Preliminary research of the Locomotion mode recognition based on Data driven method

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***Abstract*—Locomotion mode recognition for hip exoskeleton robot is a technique to use in various environments. Hip exoskeleton robot has been used the simple model and limited sensors. It has limitation in understanding user intentions and is difficult to use in various environments. To solve these problems, we need to approach the data driven method. In this study, we use the Artificial Neural Network (ANN) considering real-time data, high accuracy, and fast computations. We were able to achieve 97.6% accuracy using dropout method.**

***Index Terms*—Locomotion mode recognition, Hip exoskeleton robot, Data driven method, Deep learning**

I. Introduction

As an aging society, the elderly population is increasing rapidly. The elderly person loses their functional performance as they get older [1]. Many hip exoskeleton robots have been developed to support a person's mobility. Locomotion mode recognition for hip exoskeleton robots is an important technology to use activities of daily living in variety of environments [2]. But hip exoskeleton robot has limitation sensors usage and use a simple model. These make it difficult to understand user intention in various environments. We hypothesis is that the Deep learning method will solve the above problems and use available in real-time.

In the related research, Samsung uses the Locomotion mode recognition using Support Vector Machine (SVM) in five terrains (level walking, stair ascent/descent, ramp ascent/descent) [3]. To increase the locomotion mode recognition performance, we need to approach the data-driven method. Therefore, we propose to use Artificial Neural Network (ANN) considering real-time data, high-accuracy, fast computation.

II. Methodology

To decide the essential sensor usage for hip exoskeleton robot, we analyzed the gait for five terrains (level walking, stair ascent/descent, ramp ascent/descent). Based on result of the gait analysis at each terrain, selecting the sensors and using the hip exoskeleton robot (Figure 1-C), we detected the data at gait platform (Figure 1-B) from hip and ankle joints as shown in the Figure 1-A. Common initial contact has been occurred at foot-flat and toe-off. We set this common point as input data, the class of 5 terrains by labeling as output data and selected the ANN model with dropout method considering the suitable conditions. The ANN model was trained and tested by using with dropout method as shown in the Figure 2-A, B and C.

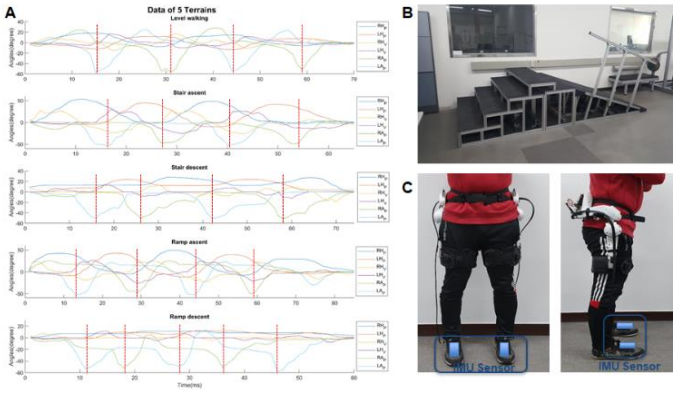
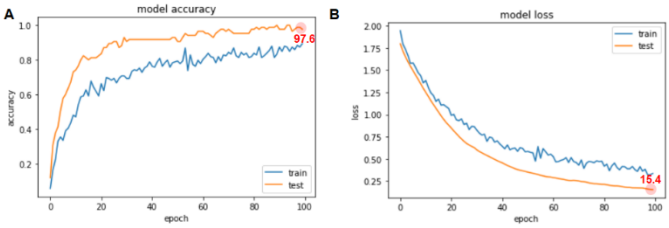


Fig. 1. A - Gait data analysis for five terrains (downward direction - level walking, stair ascent, stair descent, ramp ascent, ramp descent) (red line - Initial contact point), B – The gait platform, C – Example of the hip exoskeleton robot (front and side)



C

		Predicted Class				
		LW	SA	SD	RA	RD
Actual Class	LW	10				
	SA		12			
	SD	1		22		1
	RA				14	
	RD					25

Fig. 2. A – Accuracy with dropout method, B – Loss with dropout method, C – Confusion matrix w/o normalization at each terrain

III. Results and Discussion

The proposed method has an accuracy of 97.6% and a lower rate loss of 15.4 % using dropout method at each terrain. In the future, we need to add more gait data, and to use the model in real-time, we need to find a model that allows for faster calculation method.

References

[1] Bonder, Bette R., and Vanina Dal Bello-Haas. Functional performance in older adults. FA Davis, 2017.

[2] Martinez-Hernandez, Uriel, Imran Mahmood, and Abbas A. Dehghani-Sanij. "Simultaneous Bayesian recognition of locomotion and gait phases with wearable sensors." IEEE Sensors Journal 18.3 (2017): 1282-1290.

[3] Jang, Junwon, et al. "Preliminary study of online gait recognizer for lower limb exoskeletons." 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2017.