Fusion of Leap Motion and Kinect Sensors for Improved Tracking for VR Applications

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Motivation

Leap Motion Sensor

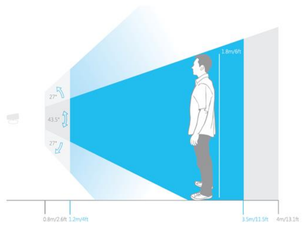
Pros	Cons
Accurate tracking and gesture recognition	Poor Range
Moves with user thereby avoiding occlusions	Can only see in front of user

Kinect

Pros	Cons
Large range	Poor accuracy and noisy tracking
Sees the user's full body and surroundings	Tracking effectiveness dependent on orientation

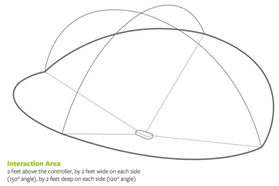
Method

Kinect

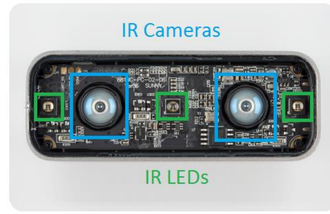


- Tech: IR Depth Camera, Color Camera, IR Illumination Array
- Range: 1.2m to 4m
- FOV: Hor. 57˚, Ver. 43˚
- Position: Placed in Front of User

Leap Motion



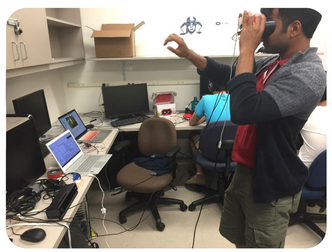
- Tech: 3 IR LEDs, 2 IR Cameras
- Range: 0.6m
- FOV: Hor. 150˚, Ver. 120˚
- Position: Placed on HMD



VR Application

Requirements: input for controlling objects
Solution: 3D Angry Birds
Input: velocity of right hand & trigger gesture

Tracking Algorithm



Trigger Event:
Open palm detected by either Leap Motion or Kinect

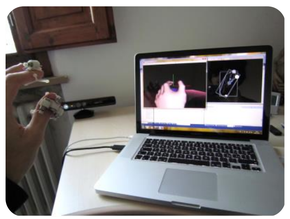
Velocity Tracking:
Weighted average of the frame-by-frame velocity provided by each sensor. Weighting based on confidence level of data provided by sensor.

Related Work

Previous Tracking Applications

Leap Motion controlling robotic hand [1]

Improving the stimulation of wearable haptic devices. [2]



Evaluation of Tracking

The tracking of both devices has also been evaluated, leading to the following conclusions:

- Kinect sensor:
  - Errors up to 2cm for static frame [3]
  - When user becomes perpendicular to Kinect, tracking breaks down. [3]
- Leap Motion:
  - Dynamic tracking errors of below 1.2mm [4]
  - As object exceeds distance of 250mm away from sensor, errors increase drastically [5].

References

[1] Bassily, D., et al. "Intuitive and adaptive robotic arm manipulation using the leap motion controller." *ISR/Robotik 2014; 41st International Symposium on Robotics; Proceedings of.* VDE, 2014.
[2] Frati, Valentino, and Domenico Prattichizzo. "Using Kinect for hand tracking and rendering in wearable haptics." *World Haptics Conference (WHC), 2011 IEEE.* IEEE, 2011.
[3] Obdrzalek, Stepan, et al. "Accuracy and robustness of Kinect pose estimation in the context of coaching of elderly population." *Engineering in medicine and biology society (EMBC), 2012 annual international conference of the IEEE.* IEEE, 2012.
[4] Weichert, Frank, et al. "Analysis of the accuracy and robustness of the leap motion controller." *Sensors 2013.* 13.5, 2013: 6380-6393.
[5] Guna, Jože, et al. "An analysis of the precision and reliability of the leap motion sensor and its suitability for static and dynamic tracking." *Sensors, 2014.* 14.2 2014: 3702-3720.