Free Fall Detector

Free fall detectors are implemented in a wide variety of mobile hardware devices to 'park' the device in a state in which data loss and/or hardware damage can be avoided or minimized. In general it takes a brief moment for the device such as an MP3 player, cell phone, or hard drive to reach this park state and of course it takes some time to reliably detect a state of free fall of the device.

Free fall can be detected using a single triaxial accelerometer as long as no excessive rotation of the device is involved. If the accelerometer is static in the earths reference frame, gravities' constant acceleration is measured by the accelerometer as a normal force away from earth. During free fall this normal force is absent and theoretically zero total acceleration is measured by the accelerometer. Noise and slight rotation of the free falling object can result in small deviations from zero total acceleration of the device. Nevertheless, a sustained drop of total measured acceleration yields as a free fall detector.

The simplest form of free fall detection algorithm monitors the total acceleration $a_{tot}=sqrt(ax^2+ay^2+az^2)$ as a function of time. If a_{tot} falls below a threshold (gcritical) for more than a predetermined time (tcritical) the free fall warning is triggered and some action can be initiated.

Complications of false positive free fall detection arise from activities that involve parabolic free fall trajectories such as running. Frequently MP3 players are worn during workout such as jogging. Between steps the runner is technically in free fall and zero gravity is detected by an accelerometer. This is a case in which it is not desired to put the device into a secure state. A new criteria using integral of acceleration was put forward by J. Stoev *et al* [1]. Specifically, they find a big difference of the integral of acceleration between damage causing free-fall and intended human activities induced free-fall.

Both detection mode is offered by our program. In the simple direct value mode, gcritical and tcritical can be chosen freely by user. In the second integral mode, however, gcritical is fixed to be 0.5g and tcritical to be 0.2s, since these values is suggested by Ref[1]. Users can adjust the source code id they want to test different values. Whenever a free-fall is detected, a warning is sounded and free-fall period is marked by red color on the real time data plot.

Reference:

[1] J. Stoev, K. Cho, J. Shim and H. Lee, SICE-ICASE International Joint Conference (2006)