KEYNOTE SPEECH

HEALTH TECH FORUM 2020 – HEALTH TECH FOR COMMUNITY, HONG KONG

Taiwan Perspective I:

Insights of Successful HealthTech Innovation
– from Research Lab to Community

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Aging boom, baby bust -- Some demographics of Taiwan

• Taiwan became an aged society in 2018, and is expected to become a super aged society by 2025.

• Age 65+: 15.28% (3.61M) @2019/12

• The average life expectancy in Taiwan hit a new high of 80.7 years in 2018

• Life expectancy at age 65: men 18.44, women 22.12 @ 2018

• Total fertility rate by World Population Review 2020
   Macau: 1.347 (190/199),
   Hong Kong: 1.326 (192/199)
   Singapore: 1.260 (196/199)
   Taiwan: 1.218 (199/199)

• Taiwan had 177,767 births and 176,296 deaths, or almost zero natural population growth in 2019
   Average age of first time mother: 30.9 @2019 (Italy 31.1 @2017)
   Age of first time mother 35+: 22.3%
...to provide positive solutions in maximizing the efficiency and effectiveness of manpower and resource for the care of older adults.

IT IS ONLY NATURAL TO CONSIDER APPLYING TECHNOLOGIES...
3G’s for the aged society: Gerontology, Geriatrics, Gerontechnology

- First International Congress on Gerontechnology 1991,
- International Society for Gerontechnology, 1997
- 老人「福祉」科技，樂齡科技...

“Design technology and environment for independent living and social participation of older persons in good health, comfort and safety”

- Scope of Gerontechnology: Health, Housing, Mobility, Communication, Leisure, Work
Proud to be a designer – How I got into gerontechnology…

• PhD 1992, Stanford University, Mechanical Engineering, **DESIGN DIVISION**
• Teaching and doing design at Yuan Ze University, Taiwan, for 28 years
• Design for people…
• Medical devices, assistive technology…
• **Gerontechnology!**
Gerontechnology is only valuable if we can bring research to daily applications.

A design approach to gerontechnology: Creativity ➔ Prototype ➔ Products ➔ Sales

Mission: To carry out a successful industrial and educational experiment
What exactly do people do in Gerontechnology?

• My (unscientific) classification of the 81 papers published in Gerontechnology, from 2017~2020, average 178.4 downloads per paper (data collected 2020/04/29)

1. Monitoring of vital signs / behavior patterns, and platforms for health management
   • 18 papers (22.2%), 137 downloads

2. Technology interventions for enhancing physical and cognitive ability
   • 11 papers (13.6%), 232 downloads

3. Technology assistance in everyday lives
   • 17 papers (21.0%), 182 downloads

4. Platforms for social communication and participation
   • 10 papers (12.3%), 177 downloads

5. Robots
   • 4 papers (4.9%), 162 downloads

6. General issues: design methodology, education, culture, business, policy, etc.
   • 21 papers (25.9%), 186 downloads
How can telehealth systems enter the homes?

Connect older adults with family members using a simple IoT device “WhizConnect”

- Wi-Fi
- 3G/4G
- Bluetooth
- Cloud Server
- MQTT Broker

Android App

Facebook

BP/BG Measurement

Indoor localization
temperature/humidity

Connect older adults with family members using a simple IoT device “WhizConnect”

- Wi-Fi
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Android App

Facebook

BP/BG Measurement

Indoor localization
temperature/humidity
The son is the trigger to enable the behavior

Supporting the caregivers: Care, interaction, connection, in addition to health monitoring
From research lab to community: More DESIGN THINKING!

- Empathy: User centered, persona, story
- Define the right problem: What, How, Why
- Think like a boss… (not like a professor…)

IDEO (http://www.ideo.com)
CEO Tim Brown
Rainbow in the sky?

SMART TECHNOLOGIES: INTERNET OF THINGS, ARTIFICIAL INTELLIGENCE, BIG DATA...

大數據 人工智能 物聯網
Publish, subscribe, topic ➔ IoT is a Line/WeChat/WhatsApp/… group

- M2M (Machine to Machine) communication

- The light started to have some AI…
- The bed started to collect big data…
Transfer familiar artifacts in homes into IoT devices – starting from the bed

• **WhizPad** is an extremely comfortable mattress capable of motion sensing

• Pressure-relieve material for prevention of pressure ulcer

• In Taiwan 2017, 22.5% hospital falls occurred when patients leave the beds

• Three-stage leave bed alert (sit-up, sitting at the side, leave bed) for fall prevention.

• Four sensing areas / rule based

• Private cloud IoT
2nd generation: Machine Learning to capture the intention of leaving bed

- 1000+ learning samples from 31 testers in 7 weight groups
- 30 sensing areas, classification of lying/sitting/left edge/right edge
- **Edge AI**: Neural Network model deployed on chip
  - Testing accuracy: 96.0% (360 test examples)
- Individual patient management
  - 3-stage leave bed alert
  - Long lasting pressure area alert
- Using 2 AAA batteries (for 6 months)
- **Amazon Web Service (AWS)** for **Cloud AI**: Living pattern, sleep quality…
Daily living pattern obtained from WhizPad

1 week
51.09%

2 weeks
45.88%
Accumulating the norm -- Use 70% as threshold to define “normal activities”

Normally, the older adult
1. Gets up no earlier than 05:50
2. Gets up no later than 07:30
3. Not in bed during the day
4. Goes to bed no earlier than 19:00
5. Goes to bed no later than 20:40

- In-bed longer (64.58%)
- Got up later than normal at 07:50
- Back to bed multiple times during the day
- Went to bed earlier at 17:30
- Left bed multiple times during the night

AI: Learning ➔ Prediction
Machine learning for measuring sleep using “bed actigraphy”

- In-bed movement count from WhizPad vs. Polysomnography (PSG) sleep/wake state

Training example
- 30 second episodes
- In-bed movement count from the 4 sensing areas
- Real time + previous $n$ minutes
- Sleep/wake by PSG

Real time $n=1$  $n=2$  $n=3$  $n=4$  $n=5$  $n=6$  $n=7$ status
### Machine Learning results (J48 Tree)

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<th>wake</th>
<th>sleep</th>
<th>accuracy</th>
<th>sensitivity</th>
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<th>ROC area</th>
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- 35 testers, 2 hour sleep
- 7,751 30-second episodes
- Real time + 7 previous minutes gave the best specificity

Accuracy, sensitivity and specificity obtained from 10-fold cross validation

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Business viable: Support caregivers in the homes
Use smart technologies to provide real-time status and long-term patterns of the older adults
Motion sensing WhizCarpet: Hardware is often much more difficult...

Easy and flexible set up; soft surface reduces risk of fracture when falling
Real time position display, fall detection and alert

Mobility and pattern analysis, abnormal pattern alert
Wandering behavior, path, hot spot analysis of demented patients

Three types of water to handle: bathroom, floor cleaning, urine
Starting small in the homes: WhizConnect to integrate Bluetooth products

- Environmental data
- Vital signs
- Long term health and living pattern
- Real time status and event alerts
WhizTouch: IoT call button for bedridden older adults

• Big button; mobile phone as receiver; green light to confirm the call
• But…

IoT care products at home?

• Internet usage is low for older adults (31.1% /8.6%@2018). High monthly fee for Internet service is not acceptable.
• Connecting the IoT product to home Wi-Fi AP has been a major usability issue; Wi-Fi coverage is often poor in bedroom

Narrow Band IoT: the last mile

• Sim card connects directly to NB-IoT base station; used anywhere without setup
• NB-IoT based WhizConnect to bring smart homecare products to the homes
Smart technologies happening in the homes (2015: IoT; 2017: NB-IoT; 2019: ML/AI)

- Consider B2B2C business model

Cloud AI: pattern recognition
- AWS IoT
- AWS ML
- AWS DB
- AWS Lambda

Edge AI: event identification

Commercial Bluetooth healthcare products
- Vital signs
- Blood oxygen
- BP/BG
- Body Temp.
- Wearable

3rd Party service cloud

Restful API
MQTT API

FCM (Android)
APNS (IOS)

NB-IoT

WhizConnect
- WhizPad
- WhizTouch
- WhizCarpet

Activities

Environment
- Temperature/humidity

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The gerontechnology industry is not there, yet…

We are designers!
Design starts with a problem. Design ends with a solution. Design is a problem solving process.
Find that Trigger—Caregivers are the best designers!
• UX: User Experience Design

From research lab to community
• Are we really doing the right research which “will be useful in the future?”

The future world needs trans-disciplinary talents
• Are we educating students the right way?

Thank you
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https://userexperiencerocks.wordpress.com/2015/08/20/then-my-kiddo-asked-whats-the-difference-between-ux-ui/