P.C. Tuan, C. Pei, C.S. Lin. The on-line falling self-protection system design. Gerontechnology 2008; 7(2):227. In this paper, we propose a dynamical algorithm to real time estimate the body posture by using the output of a simple MEMS accelerometer as the sensor. The Body Posture Angle (BPA) is defined to detect the possible time-varied posture before fall. While the time varied BPA has been detected during falling process, we could predict the time to fall and then a control command is triggered. Self-protection was effected with an air bag, to keep the falling body from injuries. Simulation and limited experiments results are presented in this paper. **Methods** Figure 1 illustrates the two posture angle while subject's body is in rotational motion; the pitch angle and the yaw angle[1]. Let's consider the fall is under stationary situation. We investigate the accelerometer model is:

$$\vec{f} = \vec{a} - \vec{G} \quad (1)$$

Here, $\vec{f}$ is the specific force and $\vec{a}$ is the acceleration of the body, $\vec{G}$ is the gravity. Let $\vec{\theta}$ be the angle between the sensing orientation and gravity, then the output of the acceleration is:

$$S = \vec{f} \cdot \vec{\theta} \quad (2)$$

Now, for a 3-axis MEMS accelerometer, let the coordinate transformation is

$$\begin{cases} S_x = -G \sin\theta_y \\ S_y = 0 \\ S_z = G\cos\theta_y \end{cases} \qquad \begin{cases} S_x = 0 \\ S_y = G \sin\theta_x \\ S_z = G\cos\theta_x \end{cases} \quad (3)$$

Since S_x, S_y, S_z already knew, $\vec{\theta}_y$ could be written as

$$\theta_y = -\sin^{-1}\frac{S_x}{G} \quad \text{or} \quad \cos^{-1}\frac{S_z}{G} \qquad \theta_x = \sin^{-1}\frac{S_y}{G} \quad \text{or} \quad \cos^{-1}\frac{S_z}{G} \quad (4)$$

Results and discussion Under the assumption that $\vec{\theta}_x$ and $\vec{\theta}_y$ rotate from 0 to 90 degree at stationary condition, we measured the accelerations by using a 1 mini-g error 2 axis MEMS. Simulated outputs (*Figure 2*) and the comparison results between computed BPA and true BPA (*Figure 3*) are shown Results show the excellent estimation match to the proposed fall angle.

References

1. Hansen TR, Eklund JM, Bajcsy R, Sastry S. Proceedings European Medicine, Biology and Engineering Conference (EMBEC); 2005

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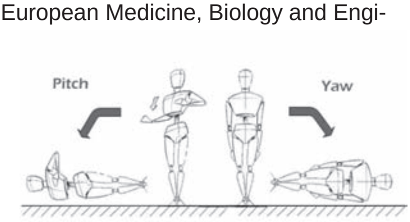

Figure 1 Fall posture

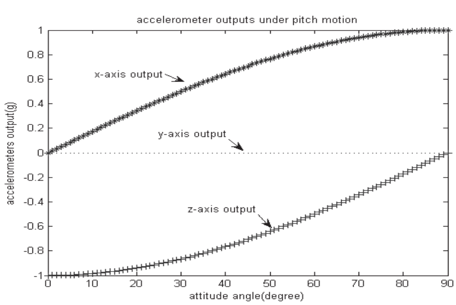

Figure 2 Simulated outputs

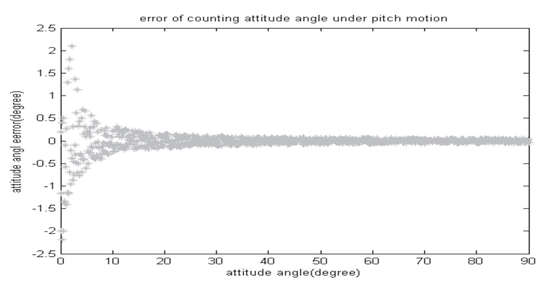

Figure 3 Comparison results between computed BPA and true BPA