Visualizing Heterogeneous Temporal Data for Streaming Health Applications

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Need/Industrial Relevance

In-home and wearable health sensors generate an enormous amount of data that can be difficult to manage. Visualization is one of the first steps towards creating a unified understanding of all available data collected from a user. The quantity and variety of data sources makes it challenging to visualize all of the different heterogeneous data types in a concise and comprehensive way. This is particularly important for retrospective longitudinal studies using existing datasets. Furthermore, different users may have unique objectives that require customized visualization interfaces to provide relevant information in the most appropriate format. This project proposes to address these visualization challenges for large temporal health-monitoring datasets.
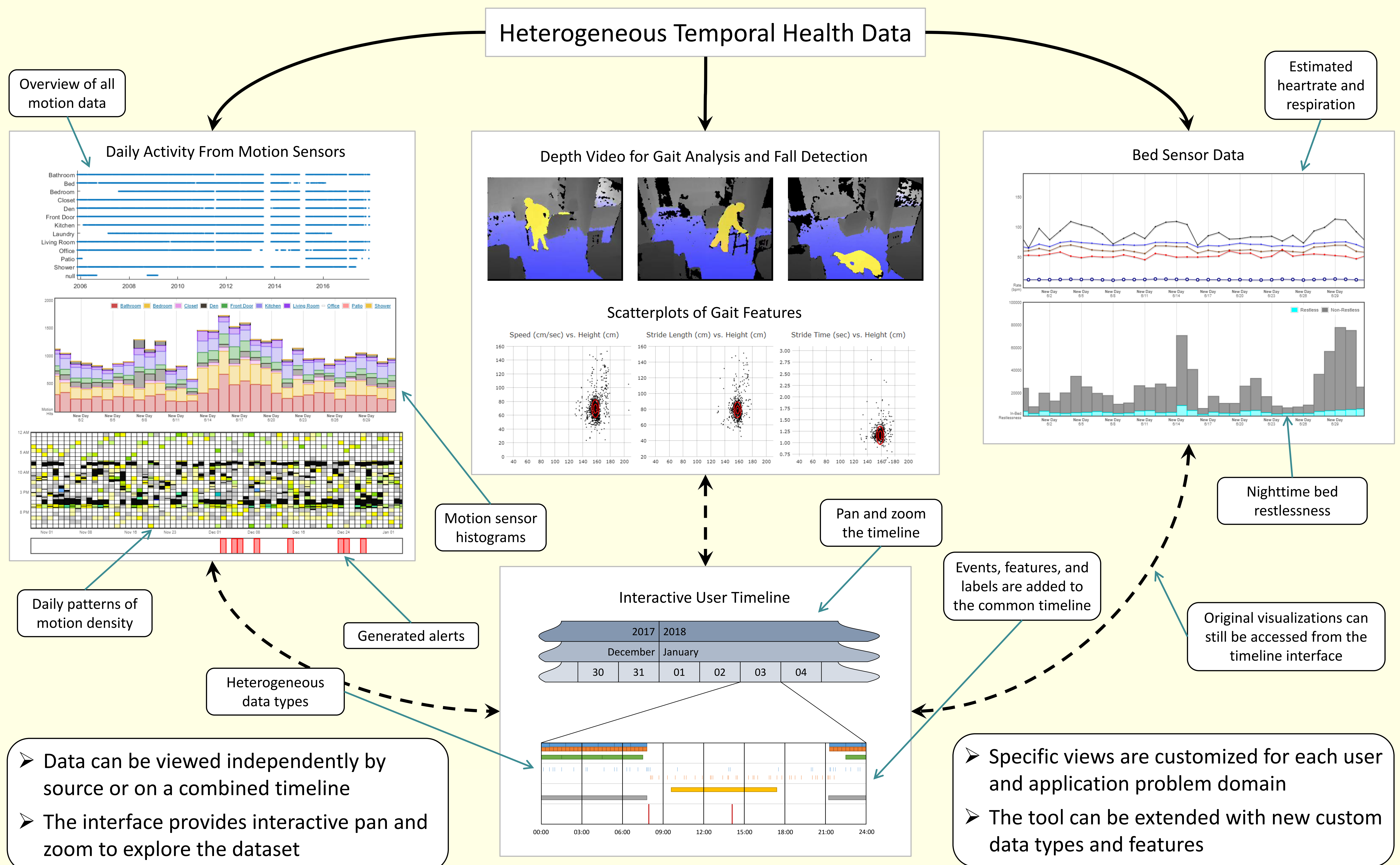
Project Goals and Objectives

Each data source, computed feature, and labeled annotation has a timestamp or interval that can map onto a timeline. This project will explore the best ways to present a person's data timeline for the following three application domains:

1. Clinical analysis by nurses and medical staff to understand trends for a specific individual
2. Data mining research to curate datasets of longitudinal studies for feature extraction and machine learning tasks
3. Self-monitoring by a non-technical user to understand one's own health data

These three user perspectives each have unique needs that may require different visualization approaches.

Approach

Heterogeneous Temporal Health Data

Overview of all motion data

Daily Activity From Motion Sensors

Depth Video for Gait Analysis and Fall Detection

Scatterplots of Gait Features

Speed (cm/sec) vs. Height (cm) — Stride Length (cm) vs. Height (cm) — Stride Time (sec) vs. Height (cm)

Estimated heartrate and respiration

Bed Sensor Data

Motion sensor histograms

Pan and zoom the timeline

Nighttime bed restlessness

Daily patterns of motion density

Generated alerts

Heterogeneous data types

Interactive User Timeline

Events, features, and labels are added to the common timeline

Original visualizations can still be accessed from the timeline interface

- Data can be viewed independently by source or on a combined timeline
- The interface provides interactive pan and zoom to explore the dataset

- Specific views are customized for each user and application problem domain
- The tool can be extended with new custom data types and features

Outcome/Impact

This project will provide tools and methods to visualize heterogeneous temporal data that can be customized for individual use cases. Specific deliverables include:

- Description of the common data format for heterogeneous temporal data
- Visualization interface prototype
- Case studies to show usability and extensibility

Project Milestones

- (2 mo.) Develop a common data format that can represent the various data types, computed features, and annotations
- (8 mo.) Construct a temporal database and design an interface to display and interact with the current dataset
- (10 mo.) Show the extensibility by adding additional features and labels
- (12 mo.) Create use case scenarios to demonstrate the potential applications and benefits to users.