

Man-Machine Synergy Effector as Human Power Amplifier

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Man-Machine Synergy Effector (MMSE) is the concept of high-performance mechanical tools for human use, which are realized by introducing robotic technologies. MMSE makes it possible to perform conventionally impossible tasks by human alone or robot alone, because the system synergizes better assets of the both parties.

The hybrid approach of human and robot is the basic principle of MMSE. Then, what assets should be hybridized? And how? Brain-Machine interface? No. Not only that invasive techniques are controversial, but also we think the direct connection between human brain and machine body passing through human body will spoil the human experienced skill.

The hybridization in MMSE is based on the Man-Machine interface only through human body mechanics. The overview of the hybridization techniques is described.

Firstly, we focus on the hybridization of human operation and robot control. It is realized by human power amplification by robot. An important characteristic of this amplification is a force amplifying control based on force sensing, although almost all conventional exoskeletons are under trajectory control. The implementation of the force amplifying control is easy itself, but here the human and the robot are physically connected. This is a human-in-the-loop system. So the force amplifying control causes instability due to the positive feedback.

A technique to avoid the instability is proposed. We call this Virtual Power Limiter System (VPLS). VPLS monitors and limits the power flow between human and robot so that the human-in-the loop system never go unstable. By using VPLS, the force amplifying control is realized on MMSE.

Secondly, we focus on the bipedal walking of MMSE which has lower extremities. The human power amplification is also effective to the operation of lower extremities. But it is not enough. The dynamics of human operator with MMSE as a mechanical tool is quite different from the human body itself. Keeping balance while walking with MMSE is too difficult to do only by the human operation.

We need another hybridization of human operation and automatic balancing control for MMSE with lower extremities. This hybridization requires some techniques in terms of hardware and software. These techniques are also described.

This hybridization realizes the intuitive voluntary operation of powered MMSE by a human operator and the automatic balancing control on a pair of lower extremities simultaneously.

In this presentation, some developing prototypes of MMSE as power amplifying robotic tools are introduced. We will realize the human whole-body power amplifier in the very near future, so we need constructive collaborations with Egyptian academia and business to discuss how to take advantage of the cutting-edge robot technology in the Egyptian society.