Tech Note 2

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Simple sensor threshold calibration

This tech note shows how to determine your sensor's response (or detection) threshold. Not to be confused with saltation threshold, no relationship.

To remove as many variables as possible, let's always use glass spheres. These will be fairly spherical and densities close to 2.5 gm/cm^3. This way we can repeat the test comparing various sensors anywhere, any time.

If we drop a particle from a low height, avoiding air viscosities, we can replace the (PE=*m*v)* velocity term (*dv*) with the release height (*dh*) times the acceleration of gravity constant (*g*) and consider the impact energy as the same as potential energy (PE) at height *h*. By doing this we are saying kinetic energy equals potential energy if aerodynamic effects are removed.

KE = PE = *m dh g* = mass x change in height x acc. gravity

Particle drop test

Good rule of thumb: Use a 600u and 1mm glass spheres because they are large enough to be physically handled by hand and produce results in the desired range when released from very small heights. Start releasing the spheres from a height of 0.5 -> 1cm. The Sensit generally starts responding to the impact energy of a 1000u sphere released at a drop height of 1 -> 3cm.

dia = 1mm (1000u)
mass = density * volume (mass = 2.5 * volume, volume = ¾ pi r^2)
m = ~0.026179939 gm/cm^3.

ASSUME: PE (potential energy) = *m dh g* = KE(kinetic energy) for low drop heights (*h*<=5cm).
dh = 1cm (release height)
g = release height * 980 cm/s^2.
PE = 0.026179939 * 1 * 980 = **25.66** Dyne-cm, (ergs) = 2.56563E-06 joule
(1 joule = 1 Dyne-cm * 10^{-7}, 1 Newton = Dyne-cm * 10^{-5})

Release a sphere close to the sensor surface. Then increase the release height until the sensor starts to respond. Look at the PC output for a pulse indicating a response. Repeat this test selecting both sensor gains of 1X and 10X.

Calculating Particle Velocity

Considering potential energy vs. kinetic energy for a simplified calculation of impact energy, potential errors become obvious as the effect of air viscosity becomes apparent. In air, the particle will ultimately reach a constant velocity called terminal velocity. In a vacuum acceleration continues of course.

Potential Energy Calc (i.e. in a vacuum)

dh	10 cm	given
dt	0.102 s	found via g(h)
dv	98 cm/s	simple particle velocity calculation result

Ignoring viscosity of air, we can calculate particle velocity solely as a function of the acceleration of gravity. Admittedly, potential for up to 20% error exists for drop heights as small as 50cm increasing in error as particle diameter (<600u) decreases. However, this simple test at low drop heights provides a sensor detection threshold that is repeatable and accurate enough for a saltation program estimates. At very low drop heights (h<5cm, d=>600u), the sensor detection threshold is quite accurate and has been used in JGR publications.

EXAMPLE: Find particle velocity for a release height of 10cm.

h = 10cm, g = 980cm/s^2
$dh = g * t^2 - t0$
10 = 980cm/s^s * t^2
t^2 = 10/980 = 0.01
t = sqrt(0.01) = 0.1
$v = g * t$, 980 * 0.1 = 98
v = ~98cm/s

Or, another rule of thumb; if h = 10 cm then v = ~1 m/s.