

Body Sensor Network

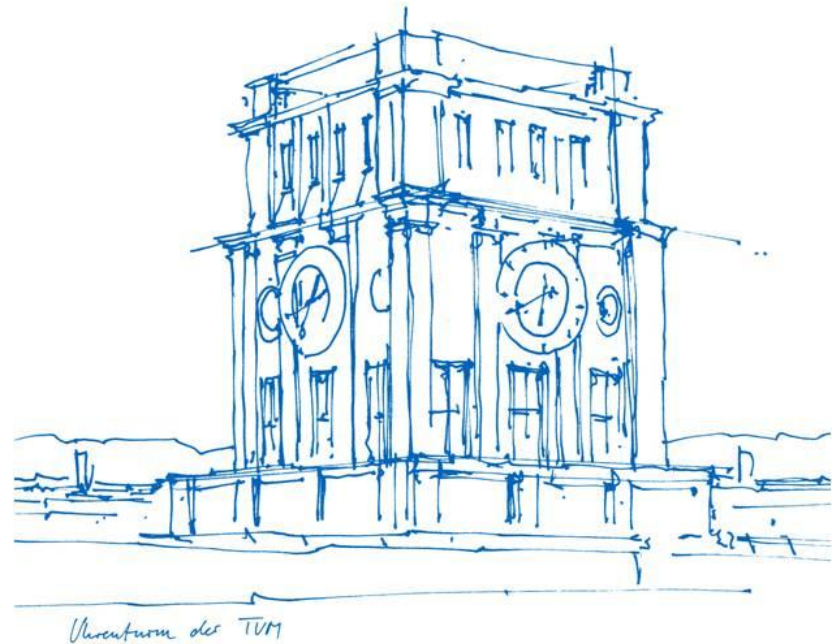
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Content

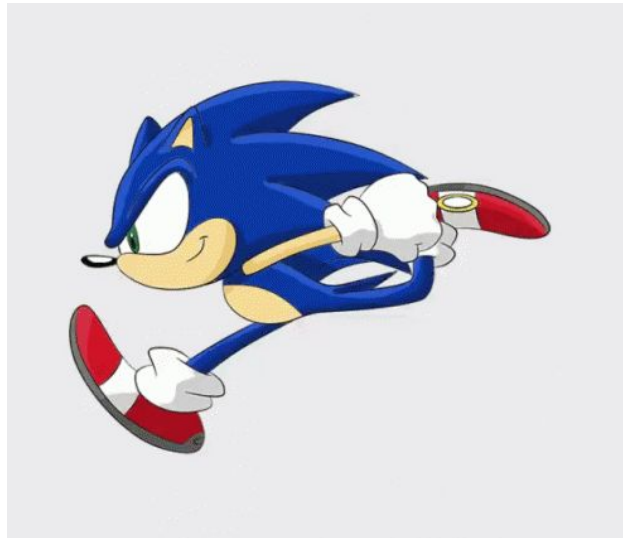
- Introduction
 - Basic Functions
 - Additional Features
 - Stability and Robustness
 - User Experience
- Concerned Algorithm
 - ML-based algorithm
 - Implementation of algorithm
- Comparison with Gantt chart schedule
- Challenges and Solutions
- Suggestions for improvements

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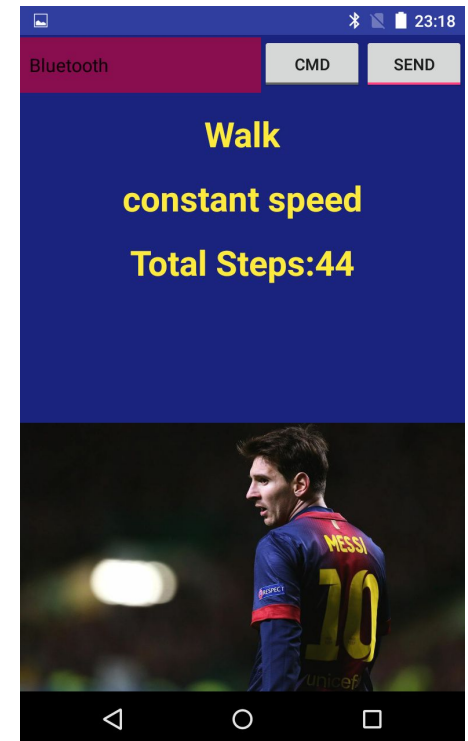
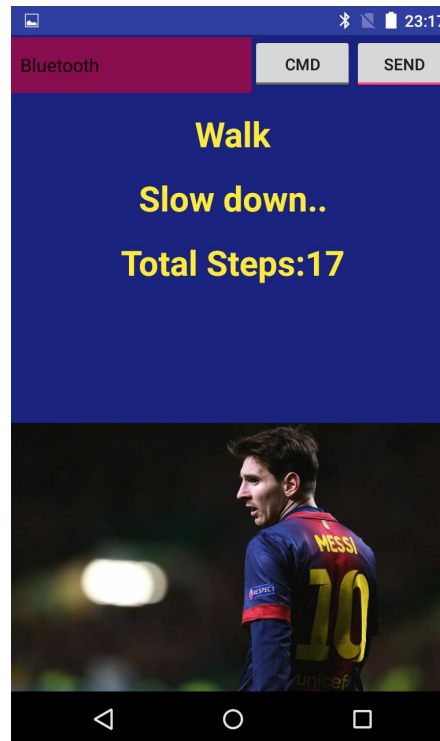
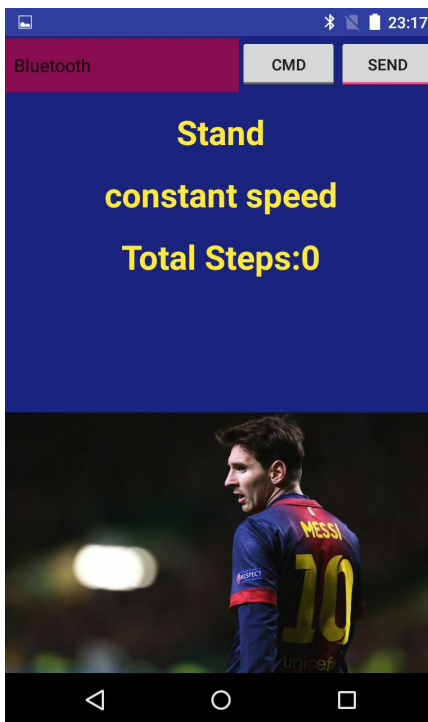
Basic function

Android app for motion state detection



Additional Features

Besides the motion recognition, steps calculation, speed evaluations are also involved.



Stability and robustness

Recognition for 4 basic states is stable and robust.

- Independent of User Preferences.
- 3-Axes need to be correctly adjusted.
- Abrupt changes of motion can also be detected.

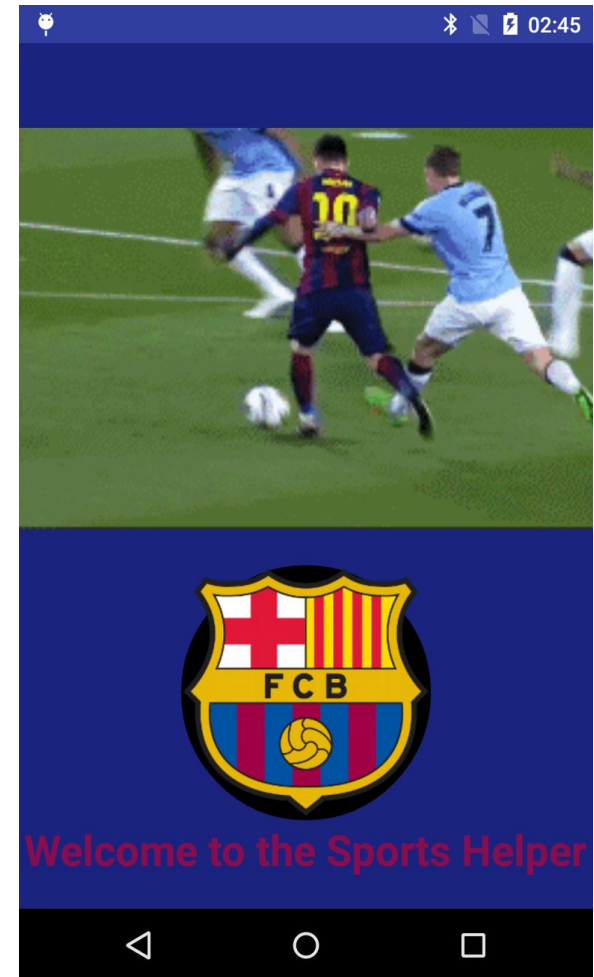
Steps calculations and speed evaluation are stable and less robust.

- 3-Axes need to be correctly adjusted
- Abrupt stop may not end steps calculations immediately

User Experience

Users deserve good experience

- Fashion style: FC Barcelona color scheme and Barca fans specific.
- Professional design: correct and real-time motion detection.
- Personalized service: with background music users can feel better during sports.



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Concerned Algorithms

Problem formulation

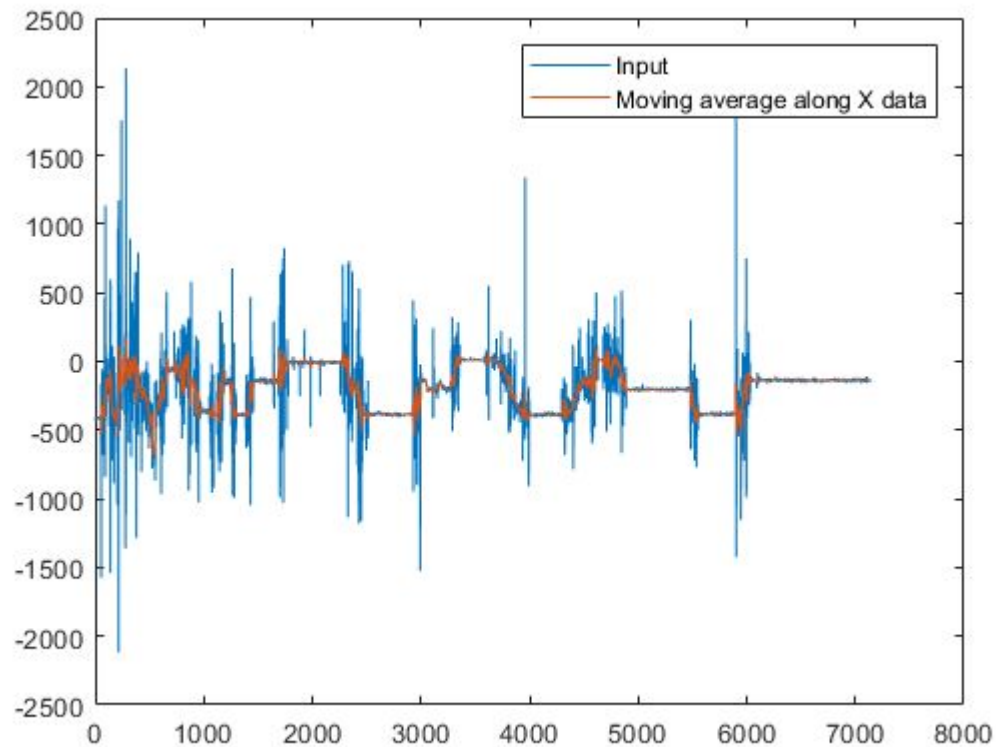
- Sensor data processing
- Feature extraction
- State pattern analyzing
- Android and Java code...

Machine learning algorithm

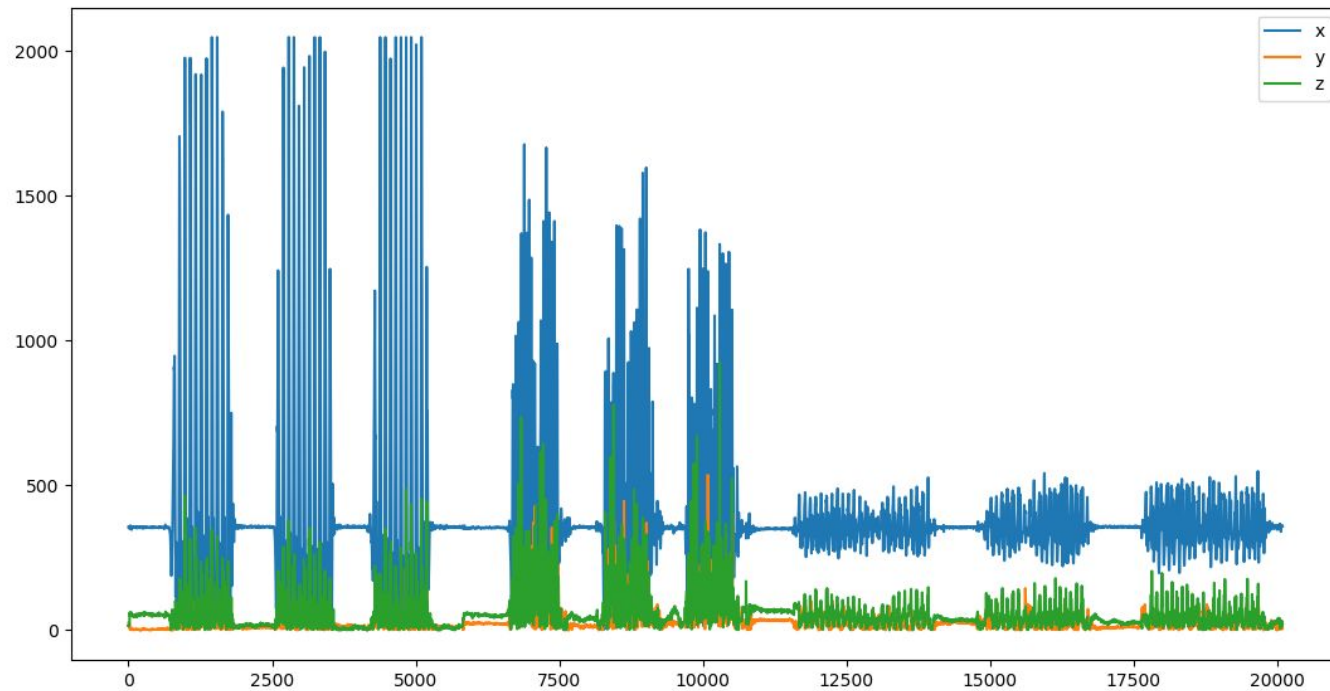
1. SVM
2. Decision Tree
3. KNN

Preprocessing

k-point smoothing in Java



Feature extraction



Feature extraction

After applying Principal Component Analysis (PCA), three key features are chosen

1. Maximum Value (X-Axis)
2. Standard deviation (X-Axis)
3. Skewness (X-Axis)

Abandoned Features

1. Features under Y-Axis, Z-Axis
2. Kurtosis
3. Mean Value

All under a window of certain size!

Version 1: Decision Tree

- Easy to implement
- Three features cannot provide good classification
 - At the transition phase, misclassification will occur
 - Need to train, maybe dependent too much of the training data

Version 2: SVM

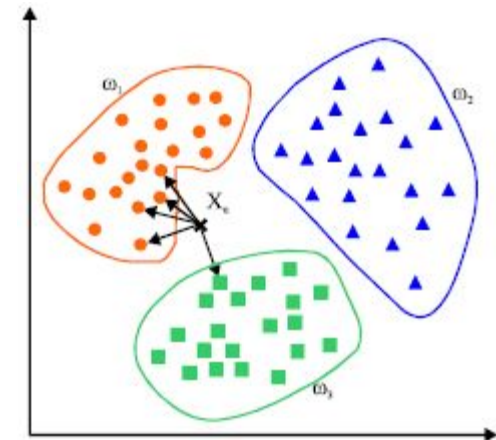
Waikato Environment for Knowledge Analysis(Weka)

1. Weka is a suite of machine learning software written in Java, developed at the University of Waikato, New Zealand. It is free software licensed under the GNU General Public License.
2. Weka contains a collection of visualization tools and algorithms for data analysis and predictive modeling.
3. Support Vector Machine (SVM) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis.
4. But Weka is not user-friendly so that we face a lot of difficulties by loading models (horrible crashes).

Version 3: KNN

K Nearest Neighbour Method

- Exploit obvious differences between different states.
- Bigger K means more accuracy.
- Distances need some tricks.
- Normalization.
- Choosing $K=3$ already gives good estimation.



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Comparison with Gantt chart schedules

Gantt project			Gantt project		
Name	Begin date	End date	Name	Begin date	End date
• Structure design	11/30/17	12/4/17	• Structure Design	11/30/17	12/4/17
• sensor test	12/5/17	12/7/17	• Sensor test	12/5/17	12/7/17
• do research for Algorithms	12/8/17	12/12/17	• Research for Algor...	12/8/17	12/18/17
• algorithm development	12/13/17	12/27/17	• Algorithm development	12/20/17	1/3/18
• app development	12/8/17	12/25/17	• App development	1/4/18	1/25/18
• UI design	12/29/17	1/8/18	• UI design	1/26/18	1/29/18
• integration phase/debug	1/9/18	1/15/18	• Integration phase/...	2/1/18	2/5/18
• final test	1/18/18	1/22/18			

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Challenges and Solutions

- Android framework learning: we spend much time learning Android.
- APP always crashes during testing: by checking logcat and step debugging we can locate the bug.
- Some open-source libraries cannot be easily applied.
- Matlab coder works not perfect, so we decide use pure Java to achieve all of these functions.

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Suggestions for improvements

- Because of the ML algorithm, we need accurate data. But the master software that we used is not convenient. Maybe we can design an online and real-time data collector software for students, by which we can save much time.
- If we want to collect data of going up- and downstairs, the working distance of Bluetooth is not enough. Maybe we also need a mobile data collector.

References

- [1] Bayat A, Pomplun M, Tran D A. A study on human activity recognition using accelerometer data from smartphones[J]. Procedia Computer Science, 2014, 34: 450-457.
- [2] Detecting User Activities using the Accelerometer on Android Smartphones

Thank you for your attention!