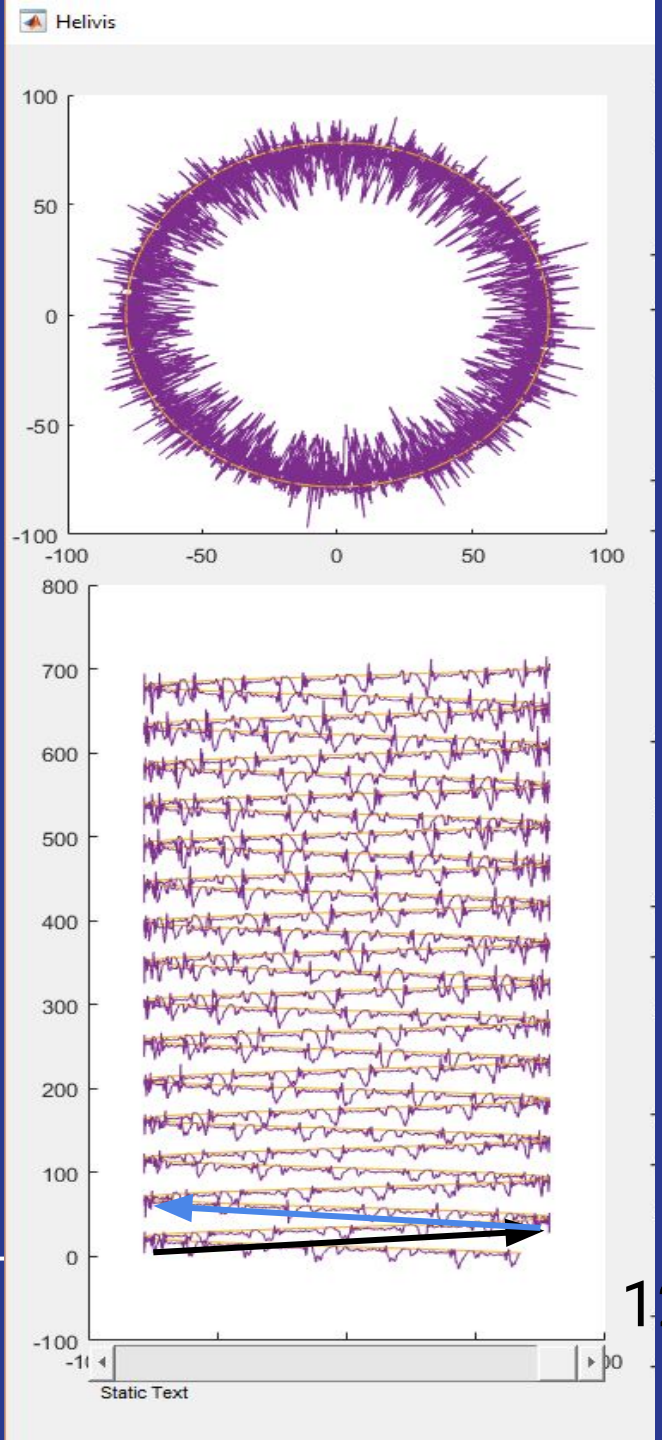


- Reduce the need for zooming and panning
- Enable precise selection of number of similar sequences.



Alternative design

Helix to support intuitive browsing through a large data set.



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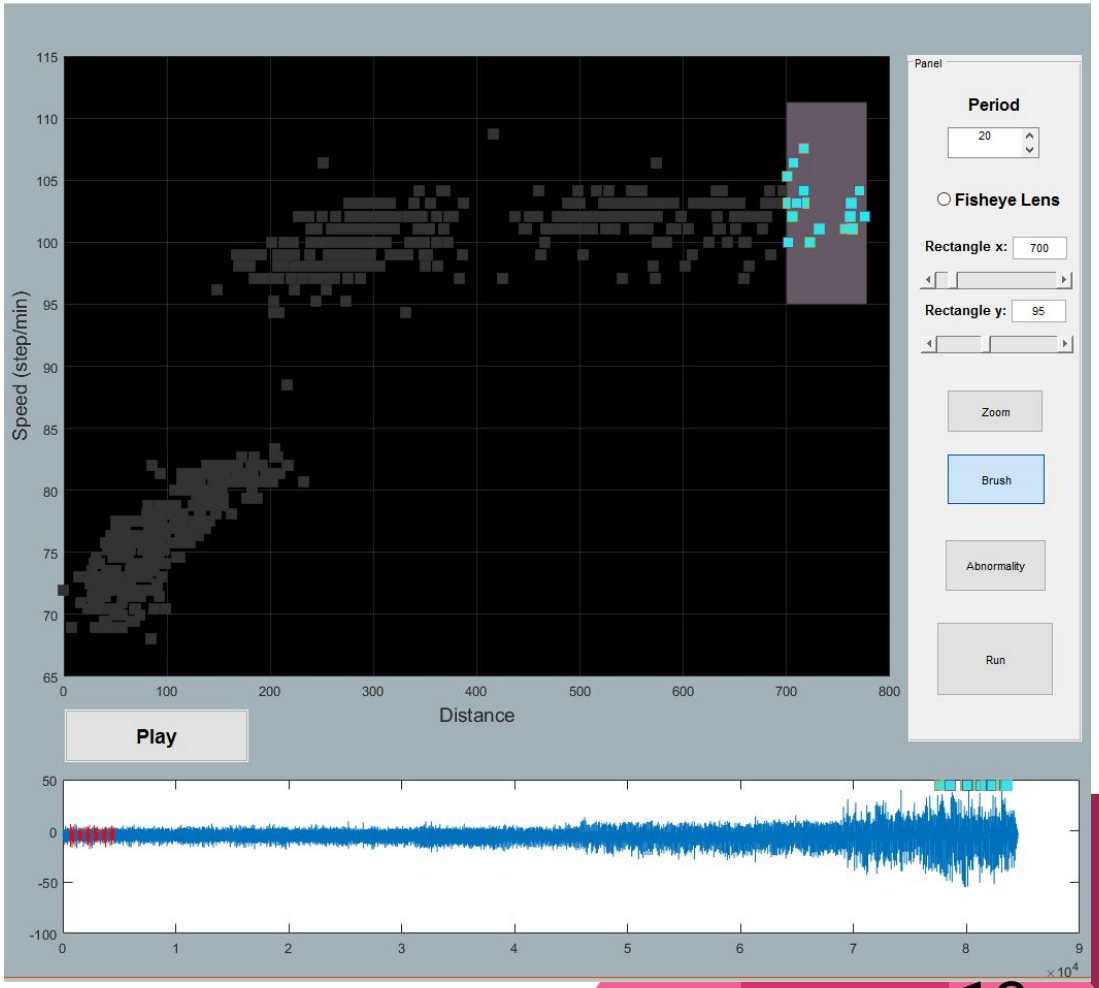
Abnormality detection

- Dynamic time warping (DTW) to measuring similarity between labeled data to the rest of gait sequences
- Spatial encoding of speed and distance in a scatter plot
- Item filtering in the region of interest



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Video

Video Link

Summerize

What: Data	Quasi periodic time series data with quantitative attribute. Key attribute of marked initiation of each cycle.
Why: Tasks	locate, identify and compare, produce by annotating.
How: Facet	Faceting into multiple views. Superimposed layers of data with distinguishable color and partitioning into parallel coordinates
How: Encode	Line charts (colored by partition number attribute), Scatter plots (using spatial encoding)
How:Manipulate	Selecting similar patterns and navigating
How:Reduce	Filter, Embed
Scale	Hundreds to thousand gait cycles (100000 sample points)

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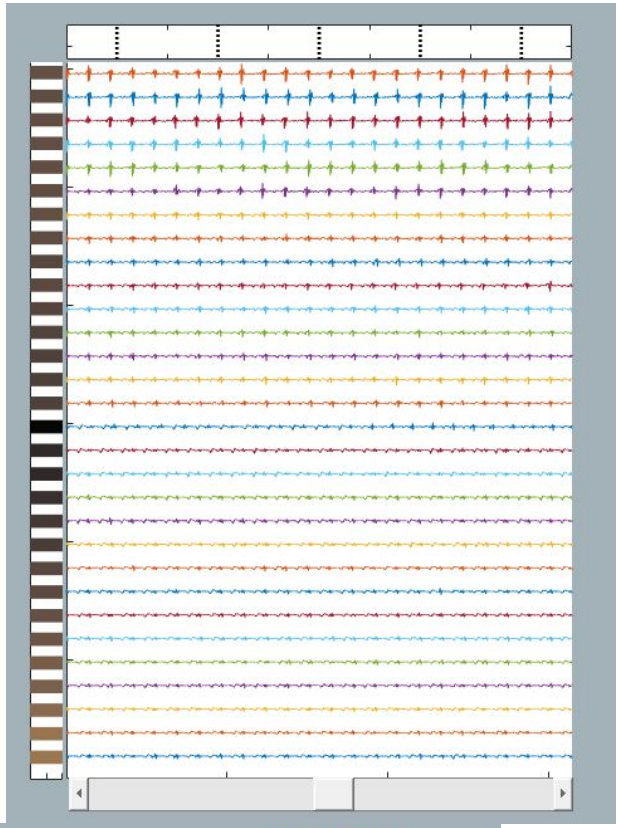
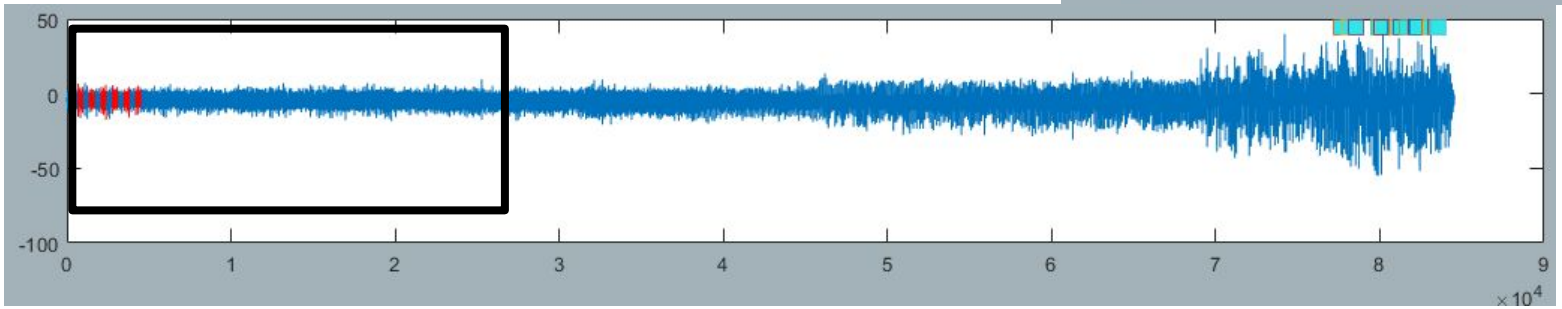
Limitation

- Only data form right ankle
- Video control
- MATLAB was not a good choice for linking data in multiple views
- Better recognition and classification algorithm
- Enable user to select part of dataset (Scalability)





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Conclusion

- A visualization interface for rehabilitation purposes
- Connect observation to sensors’ signals for robusts diagnosis of gait disorders
- Multiple views to increase reliability of diagnosis and group labeling data
- Speed up abnormality detection and visualizing the results
- Filter the reported results for post hoc analysis

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Questions?