# Peekaboo – Head Gesture Recognition on HoloLens


**Xinyi Guo, HCI Mobile Lab in National Taiwan University**

Department of Electrical and Computer Engineering , College of Engineering, University of Illinois at Urbana-Champaign


NTU HCI LAB


## Keywords

- Head-Mounted Devices (HMD)
- Fatigue : a subjective feeling of tiredness that has a gradual onset
- Dwell time : time spent in the same position, area, stage
- Degree of Freedom (DoF) : each of a number of independent variables factors affecting the range of states


## Background

- HMDs gaining more popular in VR/AR/MR/Game, etc areas
- I/O interface stayed behind development of HMDs
- People with disabilities need special assistance, which is far underdeveloped
- User interface is non-intuitive and easily causes fatigue in using

## Objectives

- **Intuition** : substitute traditional I/O devices, such as keyboards, mouse with more intuitive ones when in context of HMDs
- **Hands-free** : achieve real hands free interaction without social awkwardness yet with more accuracy

For our project specifically :
Replace inbuilt clicker-based / hands-gesture input control of HoloLens by applying Head Gesture Recognition Algorithm on Nodding.

## Study One :

- Design user friendly display screen on HoloLens
- Gather Nodding / non-nodding data for later algorithm training and false positive reducing

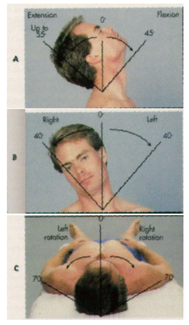
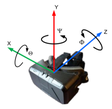
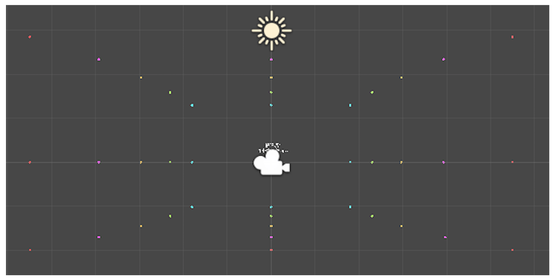



Fig. 1. Range of motion for neck rotations: A. Flexion and Extension. B. Lateral Bending. C. Axial Rotation. (Thibodeau and Patton 1996 p. 298).

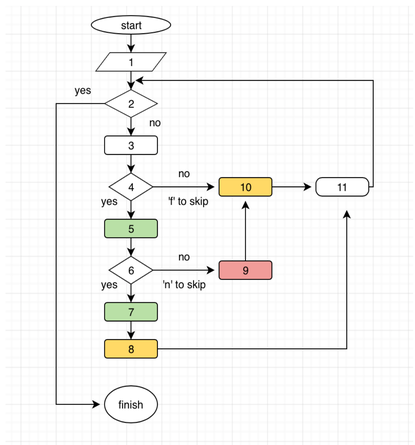
- Based on previous papers(Thibodeau, G.A. and Patton, K.T. Anatomy and Physiology Third Edition. Mosby, St. Louis, 1996.
- ) on the limitation of human neck movement, which then determine the limit of head movements:
- X-axis: 45 to -55
- Y-axis: 70 to -70
- Z-axis: 40 to -40





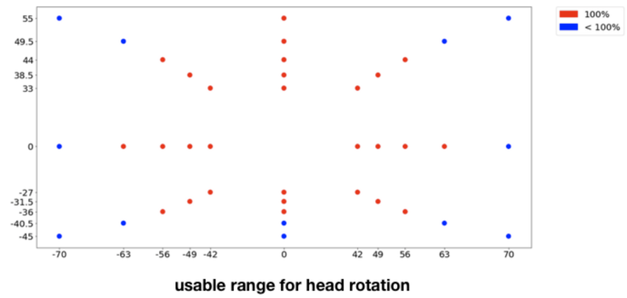
Test screen from user direct view
40 points in total with 8 points per different percentage of the max limits (100%, 90% 80% 70% 60%)

### Part one:




1. Initialization for random order
2. Iterate through all dots?
3. Light up next dot, ask user to point their head toward that dot
4. Can user point their head to that dot?
5. Ask user to click first, start data collecting
6. Can user nod at such position?
7. Let user nod and click again to signal ending, stop recording data
8. Ask for feedback at suck location (the ease of nod and pointing)
9. Discard data stream
10. Autofeedback as "extremely uncomfortable"
11. Increment the counter

- Ask user put on HoloLens
- Present the previous designed display with only one random order dots show up each round
- Collect data for nodding
- Record feedback
- Exception mode for unreachable / impossible action
- User keep body fixed with only movement in neck
- Analyze cumulative feedback to redesign display screen that 100% reachability
- Nodding data for training nodding recognition algorithm




### Part two:

- Collecting data for using HMDs in social scenarios that might trigger nodding recognition as false positive
- Feed those data as negative training to reduce false positive rate of Head Gesture Recognition applied on recognizing Nod

- ask user to walk around with HoloLens on, collecting data
- Ask user to go shopping at convenience store with HoloLens on, collecting data
- Ask user to use web browser that within HoloLens, collecting data
- Ask two users to talk with each other face to face with each of them having HoloLens on, collecting data

## Study two: (in progress)

- based on feedback data collected in user study one about different dots of limitation, design appropriate display screen that with 100% reachability for our sample users.
- Design and implement algorithm for recognizing nodding (using Hidden Markov Model for current stage) using collected nodding data from study one
- Feed in noise data from part two of study one to reduce false positive rate
- Conduct further user study for three hands-free methods and compare their feasibility
  - Head gesture (nod)
  - Head dwell
  - Hand gesture (default for HoloLens)

## Challenges

- Humans good at adapting and learning, which leads to impatience toward fatigue when too familiar with HoloLens
- Algorithm's hard to be zero false positive and the efficiency of algorithm would become limiting factor in the future
- Dominant use of HMDs is hard to anticipated, which makes it harder to disguise appropriate way of user interface design


## Acknowledgements

Work credit to Peekaboo team @ NTU HCI Mobile Lab :

Mike Y. Chen, Yuan-Chang Hsieh, Bo-Xiang Wang, Pai-Chien Yen, Pin-Sung Ku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