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Title
HYSCOM Knee, a Prosthetic Knee Joint with Stance and Swing Control System Utilizing Compact MR Fluid Brake

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Summary
HYSCOM knee joint with stance and swing motion control system utilizing a developed compact MR fluid brake has been developed, and the details of the knee design and control system and the field walking test results on some individual TF amputees are reported.

Introduction
The author reported on a developed HYSCOM knee joint at the 12th ISPO Congress in Vancouver in 2007. The knee allowed TF amputees to select the three modes of Lock, Yielding and Free by the optional motion of leg utilizing a simple hydraulic cylinder and solenoid valves. So, the field walking tests showed that the HYSCOM knee allowed TF amputees to ascend and descend stairs and to go up and down a slope with a reciprocating gait. However, since this knee joint was not able to harmonize with some demands of amputees in some situations due to the simple control strategy, it was concluded that a more sophisticated and precise control system was required for the knee joint.

In this research, a developed compact MR fluid brake, some sensors and computer control system has been installed to the HYSCOM knee instead of the hydraulic cylinder and solenoid valves, in order to improve the control performance.

Methods
A compact MR rotary brake of multi-disks type using magnetorheological(MR) fluid, which can be changed their rheological properties in a reversible manner by applying magnetic field, has been designed and developed to satisfy patient’s demands using a magnetic field analysis. The new knee joint utilizing the developed MR fluid brake has several sensors; the first one is put above the knee axis which detects A-P movements, the second senses knee angular, and the
third one is put on the lowest part of the joint and measures the vertical loads. These data are taken in to a laptop computer through a cable and calculated according to a control strategy. And then, adequate voltages are given to the MR fluid brake to harmonize with individual situations.

Results
The developed MR brake performed enough braking torque to adjust the resistances for individual situations. Although the HYSCOM MR knee system has been tested in the labor and not on the field, it enabled TF amputees to ascend and descend stairs and go up and down a slope very smoothly with a reciprocating gait. It was even better than the previous model. Also this MR knee system enabled us very easily to change the program and to let adjust precisely the resistances for individual situations.

Conclusion
This trial evaluation has proved the MR fluid brake + laptop computer system has enhanced the adjustability and helped to optimize patients walking on stairs. It is also found that it is very important to select a proper protocol for collecting all the data and calculating the knee control resistance values to optimize patients walking. It means that now we have a possibility to construct a good program that makes progress in patients ADL especially in tough situations such as on stairs, ramps or with obstacles.

References
Hikichi Y : Pilot Production of HYSCOM#HYdraulic Stance phase Controlled by Optional Motion#knee , Bulletin of the Japanese Society of Prosthetics & Orthotics : 147-153 Vol.22 No.3 2006
Image: fig2_None.JPG

HYSCOM knee

Sensor interface

DC/AC converter

Laptop computer