

## **2004 TAIWAN INTERNATIONAL SCIENCE FAIR**

**CATEGORY : Physics**

**PROJECT : Body Sway Technology:Studies on  
Data Correlations to Identify Elderly  
People Prone to Falling**

**AWARDS : Physics First Award**

**SCHOOL : Raffles Junior College**

**FINALISTS : Lee Min Wai Serene**

**COUNTRY : Singapore**

**ABSTRACT OF EXHIBIT  
TAIWAN INTERNATIONAL SCIENCE FAIR 2004**

**Category:** Physics

**Title:** Body Sway Technology:  
Studies on Data Correlations to Identify Elderly People Prone to Falling

**Name:** Lee Min Wai Serene

**Country:** Republic of Singapore

**Background:**

It is extremely costly to care for elderly people who have suffered a serious fall. Thus, doctors welcome a device or method to identify people prone to falling, to reduce elderly health costs and enable those identified as “fallers” to take precautions.

Recently, a Sound Wave Assessment (SWA) device was developed to determine if tested human subjects were prone to falling. It is based on the concept that all humans exhibit postural sway while standing stationarily. The device employs two sonar transducers, which emit and receive ultrasonic pulse signals. The first transducer is positioned on a tripod, while the second is attached to the lower back of the human subject. Each transducer emits ultrasonic modulation pulses, which are detected by the other transducer. The distance between the two transducers is calculated from the time taken for the pulses to travel from the sender to the receiver. Hence, we can measure the small displacement fluctuations of the standing human subject, both approaching and receding from a static transducer, as a function of time.

**Purpose of Research:**

Until recently, there was no conclusive method to correlate data obtained using the SWA device with a human subject's likelihood of falling. Previously, the root mean squared velocity ( $V_{rms}$ ) was calculated for each subject, and this study aims to verify the effectiveness of using  $V_{rms}$  to distinguish “fallers” from “non-fallers”, as well as derive a more effective method of differentiating between the two groups. This was done by comparing and performing calculations on the various sets of data parameters available.

**Procedures:**

38 healthy human subjects aged 65-99 years were tested using the SWA device. Using a questionnaire, those who had fallen in the past year were labelled “fallers”, and the rest “non-fallers”. 1800 displacement data points were obtained for each subject in 60s, and fed to DOS computer programs, which generated velocity readings and a  $V_{rms}$  value for each subject. Various graphs were generated in Microsoft Excel to investigate possible correlations between  $V_{rms}$ , age, moments (torque) and fall probability. A novel equation similar to that of acceleration was also introduced, with the differences in velocities being in intervals of 20 readings:

$$a_i = \frac{3}{20}(v_{i+19} - v_{i-1}), \quad 1 \leq i \leq 160, \quad \text{since } \Delta t = \frac{20}{3}s.$$

The  $a_{max}$  values (the magnitude of the maximum value of  $a_i$  for each subject) were then noted, to investigate the existence of a threshold value separating the “fallers” from the “non-fallers”.

**Results and Data:**

It was found that data parameters of  $V_{\text{rms}}$ , age, and moments were inconclusive in distinguishing “fallers” from “non-fallers”. However, the promising find was that by setting an approximate  $a_{\text{max}}$  threshold value of  $0.328\text{cms}^{-2}$ , it was found that 75% of the “fallers” had an  $a_{\text{max}}$  value above this threshold, while 77% of the “non-fallers” had a value below that, thus separating the two groups effectively.

**Conclusion:**

The results demonstrate that the new equation is more effective in distinguishing “fallers” from “non-fallers” (using an  $a_{\text{max}}$  threshold value of  $0.328\text{cms}^{-2}$ ), as compared to previous methods such as  $V_{\text{rms}}$ . Coupled with further human subject testing, these results are extremely promising in enabling the medical world to adopt the SWA device on a large-scale basis to protect the elderly from falls.