Remote Monitoring – SUBPROJECTS AND TAKS

Subprojects

1- Noise reduction

BLE signals suffer from different sources of noise and distortion. We also see signal gaps (short time periods without signal due to reading errors, etc.). Noise levels are very different form one user to another. If we want to measure users movement we need to look at signal changes, so we need to reduce noise. Any remaining noise should be similar from one user to another.

The fist approach is using a Kalman Filter to filter noise. The filter has proven able to adapt to different noise levels and to give as output a similar signal for every user.

Challenge:

The Kalman filter needs some time to become steady. When we have signal loses or gaps the filter introduces some variation in the signal that could be misunderstood as user movement. More signal processing is needed prior to get more accurate insights.

Some approaches could include signal processing, dimension reduction.

Tasks:

- To check the current Kalman filter and try to improve it.
- To suggest and implement other noise reduction solutions.

Background:

- Kalman filtering in R
- Kalman filters explained: Removing noise from RSSI signals

Members:

- Manish Danani
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2- Location

Exact location is not necessary to fulfill the project goals. However, improvements in location can help in all the other challenges.

Challenge:

To design a non intrusive location algorithm able to perform well in all the users.

Tasks:

To propose a location algorithm and to implement it.

Background:

- RSSI-Based Distance Estimation Framework Using a Kalman Filter for Sustainable Indoor Computing Environments
- Indoor Location Tracking using Received Signal Strength Indicator

Members:

- Solomon Kembo
- Hemant Vasantrao Raut

3- Measuring movement or activity levels

If we could measure the users movements from the location data we could: 1)know if he is resting or active 2)detect unusual states that could point to any issue or accident, 3)measure daily activity to make follow up of the user health.

There are several approaches to measure movement from RSSI variation signal, for example

- Signal variance for the previous minutes (mean of every sensor, only the sensor with the biggest signal, only sensors with signal above a threshold, etc.).
- Spearman correlation between the RSSI levels (measure if signals level order is changing or not), or other correlation measures.
- Frequency domain analysis (Fast Fourier Transformation, etc.).

But no single variable has proven able to clearly differentiate activity levels.

Challenge:

To be able to measure activity levels for different uses, for example:

- To differentiate if the user is wearing the beacon or not
- To differentiate if the user is asleep or not
- To differentiate if the user is resting but conscious (for example watching tv) or if he is completely motionless.

Tasks:

- To propose an activity detection algorithm and to implement it
- To evaluate performance and to select the best solution.

Background:

- Inferring Motion and Location Using WLAN RSSI
- LOCADIO: Inferring Motion and Location from Wi-Fi Signal Strengths

Members:

- Claudio Ceccotti
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4- Event pattern recognition

Using some rules combining location, activity level and time of the day can be used to detect some usual situations as getting up, resting, sleeping, etc. and some emergency situations (for example staying motionless at the bathroom for too much time at time).

Challenge:

The next step should be to use pattern mining and behavior recognition to learn behavior patterns for every user and to detect unusual behavior and emergencies.

Approaches: pattern recognition, complex event processing, deep learning.

Tasks:

- To propose a behavior processing and recognition algorithm and to implement it.

Background:

- Everyday mining
- Activity Recognition in the Home Setting Using Simple and Ubiquitous Sensors
- Human Activity Recognition and Pattern Discovery
- Behavior Analysis for Elderly

Members:

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