Translate Walk in Place to Forward Virtual Motion

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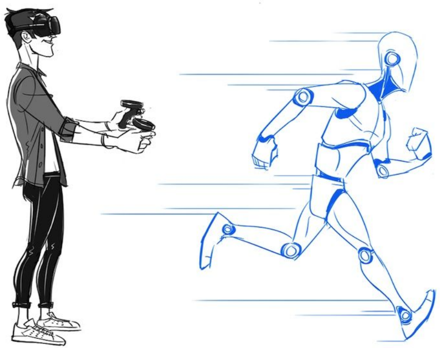
Project Goal



- Virtual travel is one of the fundamental interactions in XR. However, the physical space is often smaller than the virtual space, breaking user immersion.
- People unconsciously exhibit many other motions when walking
  - Head bobs
  - Arm swings
  - Blinks
- Can we measure these biomechanics to accurately predict walking speed on a treadmill and translate them into realistic virtual locomotion?

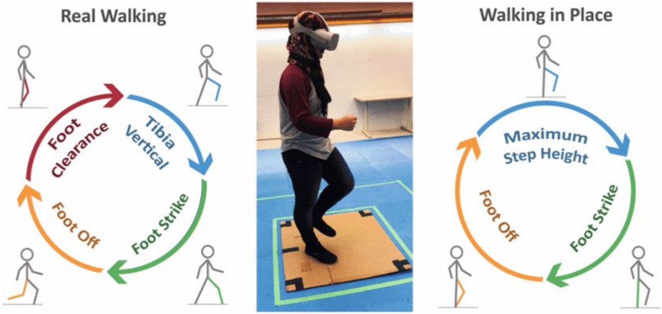
Motivation

- Alternative locomotion methods (controllers, teleportation, lean-directed steering) impose a higher cognitive load than regular walking
- Consider fitness apps - how can we make the user feel as if they are actually walking or running in the real world when they are on a treadmill?
- Full body tracking is expensive and inconvenient
- We have yet to see a commercially viable solution that is able to replicate the experience of real walking within a limited physical space

Challenges

- Biggest hurdle is that we are limited to headset and controllers. Without access to leg tracking, how can accurately can we predict how fast the user is walking?
- Non-trivial conversion of biomechanics (head tracking and controller tracking) to walking speed

Current State of the Art



- On the Usability of Consumer Locomotion Techniques in Serious Games: Comparing Arm Swinging, Treadmills and Walk-in-Place (Calandra et al., 2019)
  - Compares arm swinging, the KATWalk treadmill and the walk-in-place
  - Arm swinging resulted as significantly better in terms of easiness than KAT
- Improving Walking in Place Methods with Individualization and Deep Networks (Hanson et al., 2019)
  - Used precise head motions to detect virtual step gaits
  - Found that a trained convolutional neural network can be an effective way of implementing walking in place in terms of judged distance to actual distance
  - Very similar to what we are trying to do but without treadmill

Methodology

- Generate a virtual environment with a long straight path
- Collect walking data for different speeds
  - head positions
  - left and right controller positions
- Feed data into a convolutional neural network (or any supervised machine learning model) and train the model
- Run the model in VR to simulate forward walking
- Collect metrics comparing predicted velocities to actual velocities

Timeline

Midpoint - 4/19/24

- Create a mock environment that renders in headset
- Begin data collection on treadmill
- Have a crude algorithm that calculates speed based on given data

Final - 5/10/24

- Collect all the necessary data
- Finished training the velocity prediction model
- Have a working prototype with demonstration of program adapting to different walking speeds

Future and Long Term

- User studies on how accurate the predicted velocities are and the amount of motion sickness they experience
- Can leg tracking, heart rate monitors, and breath tracking further improve accuracy?
- Allow user to interact with environment while walking
- Extend the scope
  - support turns
  - handle both walking and running - should they be handled differently?
  - adapt to different users
  - work on bicycles or other machines

References

D. Calandra, F. Lamberti and M. Migliorini, "On the Usability of Consumer Locomotion Techniques in Serious Games: Comparing Arm Swinging, Treadmills and Walk-in-Place," 2019 IEEE 9th International Conference on Consumer Electronics (ICCE-Berlin), Berlin, Germany, 2019, pp. 348-352, doi: 10.1109/ICCE-Berlin47944.2019.8966165. keywords: {Virtual Reality;Human-Computer Interaction;locomotion;user experience;evaluation},

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