A LOW-COST MOTION CAPTURE SYSTEM FOR BODY TRACKING USING SYNCHRONIZED AZURE KINECT SYSTEMS

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SIGGRAPH THINK BEYOND
2020 19-23 JULY WASHINGTON DC

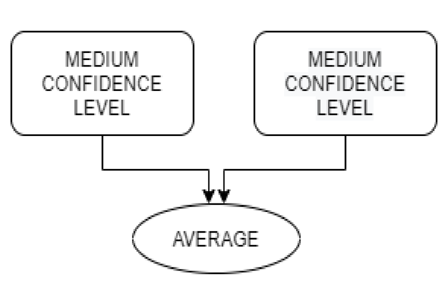
PROBLEM

- Setting up a motion capture environment for human pose analysis is typically very costly (6-figures) and restricted to a fixed lab space. In addition, we often encounter optical occlusion due to overlapping objects.
- We extend the Azure Kinect DK's capability to track body joints by synchronizing multiple devices to mitigate the effects of occlusion and illumination at a much lower cost and with portability.

METHOD

- We leverage the body data from all devices to output more precise joint estimates.

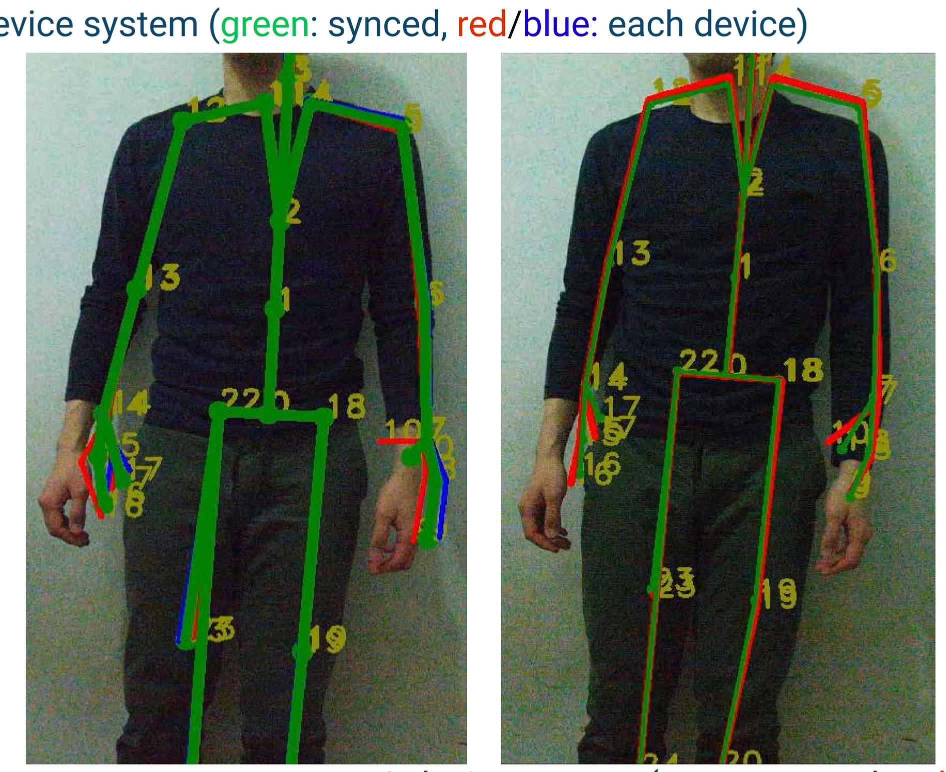
1. Configure devices in daisy-chain method (RS-232)
2. Track joints from each device
3. Compute average of the joint positions from all devices
4. Transform positions from subordinate mode devices onto master device RGB camera space
5. Project 3-D points onto 2-D display window



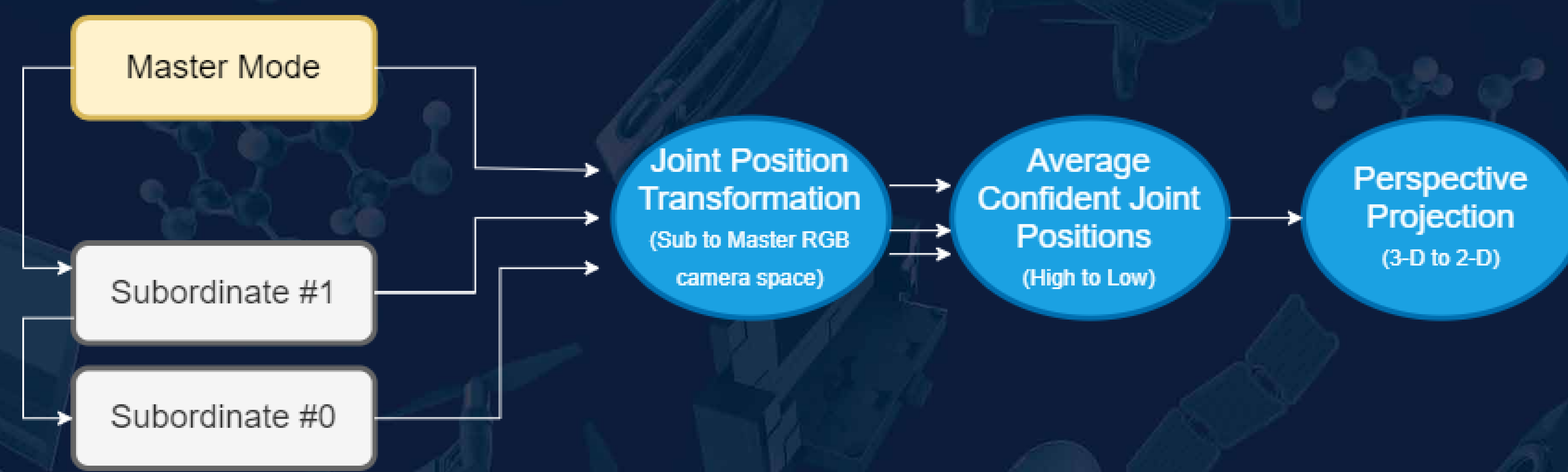
RESULTS

Synced estimation falls in between the estimated positions from each device. Caveat: varies largely by environment and posture.

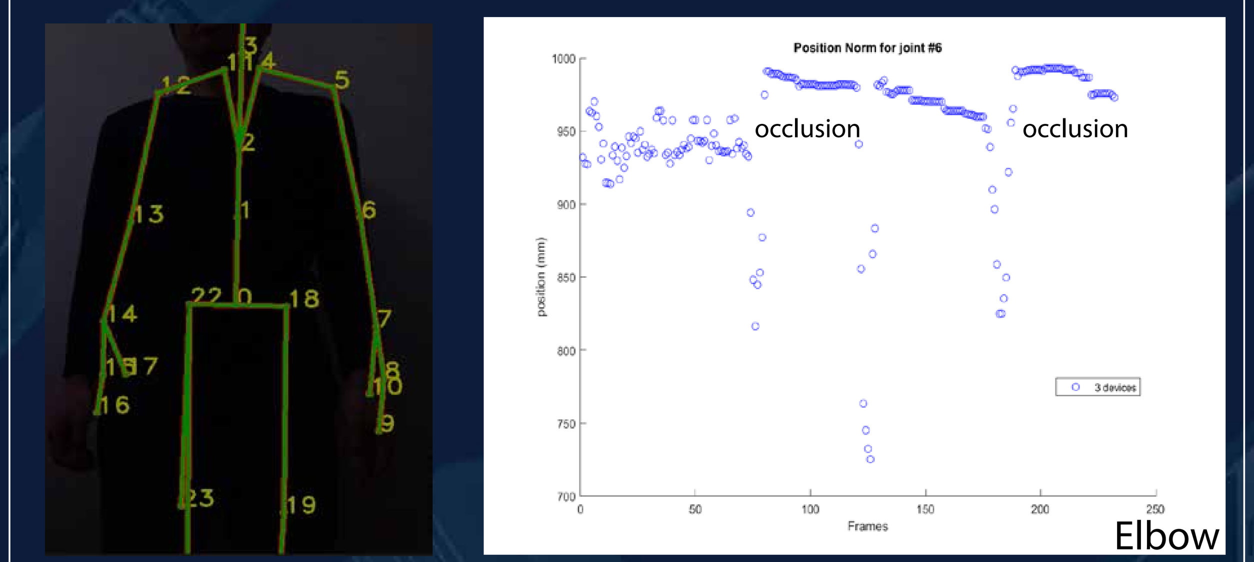
2-device system (green: synced, red/blue: each device)



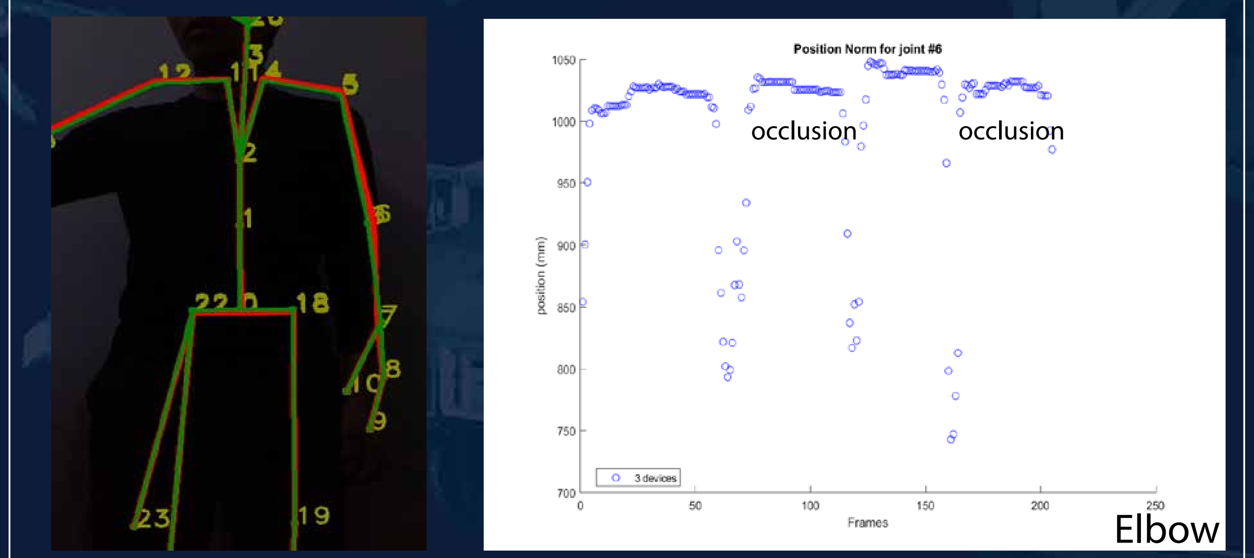
3-device system (green: synced, red: single)



Consistent Positions in Occlusion
(Multi-Device System)

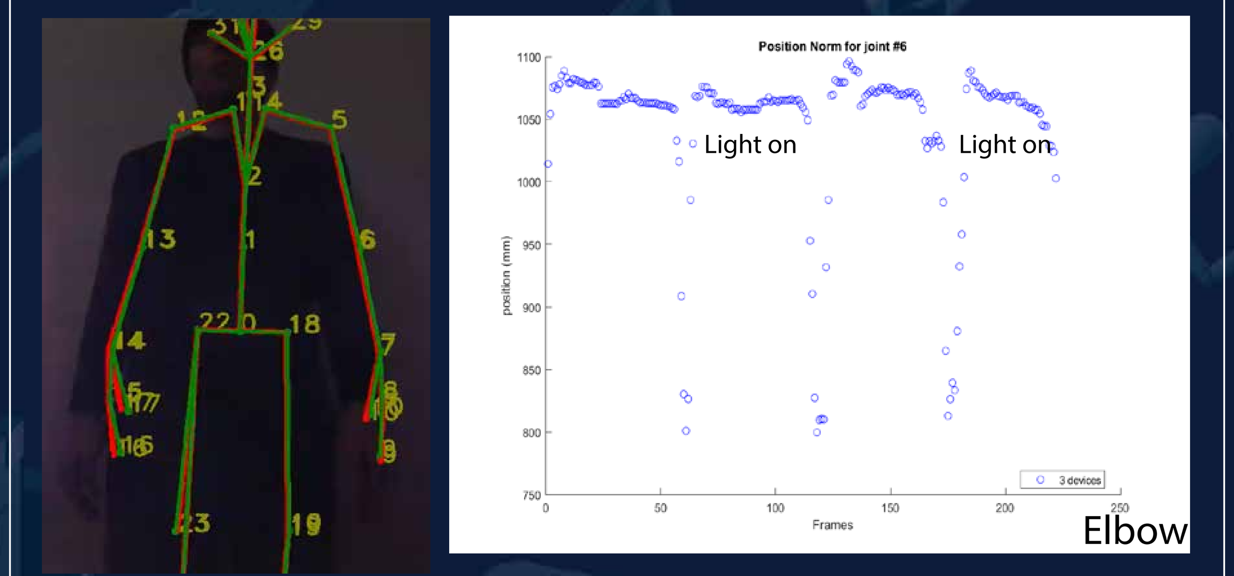


Sub #0 Occluded



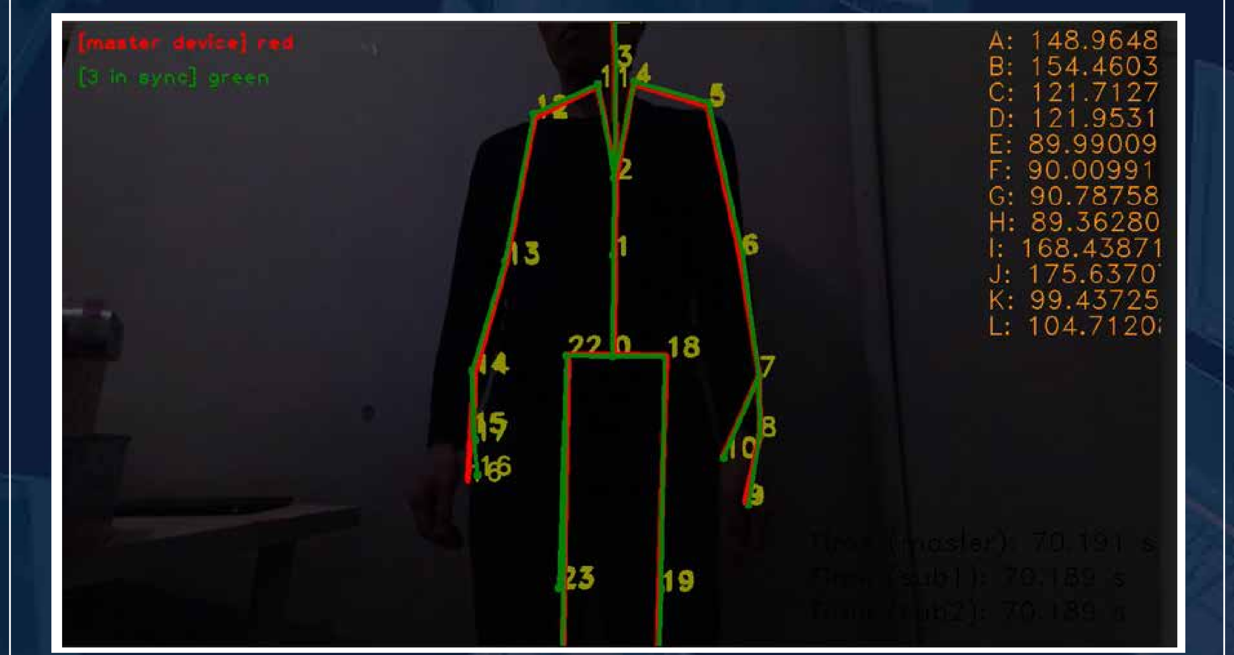
Sub #1 Occluded

Consistent Positions in Different Illumination
(Multi-Device System)



Light Directed Toward Master

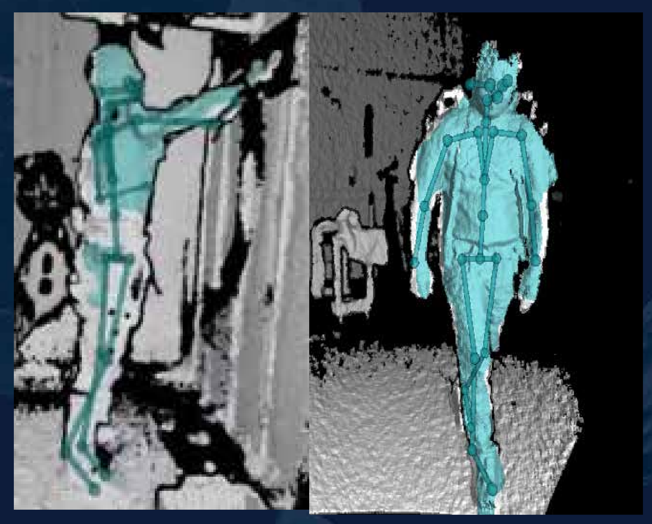
Joint Angle Estimation



Future Applications

Human Body-Controlled Drone Tracking

Graphical Figure



Gait Analysis (Exoskeletons)

APPROACH

- Our approach solves the problem of optical occlusion and illumination effects in body joint tracking. We calibrate each pair of Kinects using joint data from exintrincs computed by least-squares fitting of two 3-D positions [1].
- The final estimated joint positions is selected by the confidence of each Kinect, from high to low. If there are multiple devices with the same level of confidence, the average is output. Then these 3-D points are projected onto display by perspective projection.

RELATED WORK

- Islam *et al.* uses joint angle estimates from a single Kinect v2 to recognize a certain Yoga posture. They base their error on a reference model developed from joint data of gymnastics. We differ in that we utilize multiple devices to minimize angular distances of joints and increase accuracy in case of an occlusion.
- Napoli *et al.* compares joint angles calculated from Kinect (v2) positions and orientations with a professional motion capture system (Qualisys) at various postures and planes. Similarly, we extend this to a multi-device system for higher accuracy.

FUTURE DIRECTIONS

- Code optimization in time delay (currently ~ 1 sec).
- Validation with other MOCAP systems in market.
- This generalized low-cost motion capture system can be applied to the exoskeleton gait analysis study at NIST to provide more precise measurements of joints.
- Human body-controlled graphical media art and drone control applications using unobstructed, precise human body joint data from this synchronized system.

REFERENCES

[1] Arun, K.S. & Huang, T.S. & Blostein, Steven. (1987). Least-squares fitting of two 3-D point sets. IEEE T Pattern Anal. Pattern Analysis and Machine Intelligence, IEEE Transactions on. PAMI-9. 698 - 700.

[2] M. U. Islam, H. Mahmud, F. B. Ashraf, I. Hossain and M. K. Hasan, "Yoga posture recognition by detecting human joint points in real time using microsoft kinect," 2017 IEEE Region 10 Humanitarian Technology.

[3] Napoli, Alessandro, et al. "Performance Analysis of a Generalized Motion Capture System Using Microsoft Kinect 2.0." Biomedical Signal Processing and Control, vol. 38, 2017, pp. 265–280.

CODE MAINTAINED AT
https://github.com/andyj1/kinect