Smartphone Data Analysis for Human Activity Recognition

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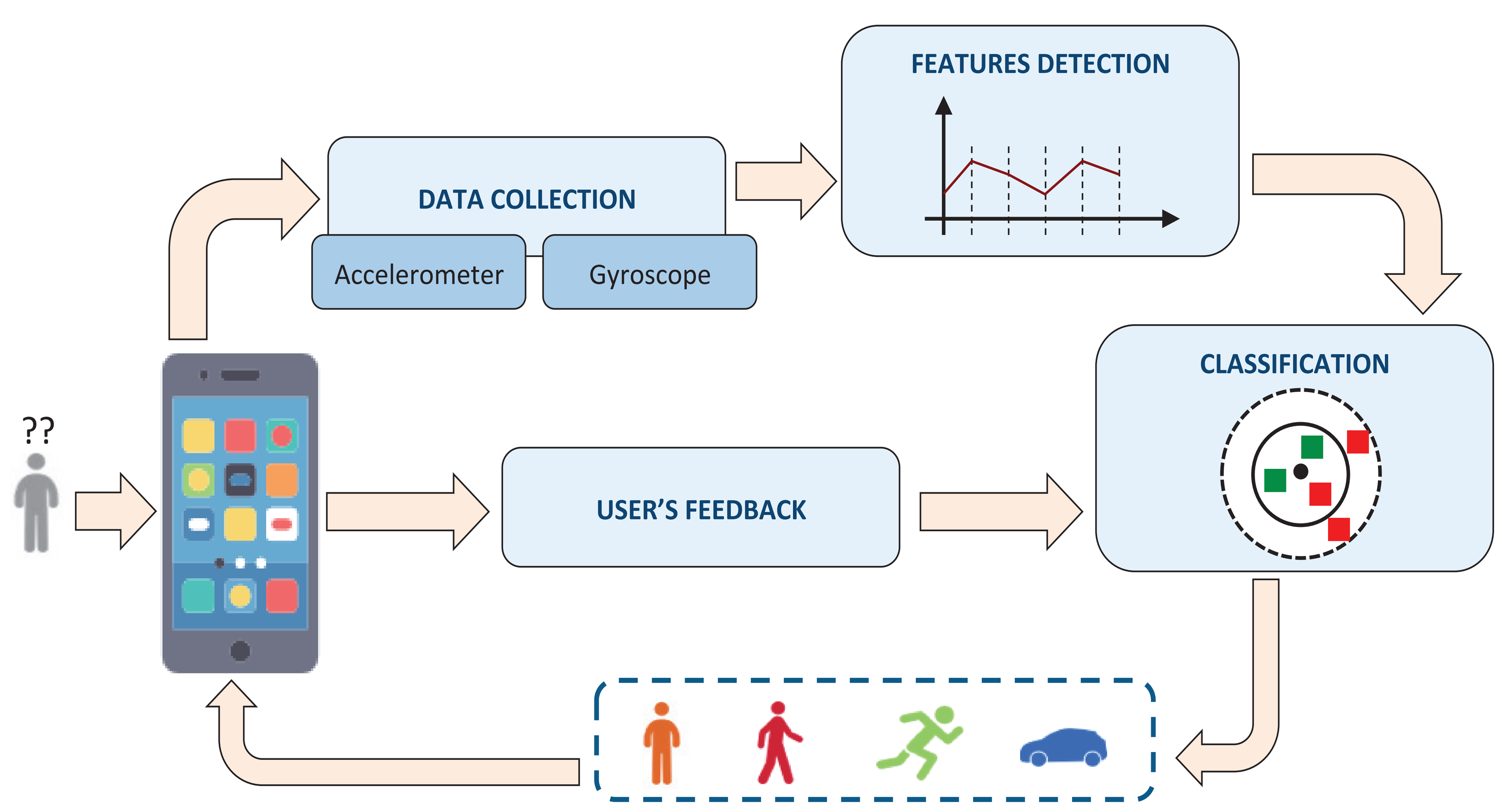
Motivations

Smartphones are equipped with many sensors that make them **real sensing platforms** able to extract relevant information about user's context. For this reason, they are one of the most interesting and investigated approaches for the HAR scenario.

The challenge addressed in the proposed work is the realization of a **framework for real-time human activity recognition using smartphone data captured by means of embedded triaxial accelerometer and gyroscope**. The system we propose also adopts a participatory sensing paradigm where user's feedbacks on recognized activities are exploited to update the inner models of the system.



System Architecture

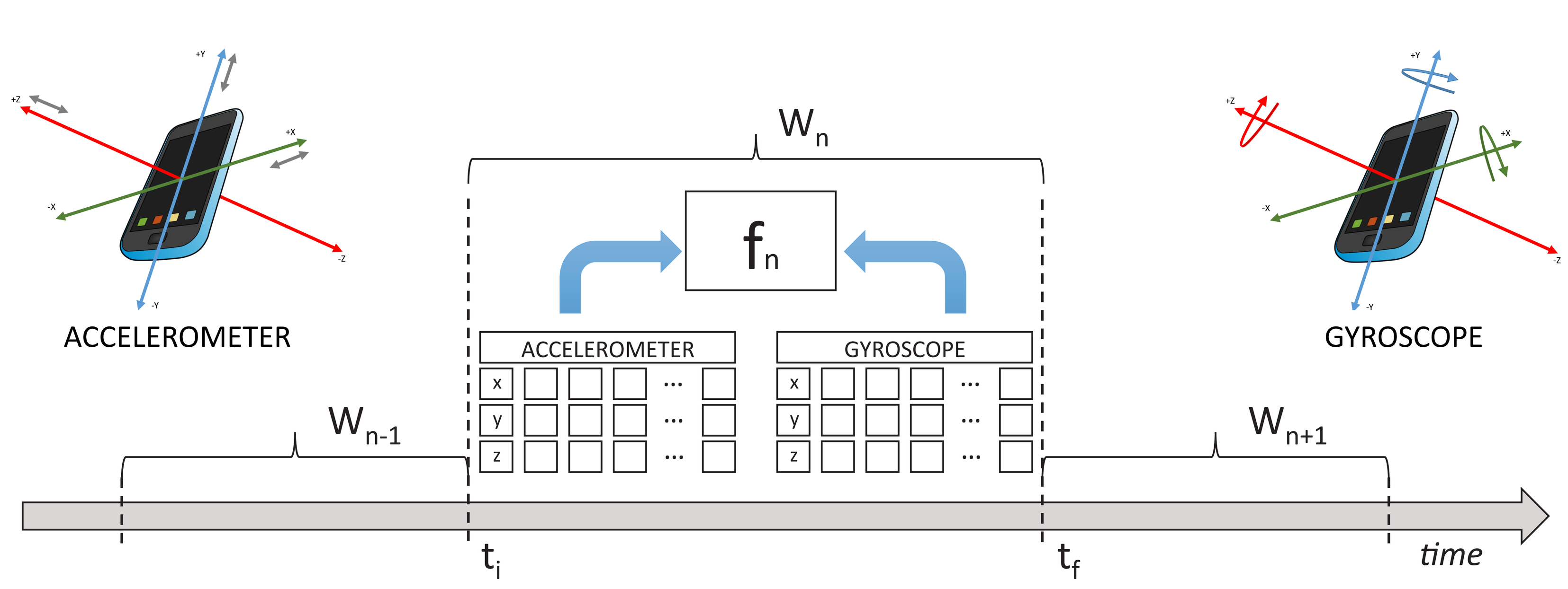
In order to efficiently organize the system we adopted an **architecture** based on **four modules**, each corresponding to a different logical task.

Data collection module is responsible for capturing raw data through the smartphone sensors while an activity is performed.

Feature detection module takes as input raw data within fixed-length time windows and extracts a set of n-dimensional points used to distinguish different activities. In particular, the activity recognition process is based on (X_A, Y_A, Z_A) values provided by the accelerometer, and (X_G, Y_G, Z_G) values from the gyroscope.

Classification module is based on the k-nearest neighbors (K-NN) technique. Given a new feature vector *f*, the algorithm assigns to f the same class of its closest neighbor, i.e., the closest point in the feature space.

User's feedback module exploits a participatory sensing paradigm. A client/server architecture has been designed allowing each user to **share** its own data captured by the smartphone, and use the same device to **leave feedbacks** about the recognition process, indicating whether the output class is correct or not.



Sensors and activities pattern

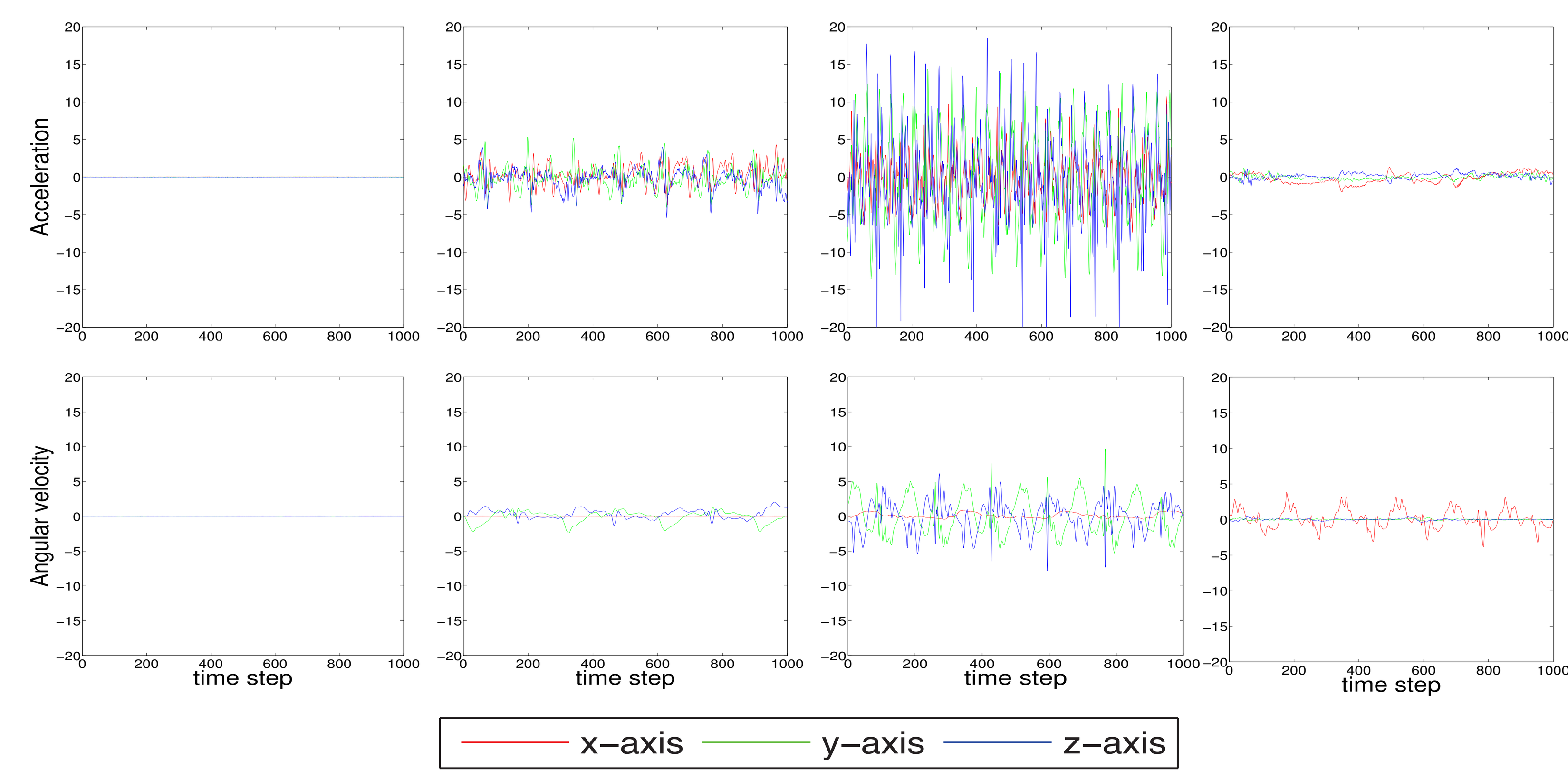
Data from accelerometer and gyroscope are combined to get the best from both sides.

Acceleration

still and *vehicle* share a similar pattern, whilst *walking* and *running* are characterized by high noise as they are intrinsically associated with a significant user movement

Angular velocity

still and *vehicle* exhibit distinct patterns, whilst other activities are generally characterized by oscillations of different width and frequency.



Case Study

Google APIs are a **black-box,** thus in-depth experimental analysis is unfeasible.

MoST considers only acceleration data, that are not useful enough for discriminating between *still* and *vehicles* activities.

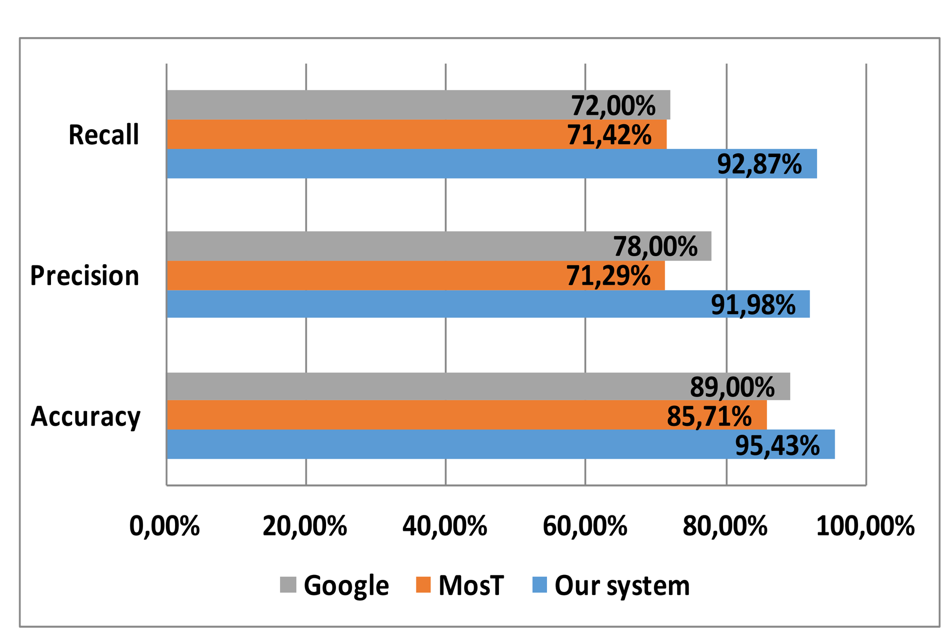
Model	CPU	RAM
Galaxy S7 Edge	8 Core 2 GHz	4 GB
Galaxy S5 Neo	8 Core 1.6 GHz	2 GB
Galaxy S4	4 Core 1.9 GHz	2 GB
Galaxy S2 NFC	2 Core 1.2 GHz	1 GB
Galaxy Note	2 Core 1.4 GHz	2GB

	still	walking	running	vehicle	other
still	.92	0	0	0	.08
walking	0	.56	.44	0	0
running	0	.45	.55	0	0
vehicle	0	0	0	.91	.09

Google confusion matrix

	still	walking	running	vehicle
still	.33	0	0	.67
walking	0	.96	.04	0
running	0	.02	.98	0
vehicle	.43	0	0	.57

MoST confusion matrix



Future Work

We want to introduce i) a **dynamic mechanism to filter out noisy data** captured just before or after an activity is performed and ii) extend the system in order to be able to **recognize complex activities composed of simple tasks**.

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