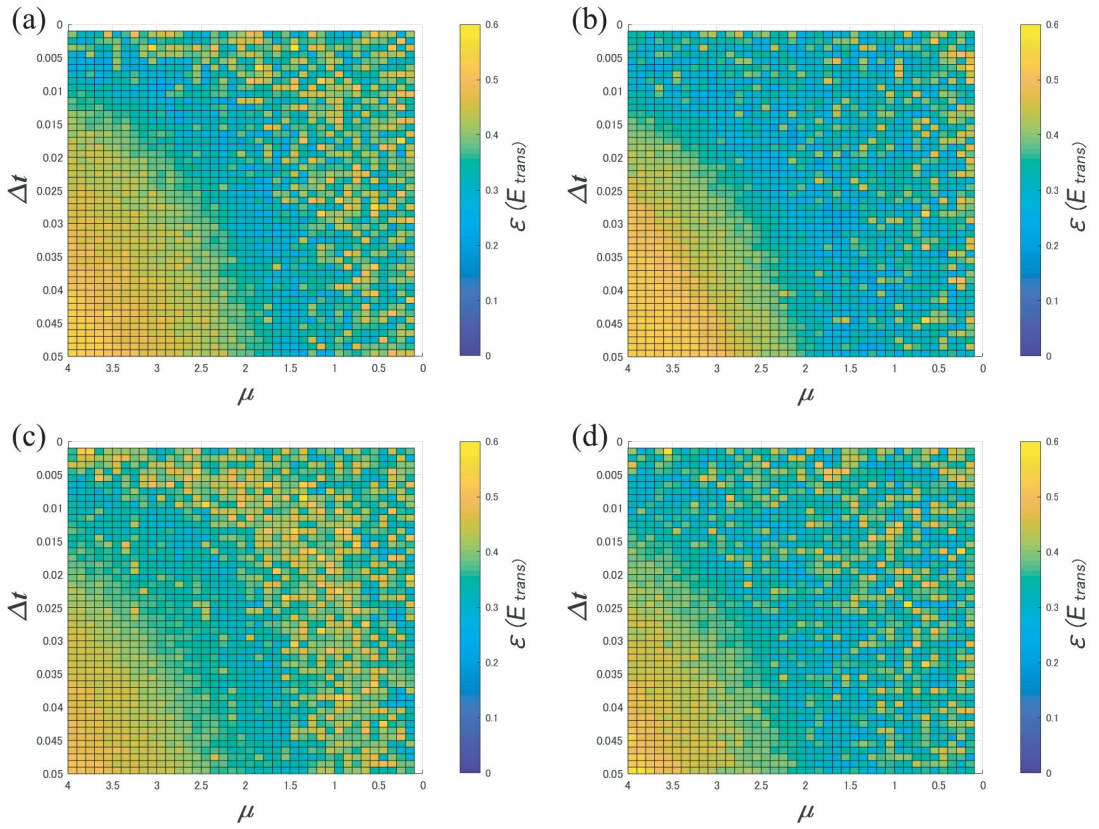

Fig. 1. Typical evaluation of numerical solutions in space spanned by the parameters μ and Δt in x-component for the young (a), in x-component for the elderly (b), in y-component for the young (c), and in y-component for the elderly (d).

tion of an individual body sway.

$$\frac{\partial x}{dt} = -\frac{\partial}{\partial x}U_x(x) + \mu_x\omega_x(t), \tag{1}$$

$$\frac{\partial y}{dt} = -\frac{\partial}{\partial y}U_y(x) + \mu_y\omega_y(t), \tag{2}$$

where μ_x and μ_y express the amplitudes of white Gaussian noises $\omega_x(t)$ and $\omega_y(t)$, respectively [14],[15]. In accordance with the previous theory, the noise amplitudes μ_x and μ_y were estimated by the numerical analysis for each component; otherwise, preprocessing for the standardization is required to compare multiple components in a polygraph. However, inconvenience is often experienced in the comparison of simultaneous measurements and/or biological loads. This problem has been eliminated in the present theoretical scheme [16]. The temporally averaged potential functions (TAPFs) $U_x(x)$ and $U_y(x)$ can be estimated by using the following formula, which is obtained from the stationary solution of the Fokker-Planck equation corresponding to SDEs (1) and (2) with the natural boundary conditions and constant fixation in the noise amplitudes. The correspondence can be shown by the calculation of the moment of transition probability.

$$U_x(x) = -\frac{\mu_x^2}{2}\ln G_x(x), \tag{3}$$

$$U_y(x) = -\frac{\mu_y^2}{2}\ln G_y(y), \tag{4}$$

where $G_x(x)$ and $G_y(y)$ represent the stationary distribution in each direction, whereas temporal variations of the distribution in each direction are expressed by the Fokker-Planck equation describing the Markov process without an abnormal dispersion.

Based on the observation, the stationary distribution can be estimated by the distribution measured for a sufficiently long time. In consideration of the nonlinearity of the biocontrol system, graphs of polynomials for degree four herein regress to the stationary distribution, as in Sec. 3. For perspective, the potential function can be estimated at each step when setting the width of moving windows for the mathematical analysis. Thus, the temporal variations of the potential function are described as a motion process in dual space [17]. Additionally, the SDEs can construct movements within the local stability with a high-frequency component near the minimal potential surface, where a high density is expected at the measurement point.

3. Statistical Processing and Numerical Analysis

Ten healthy elderly females (mean ± standard deviation: 71.9 ± 4.09 years old) and ten healthy young females (21.1 ± 0.94 years old) voluntarily participated in this study. All were Japanese and lived in Nagoya and its surrounding areas. They provided informed consent prior to participation. The following subjects were excluded from the study: subjects working night shifts, those dependent on alcohol, those who consumed alcohol and caffeine-containing beverages after waking up and less than 2 h after meals,