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A Wearable Hardware Platform for Capturing Expert's Experience

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Points for discussion

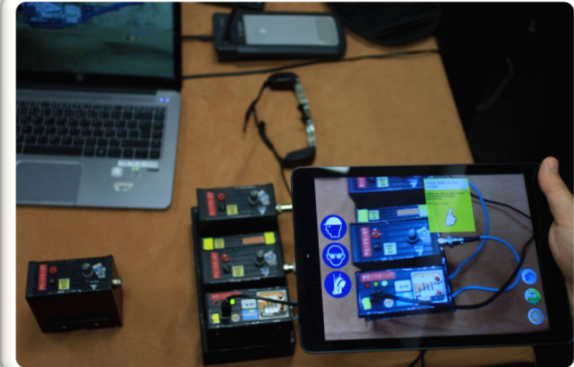
- ❑ Introduction

- ❑ Methodology
 - Mapping Transfer Mechanisms
 - Sensor recommendations
 - Proposed Hardware Platform

- ❑ Discussion & Future work

INTRODUCTION

- ❑ WEKIT is a European research and innovation project supported under Horizon 2020.
- ❑ WEKIT project develops and tests a novel way of industrial training enabled by smart Wearable Technology (WT).
- ❑ The WEKIT industrial learning methodology comprises of capturing experience of an expert, and re-enacting the experience for training novices, with the former being the focus of this article.



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REMOTE SYMMETRICAL TELE-ASSISTANCE

- ❑ Description: View and capture the activity of another person from their perspective transmit video & audio.
- ❑ Sensors: smart/AR glasses.
- ❑ Key products:

▪ Google Glass



▪ Microsoft HoloLens



▪ Meta 2



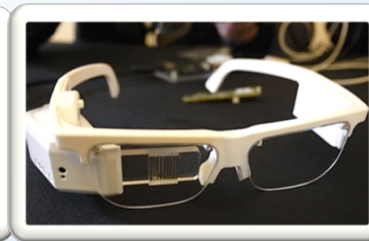
▪ Sony Smart Eyeglass



▪ Moverio BT-200/2000



▪ Vuzix M-100

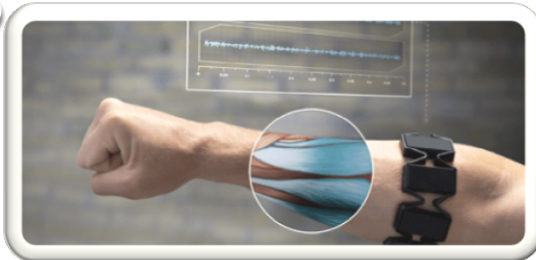


▪ Optinvent Ora-1



▪ ODG R7

METHODOLOGY – Mapping Transfer Mechanisms



▪ Myo Gesture control armband



▪ Leap Motion controller



▪ Magic ring

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VIRTUAL/ TANGIBLE MANIPULATION

- ❑ Description: Hand movement tracker, accelerometer, gyroscope.
- ❑ Sensors: Depth camera, smart armband.
- ❑ Key products: Myo Gesture control armband, Leap Motion controller

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HAPTIC HINTS

- ❑ Description: Vibrations on arm or fingers.
- ❑ Sensors: Vibrotactile bracelets and rings.
- ❑ Key products: Myo, magic ring.

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VIRTUAL POST ITS, CONTEXTUALIZATION, IN SITU REAL-TIME FEEDBACK

- ❑ Description: Object tracking in environment.
- ❑ Sensors: Smart glasses, Tablet Computer or Mobile Phone.
- ❑ Key products: several.

METHODOLOGY – Mapping Transfer Mechanisms

5 MOBILE CONTROL

- ❑ Description: control dials and other user interface elements
- ❑ Sensors: hand gesture, controller
- ❑ Key products: Myo, Leap motion



▪ Neurosky Mindwave ▪ MyndPlay MyndBand

6 CASE IDENTIFICATION

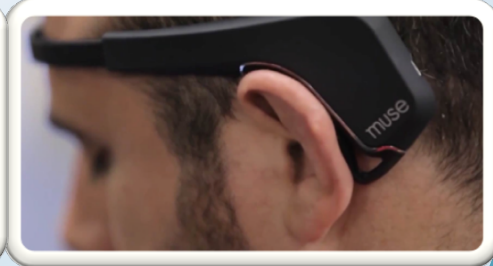
- ❑ Description: Link with existing cases, link with error knowledge
- ❑ Sensors: case based reasoning component
- ❑ Key products: no specific sensor

7 DIRECTED FOCUS

- ❑ Description: Direct focus of user.
- ❑ Sensors: Gaze direction / Object recognition, EEG (attention/focus/mental effort).
- ❑ Key products: Smart Glasses (or gyroscope only), MyndPlay MyndBand, Interaxon Muse EEG, Neurosky Mindwave, Emotiv EEG.



▪ Emotiv EEG



▪ Interaxon Muse EEG

METHODOLOGY – Mapping Transfer Mechanisms

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SELF-AWARENESS OF PHYSICAL STATE

- ❑ Description: Fatigue level, vigilance level, Biodata (e.g., steps, sleep, heart rate), body posture: ergonomics (e.g. lean back, forward)
- ❑ Sensors: EEG, smart watch, posture tracker
- ❑ Key products: MyndPlay MyndBand, Neurosky Mindwave, Emotiv EEG, Fitbit, apple watch, LeapMotion, Myo, Lumo Lyft, Alex posture

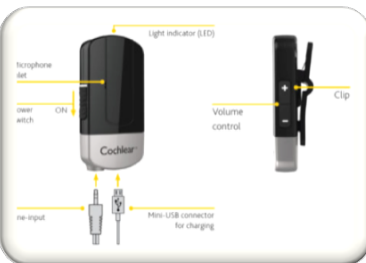


▪ Apple watch

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THINK ALOUD PROTOCOL

- ❑ Description: Capture voice of the user
- ❑ Sensors: Microphone
- ❑ Key products: Cochlea Wireless Mini Microphone, built-in microphone of Camera/Smart Glasses, Wireless Microphones (e.g. from AKG)



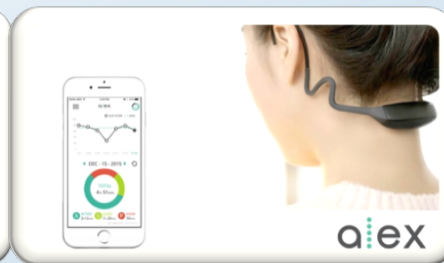
▪ Cochlea Wireless Mini Microphone



▪ Lumo Lyft



▪ Fitbit



▪ Alex posture

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ZOOM







- ❑ Description: zoom in and get details
- ❑ Sensors: Smart glasses / tablet with high-resolution camera
- ❑ Key products: several

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SLOW MOTION

- ❑ Description: Allow replay at slower speed
- ❑ Sensors: High frame rate camera (high frame rate often comes at price of resolution with smart glasses; and vice versa)
- ❑ Key products: Several

- Three Recommended High Speed Cameras (Full HD Slow Motion Cameras)
<http://fpshighspeedcam.com/>

Rank	Model	Max fps @ HD	Max FPS	MSRP
1	Sony: PXW-F55 buy @ Amazon	240fps @ 1920*1080 Full HD	960fps @ 1920*270	 Sony PXW-F55 4K XDCAM... \$4,599.00  Shop now
2	**Highly Recommended** Sony: RX10 II buy @ Amazon (NEW) Sony RX10 III	250fps @ FULL HD	1000fps @ 1136*384 (downgraded Full HD)	 Sony DSC-RX10 II... \$1,198.00  Shop now
3	Sony: RX100 IV buy @ Amazon	250fps @ 1824*1026 2 sec	1000fps @ 1136*384 2 sec	 Sony Cyber-shot DSC-RX100 IV... \$898.00  Shop now

METHODOLOGY – Sensor recommendations

RECOMMENDATIONS ON SENSOR CHOICE FOR DESIGNING AND DEVELOPING THE FIRST VERSION OF THE HARDWARE PROTOTYPE

Features	Sensor options	Suggested devices
<ul style="list-style-type: none">▪ Built-in microphone array,▪ environment capture,▪ gesture tracking,▪ mixed reality capture, Wi-Fi 802.11ac, holographic computing	AR / Smart glasses	Microsoft Hololens
EEG		MyndBand, Neurosky chipset
Detecting hand, arm movements and gestures	Smart armband	Leap Motion Myo armband
Tracking the position and angle of the neck	Posture tracker	Alex posture tracker

METHODOLOGY – Sensor recommendations

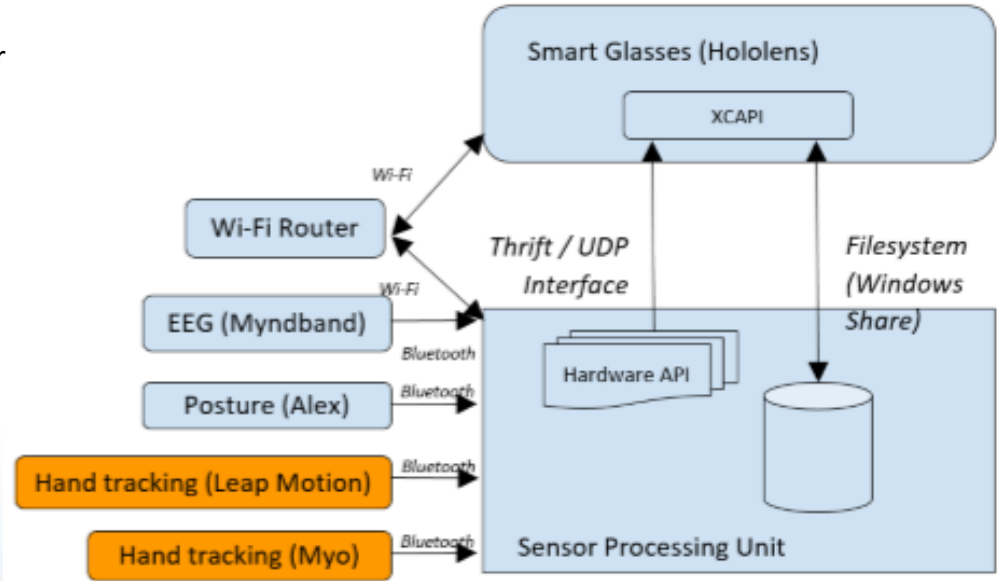
DATA FROM SENSORS

Sensor	Data		
	Raw	Processed	Interpreted
Microsoft HoloLens	Not accessible via official API	Spatial data, Orientation, Gaze	Gesture
Leap Motion	Raw sensor images	Hand model data	-
Myo	Raw EMG data available	Orientation and acceleration	Detected pose
MyndPlay MyndBand	512Hz Raw	Bandwidth spectrum 0.5Hz - 100Hz. Delta - Mid Game	Attention, meditation, zone, mental effort, familiarity
Alex posture tracker	Raw accelerometer and gyroscope	Unconfirmed from Vendor	Head, Neck and Shoulder posture



METHODOLOGY – Proposed Hardware Platform

- ❑ The proposed hardware platform consists of three components: smart glasses, external sensors and sensor processing unit.
- ❑ Smart glasses can comprise of other sensors or features such as microphone, gesture tracking, and voice command, gaze tracking.
- ❑ The external sensors comprise of components that are not part of the existing AR glasses, for instance, EEG, posture tracking, and hand tracking.
- ❑ The sensor-processing unit acts as a processor for collecting, syncing and streaming the data from all the different sensors.
- ❑ Hardware components can use different communication standards such as: WiFi and Bluetooth.
- ❑ The proposed architecture is quite flexible and allows for communication protocols such as Apache Thrift, TCP/IP, UDP.



- Proposed hardware architecture

METHODOLOGY – Proposed Hardware Platform

1. HoloLens AR Headset
2. EEG Brainwave sensor
3. EEG BT Unit
4. EEG Ref/Ground
5. Alex posture sensor
6. Micro PC SPU
7. Power Bank
8. Myo Armband

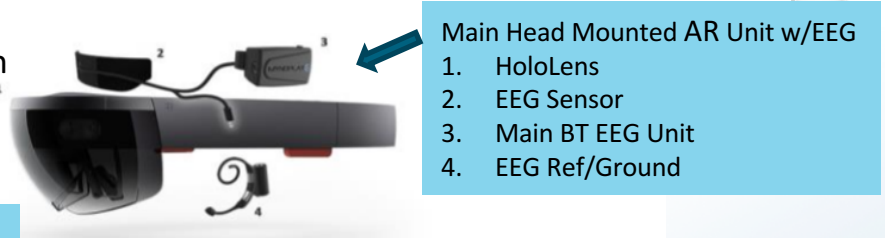
Replaced by the second iteration



Hardware platform first iteration

WEKIT Jacket/Sensor Harness:

- Protects sensors and devices
- Distributes weight evenly on body
- Provides extra space for tools or power packs



- Main Head Mounted AR Unit w/EEG
1. HoloLens
 2. EEG Sensor
 3. Main BT EEG Unit
 4. EEG Ref/Ground



Micro-PC Sits in pocket and wired to power packs on either side



Hardware platform second iteration

Discussion

CHALLENGES:

- ❑ Leap Motion hand sensor could not accurately capture hand movements at a distance
- ❑ Adjustability of the sensor placement
- ❑ Some wireless devices were more susceptible to electrical interference than others.
- ❑ Limitations on the available APIs and processing power: for providing data to the HoloLens, a simple protocol should be chosen so that it does not put much computational load on the system.
- ❑ Secure and usable sensor placement



SOLUTION:

- ❖ Detailed hand movements should be recorded separately, i.e., after an action is performed, by mimicking the movements near the sensor.
- ❖ Body vest was designed to have items clipped on all around
- ❖ Sensor choices preferring wired sensors, or by using Bluetooth 4 if available
- ❖ Initial designs used Apache Thrift, and then pure TCP, but UDP was settled on
- ❖ Ease of adjustment for various body shapes, ergonomics, health and safety, and robustness.

Future work

- Perform evaluation of completed prototype for industrial case scenarios developed in the WEKIT project and analyze the data collected from the trials.
- Try to use the AR/smart glasses and external sensors from different vendors to make the platform open.
- On location trials will be performed to further classify and resolve potential environmental factors or interference, which can affect performance of the overall system and the user experience.



Thank you !

Merci beaucoup !

Tusen takk !

