

## P406 - CONCEPTUAL DESIGN OF THE 2ND ITERATION OF BART LAB LL-EXO

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### INTRODUCTION

The patients, who had the spinal cord injury (SCI) at L3, cannot control their lower limb parts. They had to use a wheelchair for moving however the infrastructure in many countries is not support enough for the wheelchair. In addition to the support of wheelchair problems, patients have to spend more time and money to treat them for the pressure sore and joint stiffness. The BART LAB Lower Limb Exoskeleton (BART LAB LL-EXO) was introduced and developed for solving those problems.

The BART LAB LL-EXO is an ongoing project. The 1<sup>st</sup> iteration was proposed. The robot was developed for group of patients who cannot control their knee and ankle. The patients have to attaching the BART LAB LL-EXO1 suit with their leg and operate by swung their hip as normal when they want to walk. However the robot has the limitation, a little bit heavy with only walking function [1]. The BART LAB LL-EXO1 is shown in Figure 1.



Figure 1: BART LAB LL-EXO1 [1]

Moreover, the medical consult and the survey result from group of people such as patient, doctor, physiotherapist, prosthetist and orthoptist [2] show that in many case patients also cannot control their hip and more functions are requested for the daily life.

The 2<sup>nd</sup> iteration, BART LAB LL-EXO2, was designed to improve the performance and met requests from the survey [2]. The robot consists of 4 functions (walk, turn left/right, sit to stand and stand to sit) and be operated by EEG and EOG signals to serve patients daily life.

### Conceptual Design

To improve the robot performance, the limitation of 1<sup>st</sup> iteration and survey result are concerned and analyzed. The analyzed result shows that the robot function and the active

joints are not fit with the real patient condition, SCI at L3 condition is also effect to the hip movement. And also the ranges of motion of each robot joint are not covering the new robot functions. Thus, the BART LAB LL-EXO2 was designed and developed to fit with those new requirements. To fulfill them, the robot will consist of 10 DOFs, 6 DOFs are main active joints with the torque compensation mechanisms to perform walk, sit to stand and stand to sit, 2 DOFs are also active joints without the compensation mechanism to perform the turn movement and the less are passive joints for a body balance. The robot is operated by a user brain signal and eyes movement in term of the EEG and EOG signal, respectively. The conceptual design of the 2<sup>nd</sup> iteration is shown in Figure 2.

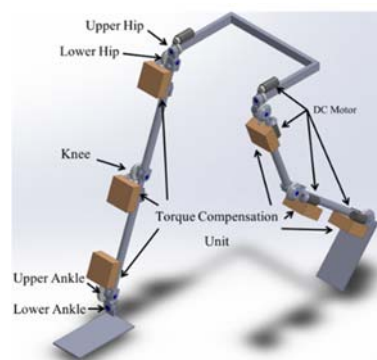


Figure 2: the conceptual design of BART LAB LL-EXO2

### CONCLUSION

The robot is re-designed to fit with the new information and survey result and reduce the overall weight of the robot. The robot performance is improved to fit with the patient condition and daily life. Next step the robot will design in detail by the CAD program and build up for testing.

### ACKNOWLEDGEMENTS

This project is full-financially supported by the National Research Council of Thailand. The medical consult and leg model are supported by the Sirindhorn School of Prosthetics and Orthotics, Faculty of Medicine Siriraj Hospital, Mahidol University. Authors would like to thank all BART LAB members.

### REFERENCES

1. Banchadit W, et al. Design and implementation of a new motorized-mechanical exoskeleton based on CGA patternized control, Guangzhou, China, Proceedings of the 2012 IEEE International Conference on Robotics and Biomimetics (ROBIO 2012), 2012.
2. Rayootee P, et al. Requirement and recommendation for development of new assistive device in spinal cord injury patient (SCI): A baseline study, Lyon, France, ISPO World Congress 2015, 2015.