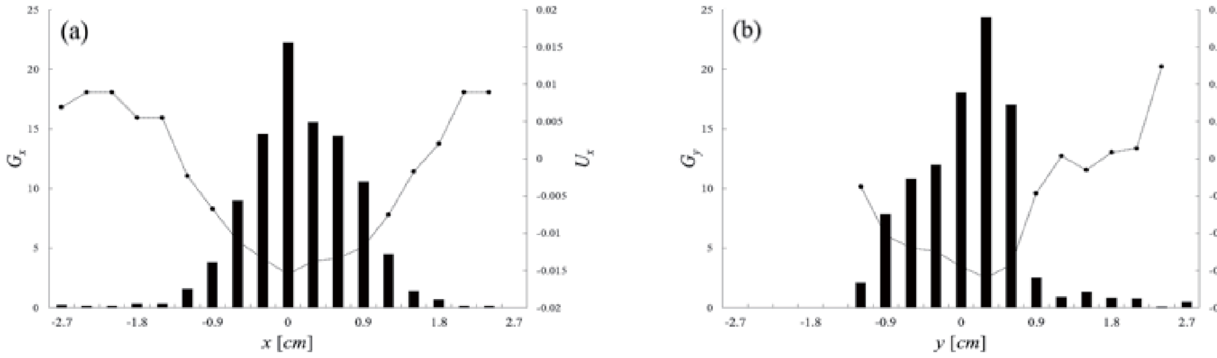


Fig. 2. A typical example of TAPF derived from stabilograms during exposure to the video clip (I)-3D: $x$ directions (a), $y$ directions (b).

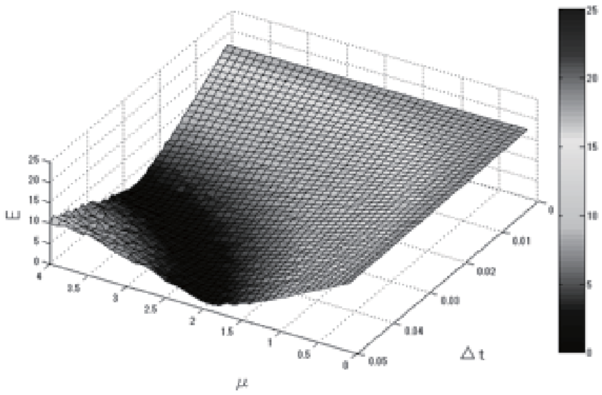


Fig. 3. A typical evaluation for numerical solutions in space spand by the parameter $\mu$ and $\Delta t$ at control.

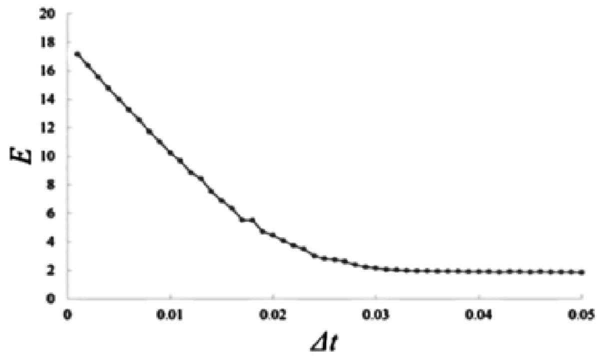


Fig. 4. A typical example of $E$-$\Delta t$ plane at control.

numerical calculus. In Eqs. (7) and (8), the initial values of $(x, y)$ were set to be $(0, 0)$. The pseudorandom numbers (mean $\pm$ standard deviation: $1 \pm 1$) were generated to substitute into the white Gaussian noise $w$. Setting the noise amplitude $\mu$ and time step $\Delta t$ were set to be every 0.1 step from 0.1 to 4 and 0.001 step from 0.001 to 0.05, respectively. Numerical analysis was employed for 22,000 steps, and the first 10,000 steps of the numerical solutions were discarded due to dependence of the initial value. The remaining 12,000 steps were divided into 1,200-step increments. The area of sway ($Ys$) and total locus length ($Xs$) were also calculated in these numerical solutions. Designating the measured the area of sway and the total locus length as ($Yr$) and ($Xr$), errors ($E$) between the numerical solutions of the mathematical model and measured data was defined as follows:

$$E = \sqrt{\frac{\sqrt{Yr}}{Xr}(Xr - Xs)^2 + \left(\sqrt{Yr} - \sqrt{Ys}\right)^2}. \qquad (9)$$

We then estimated the smallest $E$ for each parameter $\mu$ and $\Delta t$ (Fig. 3), and the variance of $E$ on $E$-$\Delta t$ plane as

$$var(\Delta t^*) = \frac{1}{\#data} \sum_{\Delta t^* \leq \Delta t \leq 0.05} \{E(\Delta t) - mean(E)\}^2, \qquad (10)$$

was calculated to determine the plateau of the error $E$. The left bound $\Delta t^*$ was defined as the optimum value for the plateau in the case that the variance (10) exceeded 0.3 in this study (Fig. 4). This parameter was calculated for each subject.

## 3. Results

Stabilograms measured during exposure to a 2D video clip were compared with those of a 3D (Fig. 5). In these figures, the vertical axis shows the anterior and posterior movements of the COP, and the horizontal axis shows the right and left movements of the COP. We also calculated the area of sway, total locus length for each stabilogram (Fig. 6). Regardless of the solidity on video clips (2D/3D), the area of sway and total locus length while viewing video clips (II) were smaller than those while viewing video clips (I), respectively. As a result of the Wilcixon signed-rank test, the value of the area of sway and the total locus length were significantly greater while viewing the video clip (I)-2D and the control compared with those while viewing the video clip (II)-3D ($p < 0.05$).

Histograms of each component were obtained from subjects's stabilograms. The TAPFs in each case (I) and (II) were constructed from the histograms using Eqs. (5) and (6). The TAPFs were sufficiently regressed by those polynomials for degree 4. Eqs. (7) and (8) were rewrote into the difference equation, and the numerical solutions were obtained with the Runge-Kutta-Gill formulae (Fig. 7). The area of sway and total locus length were also calculated in these numerical solutions. The smaller $E$ we obtained, the better description the numerical simulation could give us.