

## [제목]

Hello, this is Han Jaewoong, team 4. I will present about our topic, trajectory prediction for lower limb exoskeleton robots.

## [Contents]

The table of contents is as follows.

## [1. Backgrounds]

First, let's talk about the definition of cerebral palsy and exoskeleton robots.

Exoskeleton robot is Powered devices that attach around and to a human body and contain actuators that deliver mechanical power to aid movement.

Cerebral palsy is a group of disorders that affect a person's ability to move and maintain balance and posture (In Korean, 뇌성마비)

As exoskeleton robotics research continues to advance, lower limb exoskeleton robots are being applied to rehabilitate CP walker.

### [2. Problem statement]

Our objective is using Deep learning model to create a reference trajectory for the hip joint angle that adaptive to the patient's actual gait.

Since the reference trajectory of the existing lower limb-exoskeleton robot uses the cubic interpolate function, the following problem occurs.

Firs, it's not like a real human gait.

Second, cannot respond to various variable that exist in the walking process.

Lastly, cannot create a reference trajectory that is adaptive for the user.

As you can see in this figure, the reference trajectory of this exoskeleton robot is quite different from the TD walkers.

### [3. Data]

So, we use open biomechanical datasets provided by Georgia tech, EPIC.

Here, we used the Goniometer and IMU datasets.

This biomechanical data set consists of 25 TD walkers walking on level ground, containing about 250 sequences of walking at normal, slow and fast speeds.

### [4. Models]

Now, I'll talk about our model structure.

Our deep learning model consists of current gait phase estimation model, and hip joint angle prediction.

And we used the TSAI library, which is a collection of SOTA deep learning for time series.

Now, let's explain each model in detail.

#### <4.2 Current Gait phase estimation>

Current gait phase estimation model is a time series model to estimate gait phase from gait data of CP.

The value of gait phase is from 0 to 100 based on heel strike.

However, this value is discontinuous, so we replaced it with polar coordinates to remove the discontinuity and predict the gait phase.

The estimation model takes biomechanical data such as hip joint angle and IMU as inputs, and uses them to predict the gait phase.

The result is the following.

#### <4.3 Hip joint angle prediction>

Hip joint angle prediction model is a forecasting model to predict the hip joint trajectory of normal walking and uses it as a reference trajectory.

The prediction model generates a reference trajectory based on biomechanical data and gait phase predictions from the previous estimation model.

Gait phase is a value that as a sort of x-axis, indicating how far along the reference trajectory we are.

Here's the result.

[To do]

So, we already made the structure as I showed earlier.

From now on, we need to do parameter tuning, preprocessing datasets, data augmentation, and lastly, combine both models.

Thank you for listening.