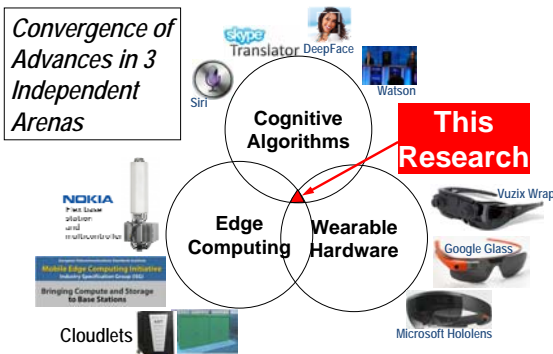


Wearable Cognitive Assistance

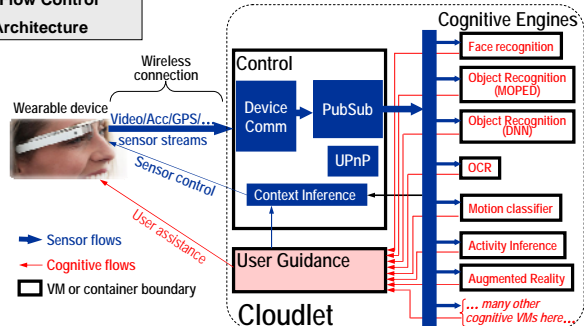
Mahadev Satyanarayanan (PI) and Martial Hebert, Roberta Klatzky, Dan Siewiorek (co-PIs)
Carnegie Mellon University
CNS-1518865

A Unique Moment in Time



Gabriel: an Angel on Your Shoulder

1. PaaS on Cloudlets
2. Adaptive Flow Control
3. PubSub Architecture



Example Gabriel Applications



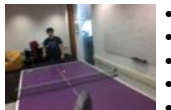
Pool

- Helps a novice pool player aim correctly
- Visual feedback as the user turns cue stick
- Calculations use *fractional aiming system*
- CV: Color, line, contour, and shape detection



Workout

- Guides correct user form in exercise actions (e.g., sit-ups and push-ups)
- Counts out repetitions
- *Volumetric Template Matching* on 10-15 frames
- Smart phone on floor for third-person viewpoint



Ping-Pong

- Tells novice to hit ball to left or right
- Choice based on which is more likely to win rally
- CV: color, line and optical-flow motion detection
- Objects detected: ball, table, opponent
- Featured in CBS 60 minutes in Oct 2016:



Face

- Jogs your memory on a familiar face
- Detects and extracts face
- Applies deep neural network face recognizer
- Whispers name



Lego

- Guides a user in assembling 2D Lego models
- CV steps
color and pattern detection
edge detection
color normalization and assignment



Draw

- Helps user sketch better
- Builds on third-party app
- Preserves back-end logic
- New Glass-based front-end for any surface and instrument



Sandwich

- Helps novice prepare sandwiches
- Non-perishable plastic ingredients
- CV: Faster RCNN + transfer learning
- Runs on both Google Glass and Microsoft HoloLens



IKEA

- Guides user in assembling an IKEA kit (table lamp)
- Uses short video segments for instruction
- Combined with active real-time guidance
- CV: DNN with transfer learning



Ribloc

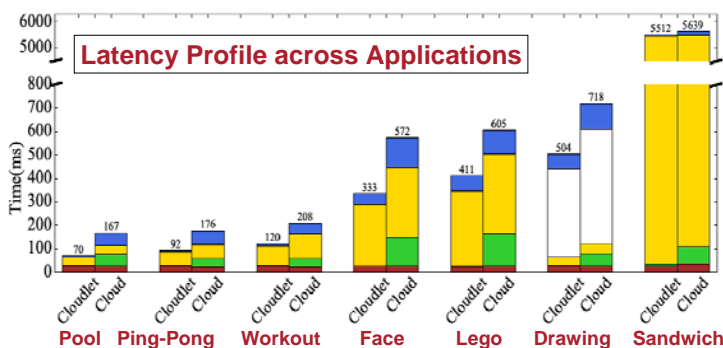
- Medical training application
- Instructs trauma surgeon in use of RibLoc
- Eliminates training visit by technician
- CV: DNN-based, small parts, easy to err
- Video created by VIZRTECH (<http://viztech.com>)



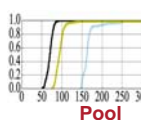
Common themes

- **State-of-the-art Computer Vision and Machine Learning**
Color/edge/line detection, optical flow, volumetric template matching, CNN, transfer learning, etc.
- **Structural similarity across apps**
Phase 1: extract *symbolic representation* (stateless)
Phase 2: generate guidance (stateful)

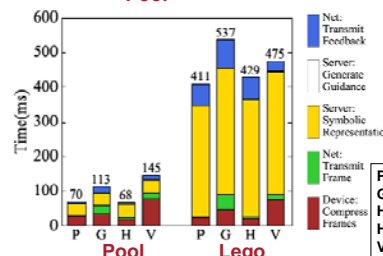
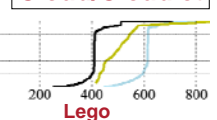
Experimental Measurements of End-to-End Latency



— WiFi + cloudlet + Phone
— WiFi + Amazon cloud + Phone
— 4G LTE + cloudlet + Phone
Phone = Google Nexus 6



Impact of Network & Cloud/Cloudlet



Impact of Mobile Device

P: Nexus 6 Phone
G: Google Glass
H: Microsoft HoloLens
V: Vuzix Smart Glass

