Correcting for SCA3000 Accelerometer Mounting Angle

Objective

A tri-axial accelerometer's measuring axes may not be parallel to the axes of an application due to a random mounting alignment of the accelerometer inside the application. This document explains the theory behind the compensation for the difference between the accelerometer's measuring axes and the application's coordinates, if the mounting alignment of the sensor inside the application is known and fixed.

Applications

The measuring motion of moving objects e.g. vehicles or humans, the mounting position of the sensor might be random inside the application due to space limitations. In addition, the operational position of an application might prevent the straight alignment of the sensor.

Solution

The measuring axes of the accelerometer, x, y and z, form the local coordinate system of the accelerometer. Its orientation with respect to the global coordinate system of the application, x', y' and z', can be described with three angles Θ_r, Θ_p and Θ_y determined by the following procedure (Please see Figure 1):

1. Put the local coordinate system of the accelerometer in the same position as the global coordinate system of the application.
2. Turn the coordinate system of the accelerometer Θ_r degrees around the axis x'.
3. Turn the coordinate system of the accelerometer Θ_p degrees around the axis y'.
4. Turn the coordinate system of the accelerometer Θ_y degrees around the axis z'.

The orientation of the accelerometer with respect to the application corresponds now to the angles Θ_r, Θ_p and Θ_y which bring the local coordinate system of the accelerometer from the starting position (1.) to the mounting alignment that we are considering. The rotations in steps 2, 3 and 4 are called roll, pitch and yaw.

Let's denote the output of the accelerometer with respect to its own local coordinate system with a_x, a_y and a_z. This output can be compensated to be the output of the accelerometer with respect to the global coordinate system of the application, denoted by $a_{x'}$, $a_{y'}$ and $a_{z'}$, using the following formulas:

$$a_{x'} = \cos(\Theta_y)*\cos(\Theta_p)*a_x+(\sin(\Theta_y)*\cos(\Theta_r)+\cos(\Theta_y)*\sin(\Theta_p)*\sin(\Theta_r))*a_y+(\sin(\Theta_y)*\sin(\Theta_r)-\cos(\Theta_y)*\sin(\Theta_p)*\cos(\Theta_r))*a_z$$

$$a_{y'} = -\sin(\Theta_y)*\cos(\Theta_p)*a_x+(\cos(\Theta_y)*\cos(\Theta_r)-\sin(\Theta_y)*\sin(\Theta_p)*\sin(\Theta_r))*a_y+(\cos(\Theta_y)*\sin(\Theta_r)+\sin(\Theta_y)*\sin(\Theta_p)*\cos(\Theta_r))*a_z$$

$$a_{z'} = \sin(\Theta_p)*a_x-\cos(\Theta_p)*\sin(\Theta_r)*a_y+\cos(\Theta_p)*\cos(\Theta_r)*a_z,$$

where $0 \le \Theta_r, \Theta_p, \Theta_y < \pi$.

Note:

- The order of the rotations (1st roll, 2nd pitch, 3rd yaw) must not be changed.
- The direction of the rotations roll, pitch and yaw in steps 2, 3 and 4 is fixed to be clockwise when looking towards origin from the positive side of the axes x', y' or z'.

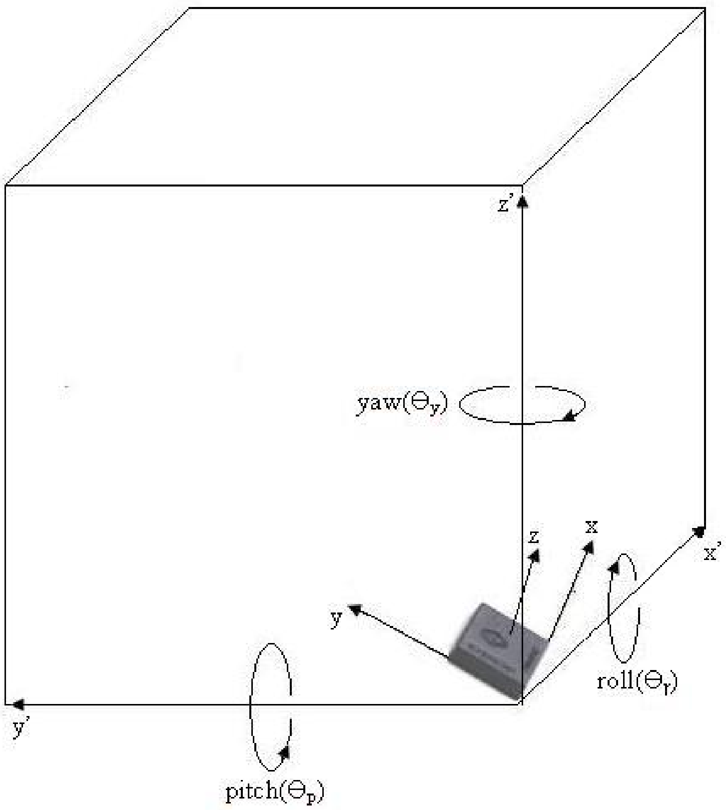

Figure 1. The coordinate systems of the accelerometer and the application

Version	Date	Change Description
0.01	05.09.2006	Initial release