MINEBIKE: TIME-SERIES DATA & MACHINE LEARNING ALGORITHMIC ANALYSIS

Trinity Key[1], Yunho Huh[2], Ph.D. Candidate, Magda El Zarki[2], Ph.D. | 1. University of Pittsburgh | 2. University of California, Irvine

ABSTRACT

Exergames are games that integrate exercise into video games and rely on sensors to track motion and game progress; MineBike is a prime example of such games. The Donald Bren Computer Science Department and the Pediatric Exercise and Ergonomics Research Center at the University of California, Irvine collaborate on this joint research project from two research perspectives: health information technology and machine learning. MineBike is an application that studies patient exercise patterns with various methods of computing that involve preprocessing, post-processing, and algorithmic analysis.

OBJECTIVES & GOALS

MineBike is an application designed to challenge participants physically, but to also discover underlying exercise patterns and service different medical functions, such as rehabilitation and prescribed exercise.
The goal of MineBike, however, is not only to integrate exercise into the screen time consumed by children and adults, but also to process and interpret the time-series data into a useful tool for prediction analysis for Internet of Things (IoT) applications such as MineBike. This application uses cleaning, interpolation, and clustering approaches in order to extract data that will further service the participant in game play.

METHODOLOGY

DATA COLLECTION

The application collects data from a series of sensors that record heartbeat, wattage, revolutions per minute (RPM) of the bike, and game tag location.

PRE-PROCESSING

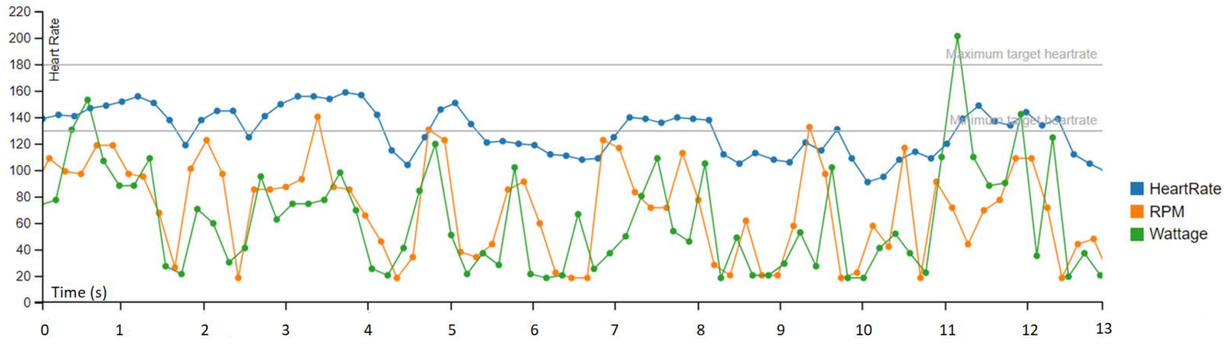
Preprocessing of this data from the server includes finding missing data lost during interprocess communication (IPC), elimination of duplicates, and finally, merging session data.

POST-PROCESSING

Post-processing of preprocessed data includes the clustering and categorization of target heart rate zones and unique RPM goals. This step also includes window classification and flags of data relevance.

PREDICTION ANALYSIS

Prediction analysis involved the machine learning and algorithmic application part of the project. Using the k-Shape Algorithm proposed by researchers at Columbia University[3], we can them programmatically discover underlying exercise patterns, target exertion points, and optimal target exercise ranges per each unique patient. Using clustering then enables the application to update game sessions in real time.



SESSION & GAMEPLAY

The premise of the testing sessions are simple; each participant completes three different 45-minute MineBike sessions, each with recordings of heart rate, revolutions per minute on the exercise bike, wattage of the bike resistance, and game tag locations in the game for progress purposes.
The participant utilizes both the bike and a generic controller to navigate through the MineBike landscapes. Completing challenges and levels continually create physical challenge and are designed to target participant exertion heart rate.
Collecting these types of exercise data provide enough base information for the probabilistic models included in the exergame to accurately perform prediction analysis.

EVALUATION

Overall, the results of this research represent the clean graph shown above. By going through the process of data collection, preprocessing, clustering, and k-Shape algorithmic analysis, clean results and further predictions can be made during game play. This project hopes to further pioneer research in exergames and the holistic creation of a healthy lifestyle.

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3. *k-Shape: Efficient and Accurate Clustering of Time Series*, Luis Gravano, Ph.D. Columbia University, John Paparizzos, Ph.D. Candidate Columbia University