Human-Robot Interaction based on gestures

Seminar on Mobile Robotics 2020/21

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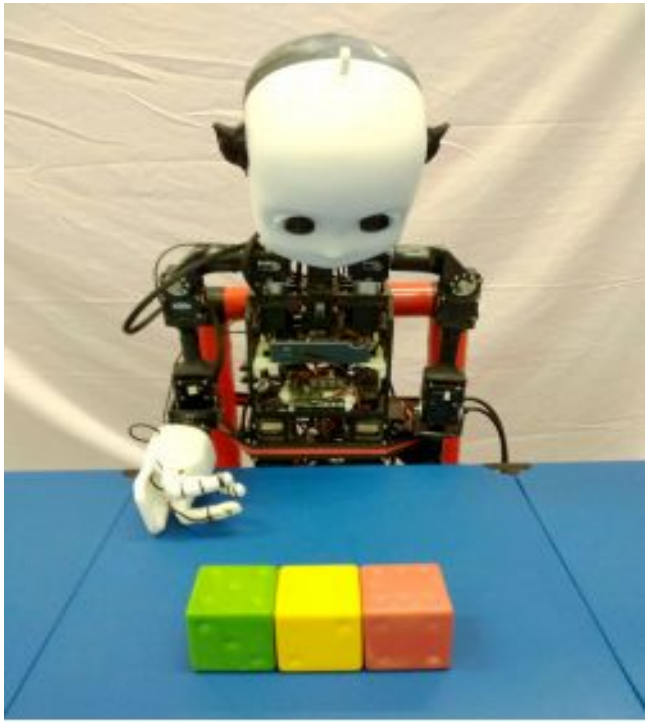
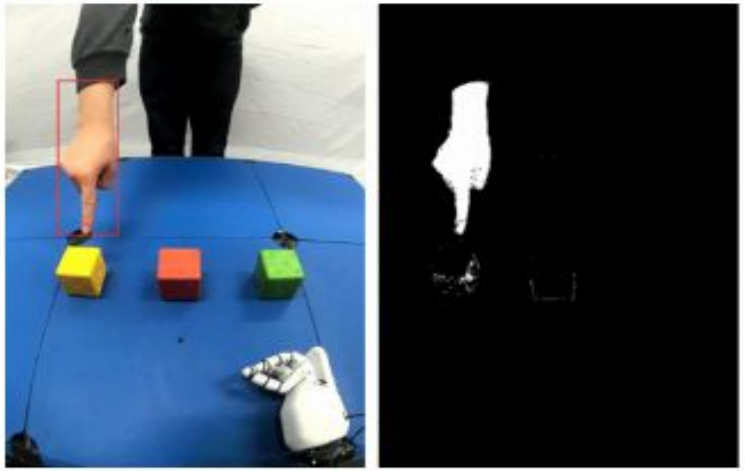
28th April 2021

Pointing at an object

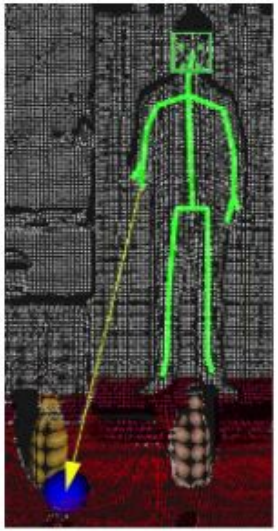




Jirak, D., Biertimpel, D., Kerzel, M. *et al.* Solving visual object ambiguities when pointing: an unsupervised learning approach. *Neural Comput & Applic* 33, 2297–2319 (2021)

https://doi.org/10.1007/s00521-020-05109-w

Pointing at an object



(a) Pointing location estimation.

(b) Example of user pointing deviation.

Gerard Canal, Sergio Escalera, Cecilio Angulo (2016). A real-time Human-Robot Interaction system based on gestures for assistive scenarios. *Computer Vision and Image Understanding, Volume 149, 2016,* (65-77).https://doi.org/10.1016/j.cviu.2016.03.004

Types of gestures

- Body gestures:

  full body actions or motions.

- Hand and arm gestures:

  arm poses, hand gestures.

- Head and facial gestures:

  nodding or shaking head, winking, ..

Model of gesture recognition

1. Sensor data collection
2. Gesture identification
3. Gesture tracking
4. Gesture classification
5. Gesture mapping

Hongyi Liu, Lihui Wang (2017). Gesture recognition for human-robot collaboration: A review.

International Journal of Industrial Ergonomics, Volume 68, November 2018 (355-367).

https://doi.org/10.1016/j.ergon.2017.02.004

1. Sensor data collection

Image based approaches:

- ❏ Marker-based
- ❏ Single camera
- ❏ Stereo camera
- ❏ Depth sensor

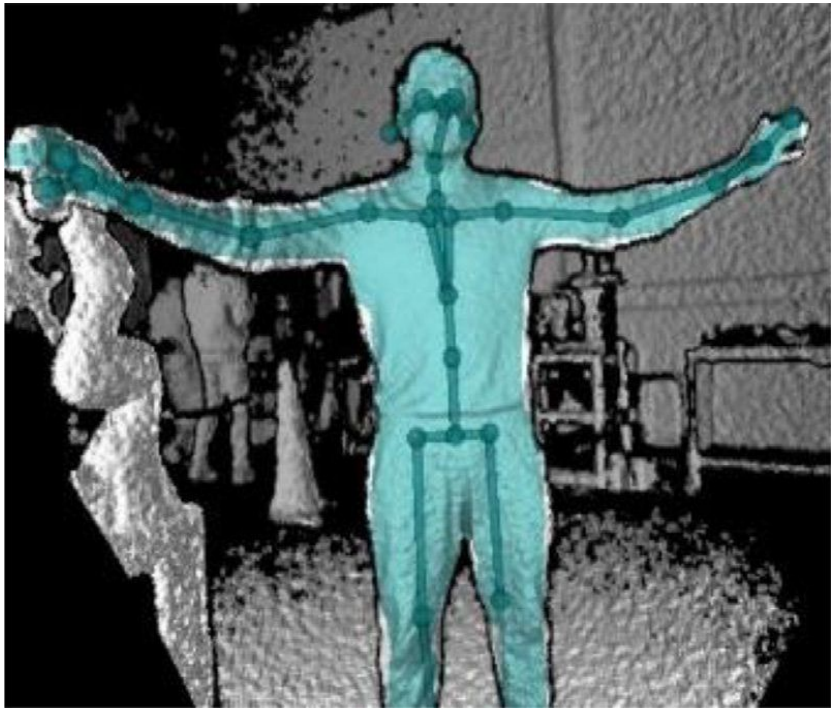
Non-image based approaches:

- ❏ wearable sensors
- ❏ non-wearable sensors

WiTrack

Microsoft Kinect

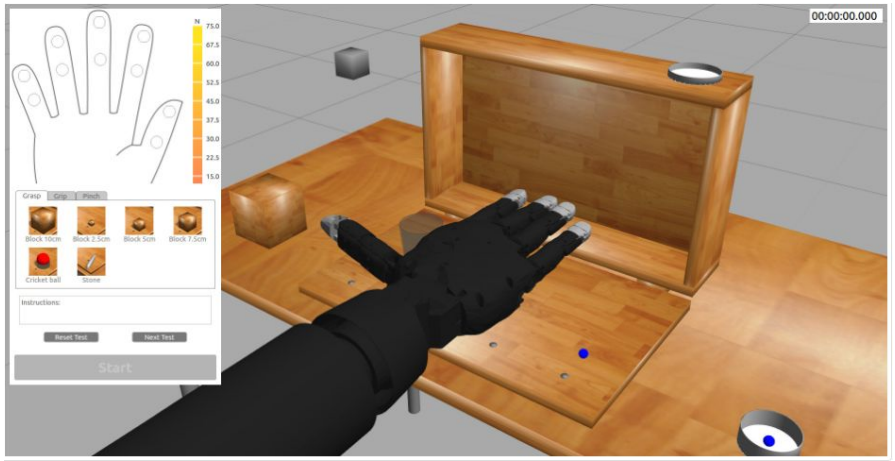
- IR depth sensor
- RGB camera
- a four-microphone array



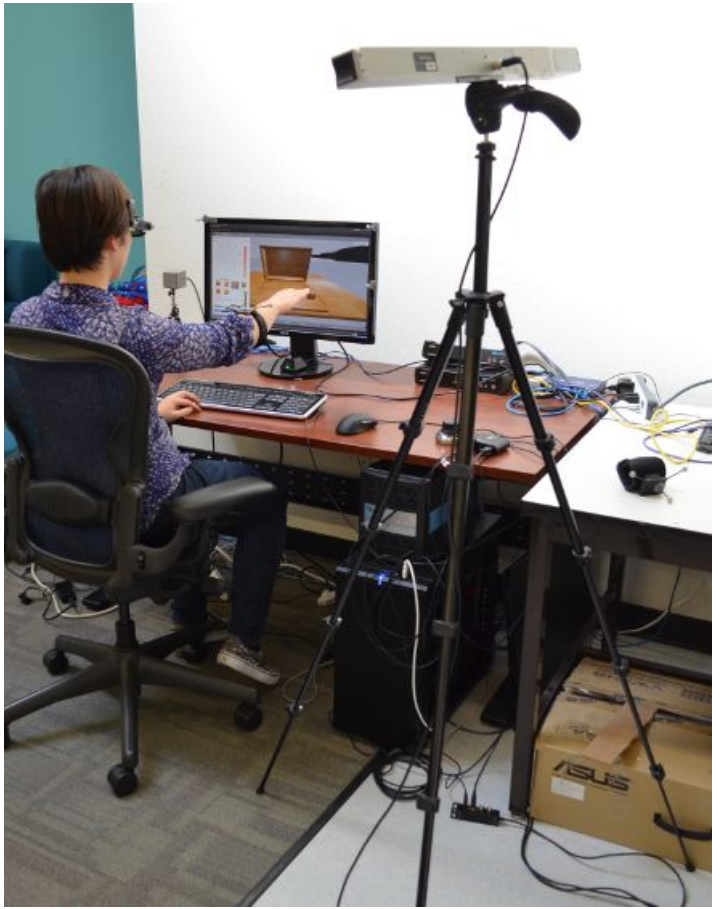
https://www.researchgate.net/publication/349222521/figure/fig2/AS:1005933446561798@1616844631710/Body-tracking-SDK-from-Microsoft-Kinect-Azure-giving-information-about-the-joints-of-a.jpg

OptiTrack

- camera systems
- compatible with active (LED) and passive markers
- https://optitrack.com/applications/robotics/



http://gazebosim.org/tutorials?cat=haptix&tut=haptix_optitrack



Leap motion sensor

- two cameras
- some infrared LEDs

https://www.ultraleap.com/motion/UltraLeap_Product05342_edit.png

Domestic Wheelchair Navigation

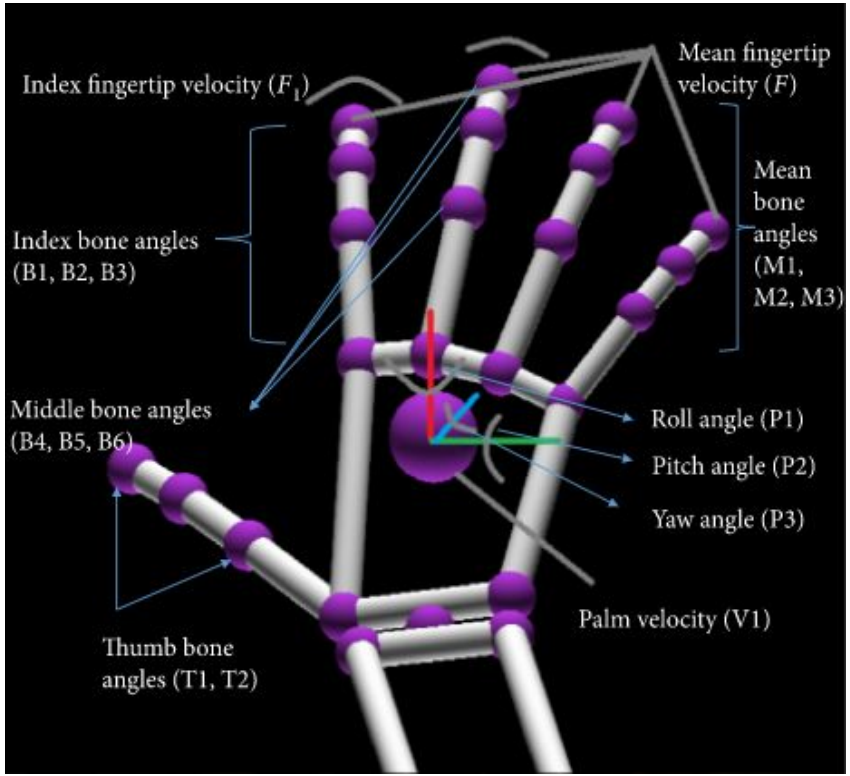
- wheelchair users:
  - with speech disabilities
  - with inability in executing precise hand gestures

- an intelligent wheelchair with hand gesture recognition facility
- leap motion sensors
- a Gesture Classification Model

H. M. Ravindu T. Bandara, K. S. Priyanayana, A. G. Buddhika P. Jayasekara, D. P. Chandima, R. A. R. C. Gopura, "An Intelligent Gesture Classification Model for Domestic Wheelchair Navigation with Gesture Variance Compensation", *Applied Bionics and Biomechanics*, vol. 2020, Article ID 9160528, 11 pages, 2020. https://doi.org/10.1155/2020/9160528

2. Gesture identification

- Visual features
  - Colour
  - Local features
  - Shape and contour
  - Motion
- Learning algorithms
  - Support Vector Machine
  - Artificial Neural Networks
  - Random Decision Forests
- Skeleton model



https://doi.org/10.1155/2020/9160528

3. Gesture tracking

Single hypothesis tracking

- Mean shift
- Kalman Filter
- Kalman Filter extensions

Multiple hypothesis tracking

- Particle filter
- Particle filter extensions

4. Gesture classification

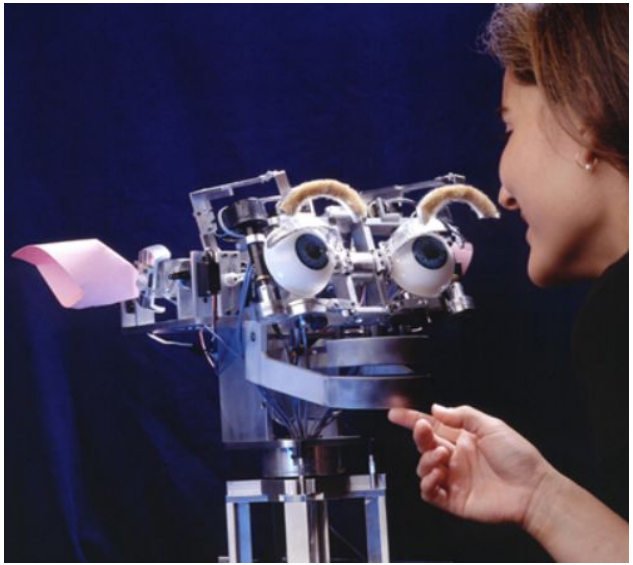
- K-Nearest Neighbours
- Hidden Markov Model
- Support Vector Machine
- Dynamic time warping
- Artificial Neural Network
- Deep learning

(a)

(b)

Kismet

- The Sociable Machines Project, MIT (late 1990's)
- built by Dr. Cynthia Breazeal



Baxter

- built by Rethink Robotics (2011),

  a start-up company founded by Rodney Brooks

https://www.automationworld.com/products/control/article/13313831/hand-in-gripper-safer-more-collaborative-robots-rise-in-manufacturing

IEEE International Conference

on Automatic Face and Gesture Recognition

- **December 15 - 18, 2021**
- **Jodhpur, India (Hybrid Event)**