Title:	**Control of Torque-Assisted Bicycle based on Physical Activity during Repetitive Prolonged Cycling Exercise**
Authors & affiliations:	Tohru KIRYU*, Shinya KATO*, Takao MORIYA**, and Yasufumi MIZUNO** *Graduate School of Science and Technology, Niigata University, 8050 Ikarashi-2, Niigata 950-2181, Japan, **Yamaha Motor Co., Ltd., 2500 Shingai, Iwata, Shizuoka 438-0026, Japan
Abstract: (Your abstract must use Normal style and must fit in this space)	Introduction: Our final goal is to design custom-fitted control for the torque-assisted bicycles based on the individual relationships between physical activity and the performance of a vehicle. Initially, we took ECG and surface EMG (SEMG) as biological data for thirteen normal subjects (20 ± 0.8 yrs) in addition to torque, speed, and cadence as the vehicle data. The result showed effective assist control by monitoring muscular activity while climbing and the power ratio of the respiratory sinus arrhythmia, pr_{RSA}, trial by trial for repetitive prolonged cycling exercise. Methods: An experimental set consisted of six consecutive trials with or without the motor torque assist and each trial comprised about 2.5 minutes of cycling followed by a 2-minute rest. The circuit path was approximately 840-m long and included a steep uphill section near the middle of the route. We represented the physical activity mainly by the time-frequency components of biosignals at each section with different path gradients, and then comparing them with the vehicle data. In practice, the time-varying behavior of pr_{RSA} was used to classify the physical activity into two types of states at each trial. Moreover, we focused on the difference in the short-term MPF of SEMG at the first and latter half of the first two strokes around the both ends of the corners while climbing. Results: In 67% of the total assist-on trials, pr_{RSA} demonstrated a temporal decrease while climbing and then recovered afterwards. Such a clear pr_{RSA} change did not appear in 68% of assist-off and 33% of assist-on trials, and remarkable muscular fatigue was observed just before the hilltop by the short-term mean power frequency of SEMG. Note that the two states were not distinguishable in the vehicle data. Discussion: It should be investigated further whether the lower torque and slower speed could create the prefarable state by torque-assisted bicycles, or whether the appropriate torque level would exist for individuals based on the physical work capacity. Besides, for customizing the control of torque-assisted bicycles, it would be preferable to combine objective and subjective indices.