

# Sensorimotor Synchronization and Man-Machine Interaction

Yoshihiro Miyake, Ph.D,

Guest Researcher, Human Wissenschaftliches Zentrum, Universitaet Muenchen  
&  
Associate Professor, Interdisciplinary Graduate School of Science and Engineering  
Tokyo Institute of Technology  
[miyake@dis.titech.ac.jp](mailto:miyake@dis.titech.ac.jp)

How to realize flexible cooperation between human and machine? This question could be replaced as follows. How to realize the synchronization between sensory process and motor process in man-machine interaction? However, conventional cybernetic approach did not give any answers to this problem, because its framework is based on the separation between sensory and motor dynamics, such as master-slave system.

On the other hand, some interesting facts have already clarified in mother-infant interaction. For example, Condon reported that "mutual entrainment" between mother speaking and baby's body motion is observed even in 2-day-old neonate, and a lot of similar phenomena were reported in adult's face-to-face communication. Base on these findings, I constructed some human support robots to realize flexible cooperation.

One example, Walk-Mate<sup>®</sup>, is shown in Fig.1 and is designed to support the walking of aged people. Everyone would have experience of synchronization of footsteps when you walked with someone. In this robotic system, footsteps of human are transferred to robot as a motor process and robot's footsteps are sent back to human's sensory system. These two paths are combined into one synchronized loop by using non-linear oscillatory dynamics equipped in the robot.

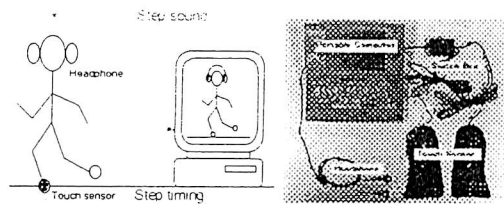


Fig.1 Walk Mate

Walk-Mate realizes "mutual adaptation" process. As shown in Fig.2, periods of walking rhythm are gradually coincided with each other after the start of interaction between human and robot.

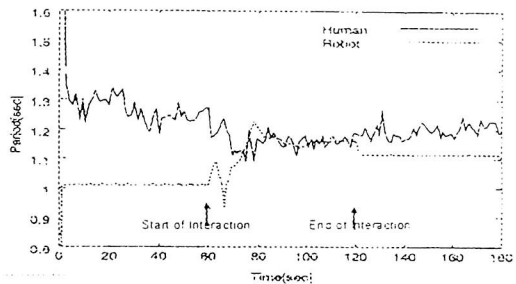


Fig.2 Mutual Adaptation

This is similar to mutual entrainment observed in mother-infant interaction, and this is the first example realized in artificial system.

In addition, development of walking pattern is also observed in this sensorimotor synchronization and both stability and flexibility are increased.

In Universitaet Muenchen, I'm studying sensorimotor synchronization in cooperative finger tapping as a simplest example of the above man-machine interaction, and its developmental process of tapping motion is analyzed base on the concept of Poeppel's temporal window and psychophysical methods.

Miyake, Y. & Miyagawa, T., "Internal observation and co-generative interface," Proc. of 1999 IEEE International Conference on Systems, Man, and Cybernetics (SMC'99), Tokyo, Japan, pp. I-229-I-237 (1999)