Using Mobile Phones for Monitoring Physical Conditions

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Abstract: Today, mobile phones are becoming an essential device in our daily life, and carried comfortably and regularly by a huge percentage of population. In this note, we propose an application for mobile phones which can turn them to devices for constantly monitoring physical conditions of a user.

1 Introduction

Over the past few years, many mobile phones are equipped with sensors that can capture information related to physical variables such as acceleration. As the mobile phone is carried by the user, these physical variables, e.g. acceleration recorded by accelerometer of mobile phone can provide some information related to physical activity of the user. Accelerometer sensors have been used for activity analysis and classification [Lee02, Bao04, Yang05, Song05], however we propose to use accelerometers integrated in a mobile phone for such a purpose. The mobile phone equipped with these sensors should be carried normally by the user in his pocket. Results of examination can be presented to the user in different ways as an indication of different health related factors. In addition to presenting these data to the user, the mobile phone can optionally analyse them, or send them to a server for further analysis. The main idea is that the mobile phone analyses physical activity pattern of the user and compare it against normally accepted pattern for the same user, or normally accepted activity pattern for the users of same age.

2 Applications

This analysis can be used for early detection of symptoms of diseases. Many diseases initially show themselves in the way the pattern of physical activity for a person changes. The system can check if there is any dramatic change in the pattern of physical activities and issue warnings in such cases. It can additionally provide certain advices by

comparing the pattern of activities over different periods of day/week/month with a reference activity pattern for the same period. In all these cases, if the mobile phone detects something suspicious regarding health, it can inform the user or a designated person such as a medical doctor.

Such a system can be also used to take care of elderly or people with certain diseases by constantly and precisely monitoring pattern of their physical activities. It can reduce the risk of fall for elderly or patients by early detection of signs in walking or standing pattern which can lead to sudden fall.

As another application, the mobile phone can be used to analyse the progress of a user/patient after taking certain medication or surgery. Again in this case, activity pattern of the user can be used as a good indication of health progress.

2 Analysis of Acceleration Signals

In order to examine activities of a user, the mobile phone should analyse acceleration data in sophisticated way. This means that relying only on magnitude of acceleration would not be sufficient. The application should be able to distinguish the source of activity leading to certain acceleration pattern. For instance, if the user is in car or public transport, accelerometers may show high magnitude of acceleration due to the acceleration of the vehicle. However, obviously the user is not engaged in high physical activity in such scenarios. Therefore, there is a need for a mechanism to distinguish the source of acceleration. As a basic solution for such a case, a high pass filter can be used. The pattern of acceleration due to a vehicle temps to change more slowly than the pattern of acceleration due to physical activities of user such as walking. The high pass filter operating on acceleration signal filters out the low frequency component (caused by vehicle movement), and keeps high frequency component caused by the physical activity of the user.

After post processing the acceleration signal by a high pass filter, a feature extraction step is necessary. Feature extraction removes redundant information, and keeps only information in acceleration signal which are presenting activity pattern of the user in a discriminative way. According to our initial studies, magnitude of acceleration along different axis, rate of change in acceleration along different axis, and absolute magnitude and rate of change in acceleration can serve as informative features. Extracted features can then be used as input to a statistical model. Feature vectors are used to train reference statistical models for normal and risky behaviour. During the test of the system, the trained models can provide scores corresponding to ongoing activity pattern of user. A warning can be issued if the scores show a very low match between ongoing activity pattern, and the one considered as normal activity pattern.

As a mobile phone can be conveniently and constantly carried by a user, and it does not impose burden of wearing extra sensors, such an application can enable the mobile phone to become a user friendly, precise and constant health and activity monitoring device.

References

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