WalkMate

Module 2
Subject Phase Input

Module 1
Phase Control

Module 3
Motor Torque Output

Mutual Entrainment

\( \theta_h \) = Human input phase

\( \theta_m \) = Motor output phase

\( \tau_m \) = Motor output torque

\( \omega_m \) = Motor intrinsic angular frequency

\( \Delta \theta_m = \theta_h - \theta_m \)

\( \Delta \theta_d \) = Target phase difference

\( \Delta \theta_{m,r} = \theta_{h,r} - \theta_{m,r} \)

\( \Delta \theta_{m,l} = \theta_{h,l} - \theta_{m,l} \)

Update left upper-limb phase

Update right upper-limb phase

Left upper-limb phase, \( \theta_{bl} = 0 \)

Right upper-limb phase, \( \theta_{br} = 0 \)

Update left upper-limb & motor phase difference, \( \Delta \theta_{ml} \)

Update right upper-limb & motor phase difference, \( \Delta \theta_{mr} \)

Update left upper-limb motor intrinsic angular frequency

\( \omega_{ml}(n+1) = \omega_{ml}(n) + \varepsilon \sin(\Delta \theta_{ml} - \Delta \theta_d) \Delta t \)

Update right upper-limb motor intrinsic angular frequency

\( \omega_{mr}(n+1) = \omega_{mr}(n) + \varepsilon \sin(\Delta \theta_{mr} - \Delta \theta_d) \Delta t \)

Update left & right upper-limb motor phase

\( \theta_{ml}(n+1) = \theta_{ml}(n) + \{ \omega_{ml} + K \sin(\theta_{ml}(n) - \theta_{ml}(n)) + K \sin(\Delta \theta_{ml}) \} \Delta t \)

\( \theta_{mr}(n+1) = \theta_{mr}(n) + \{ \omega_{mr} - K \sin(\theta_{mr}(n) - \theta_{mr}(n)) + K \sin(\Delta \theta_{mr}) \} \Delta t \)

Terminate motor by operator or end-user

Stop