Trajectory Prediction for Lower Limb Exoskeleton Robot

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Contents

1. Backgrounds

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1.1 The Definition of Cerebral Palsy and Exoskeleton Robot

- Exoskeleton Robot: Powered devices that attach to and around the human body, containing actuators that deliver mechanical power to aid movement
- Cerebral Palsy(CP): A group of disorders that affect a person’s ability to move and maintain balance and posture (In Korean, 뇌성마비) (↔ TD)

As research in exoskeleton robotics continues to advance, lower limb exoskeleton robots are being applied for the rehabilitation of CP walkers.

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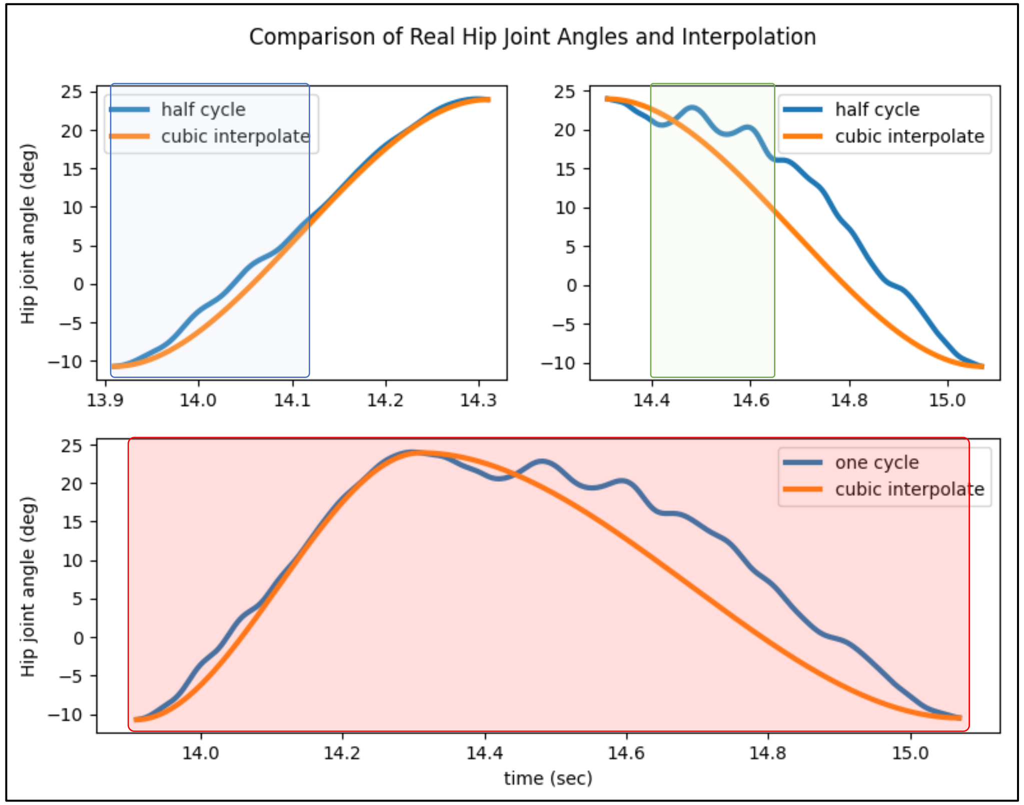
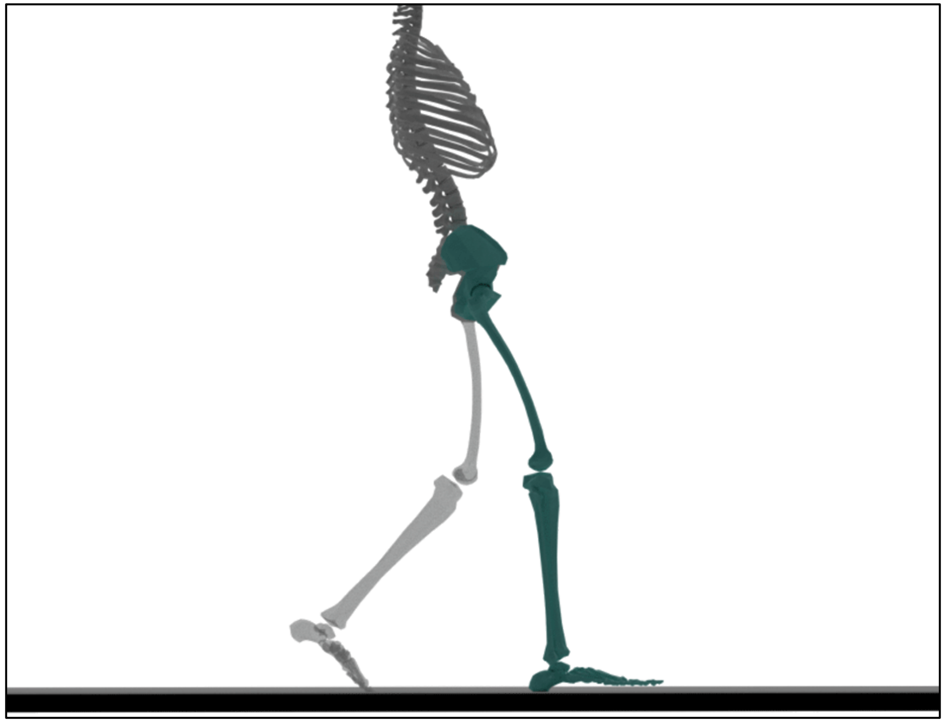
- **Objective: Use a Deep learning model to create a reference trajectory for the hip joint angle that adaptive to the patient's actual gait.**

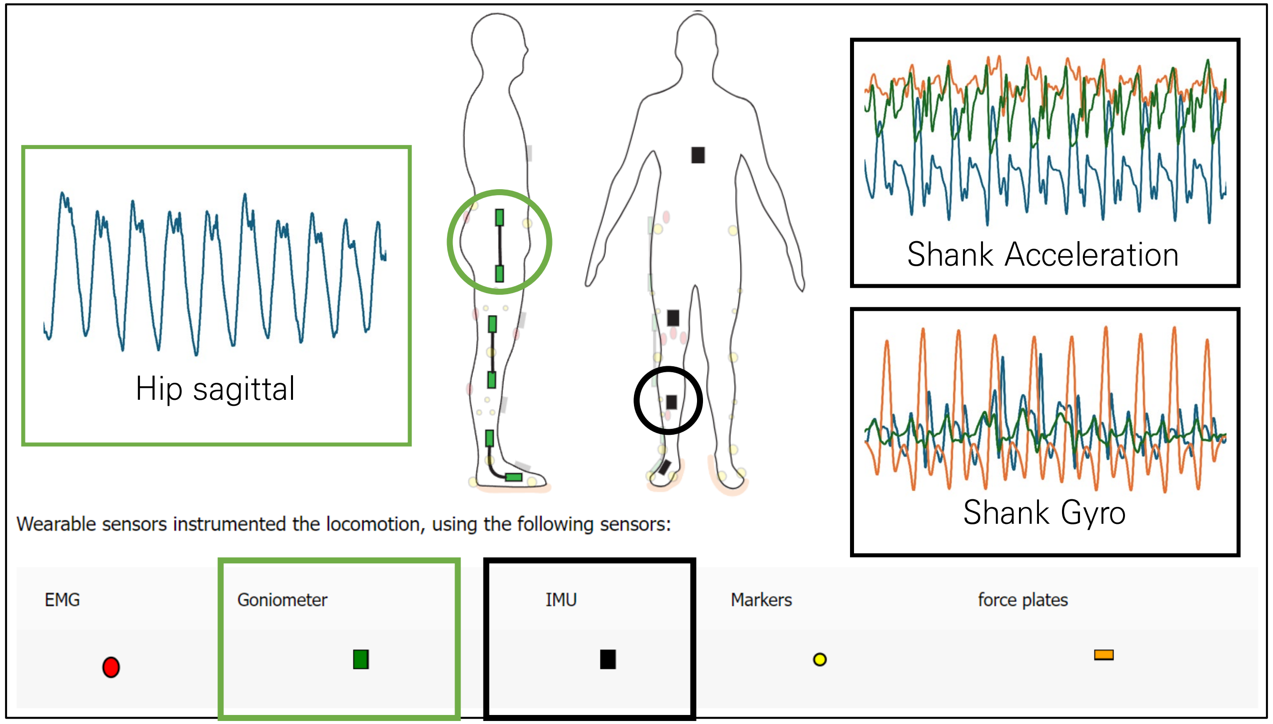
- Existing problem: The existing lower limb-exoskeleton robot uses the *cubic interpolate function* as the reference trajectory for hip joint angle.
  - Different from real human gait.
  - Cannot respond to various variables that exist in the walking process
  - Cannot create a reference trajectory that is adaptive for the user.



Open (biomechanical) datasets

- Use open datasets provided by Georgia Tech, EPIC (Exoskeleton & Prosthetic Intelligent Controls)
- Biomechanical datasets consist of 25 TD walkers walking on level ground
- Containing about 250 sequences of walking at normal, slow, and fast speeds



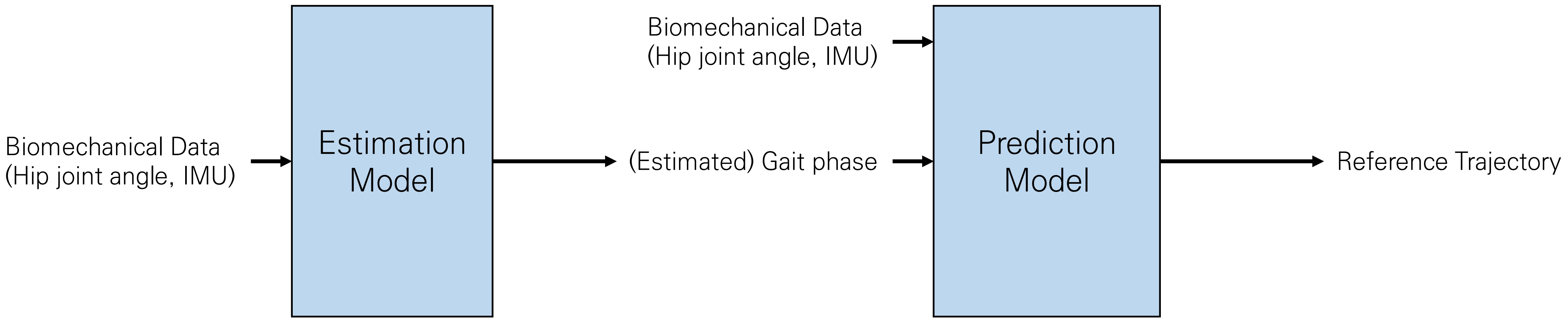


4. Models

4.1 Structure

Part 1: Current gait phase estimation

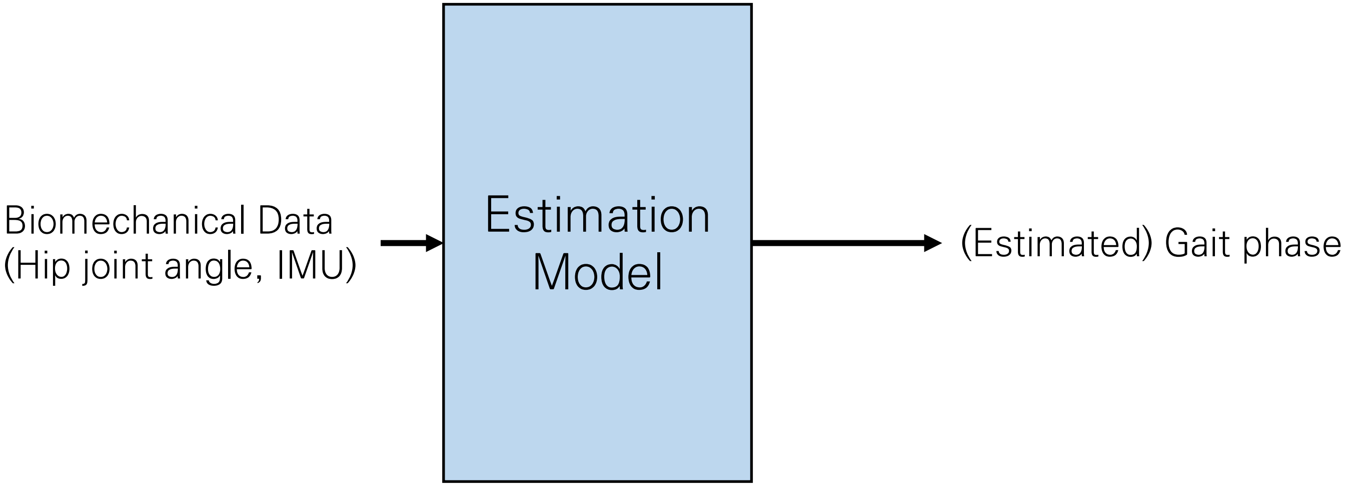
Part 2: Hip joint angle prediction

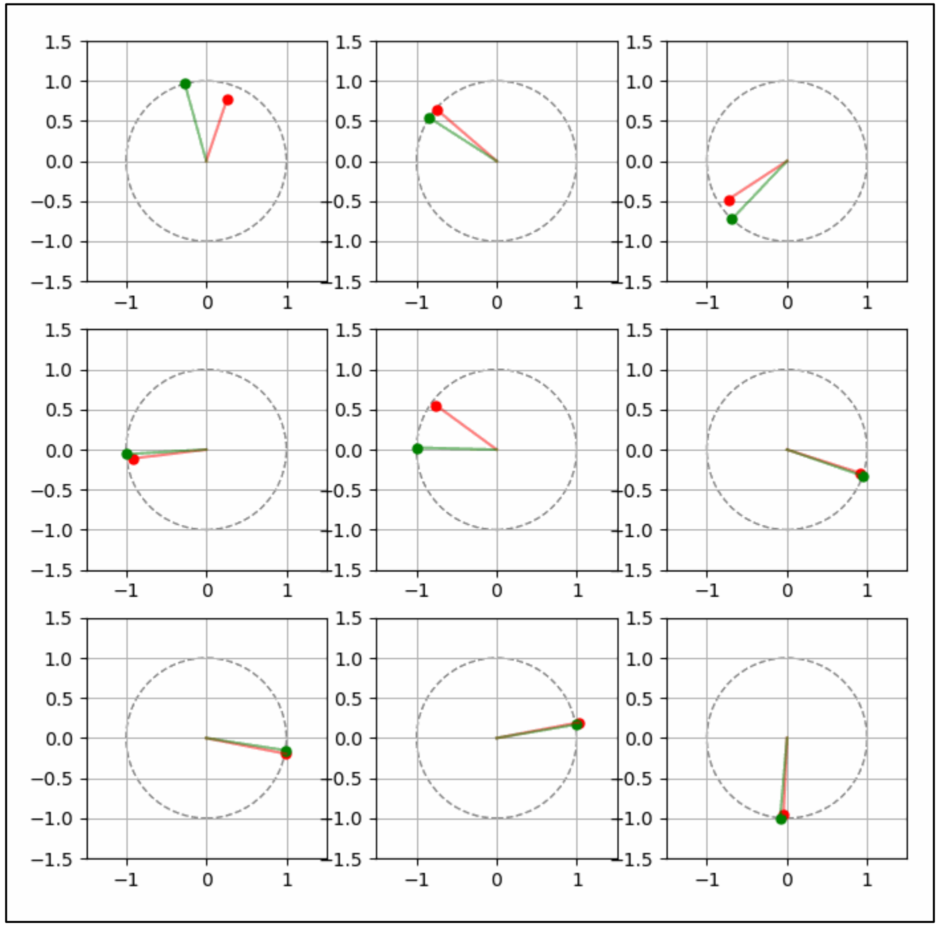


4. Models

4.2 Current gait phase estimation

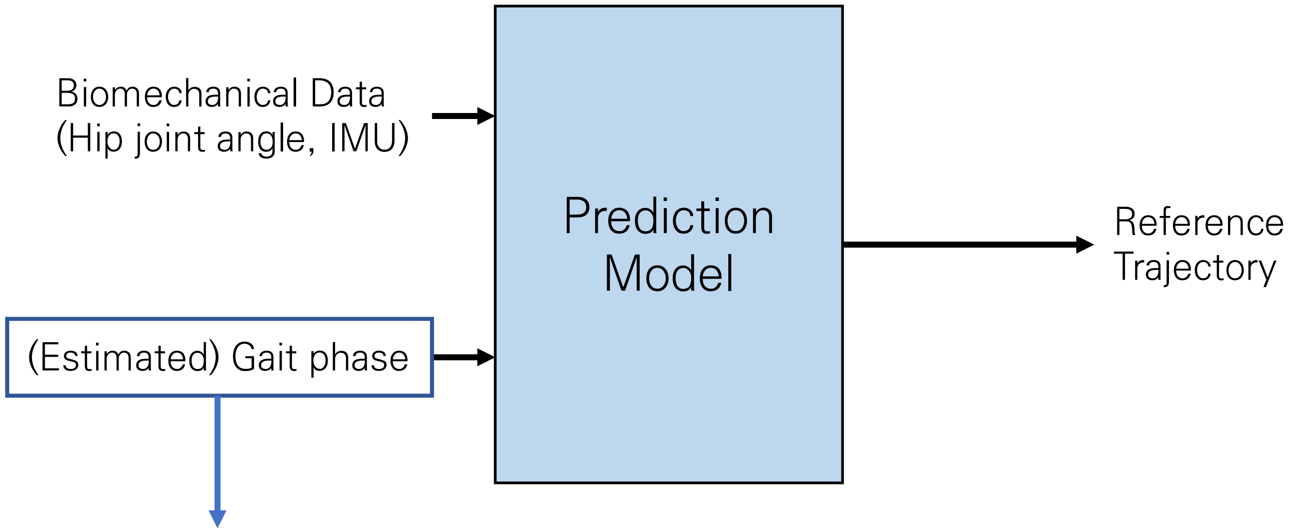
- A time series model to estimate the gait phase from CP gait data.
- Value range from 0 to 100 based on heel strike(HS)
  (Generally, the ground truth value is generated using FSR)
- Discontinuous ⇒ converted to polar coordinates during training and inference.



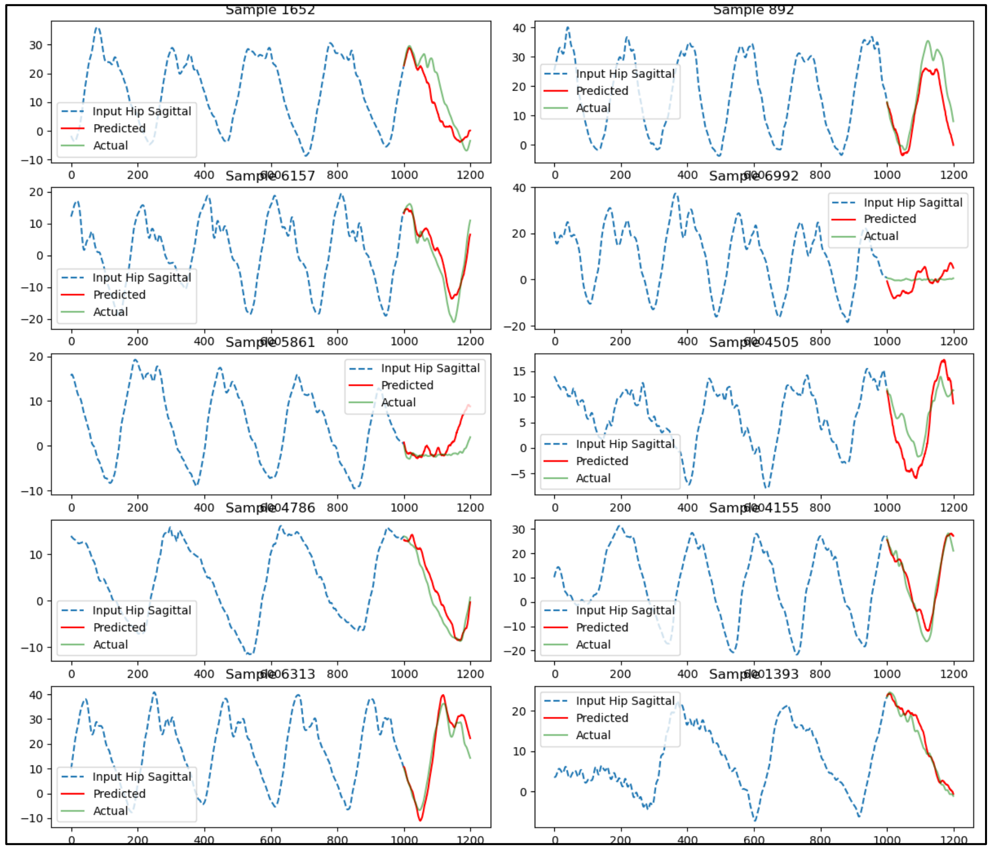


4.3 Hip joint angle prediction

- Forecasting model to predict the hip joint trajectory during normal walking and to use it as a reference trajectory



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



5. To do

- Parameter tuning
- Preprocessing datasets (For now, we use a temporary datasets)
- Data augmentation
- Combine both models

Thank you