USING A REGULAR SMARTPHONE TO COLLECT NATURALISTIC BICYCLE DATA AND AUTOMATICALLY DETECT BICYCLE ACCIDENTS

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ABSTRACT

Today's high-end smartphones are typically equipped with both GPS functionality and movement sensors such as accelerometers and gyroscopes. The aims of this study was to explore to what extent inherent smartphone sensors can be used to collect naturalistic cycling data and design an algorithm for automatic detection of bicycle accidents. A Google Nexus 4 smartphone was chosen for the study. This device is equipped with a combined accelerometer and gyroscope chip (MPU-6050, Invensense) allowing the sensor signals to be recorded with a sampling frequency up to 1 kHz. > 6 hours of cycling data from different situations was collected. Several crash tests were performed using a simple crash test dummy. In order to allow the smartphone to be easily carried, i.e. not fixed to the body and thereby not distinguishing "true" x, y, z –directions, an integrated accelerometer signal measure was created based on the sum of the square of each direction. In normal use this acceleration measure was found to be as high as 4 g. These levels could be from simple handling of the smartphone or e.g. from road bumps during cycling. This prompted that high acceleration measures alone are not appropriate to be used to indicate a fall or accident. Based on the pool of recorded "normal" data and the crash tests an adequate crash detection algorithm could be designed based on a combination of accelerometer and velocity measures and changes in orientation within a time window. The suggested algorithm was evaluated in several hours of normal bicycling without any false positive alarms and successfully in the simulated accidents using the crash test dummy. Contrary to what was expected, the algorithm did not demand any special arrangement for carrying the smartphone tightly fixed to the body.

Keywords: Collection of naturalistic cycling data, automatic accident detection, smartphone