Development of an AIoT Senior Care Bedroom

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3G’s for the aged society: Gerontology, Geriatrics, Gerontechnology

• It is only natural to consider applying technologies for the care of older adults…

• First International Congress on Gerontechnology, 1991
• International Society for Gerontechnology, 1997

“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
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
Persuasive technology: How technology is designed to change behaviors of the users

- A new behavior was created in 2007
- User Centered Design: Need≠Motivation

More fun than functions…”
If telehealth systems connect older adults with family members...
Bringing research to daily applications: More DESIGN THINKING!

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

Proud to be a designer!
PhD 1992, Stanford, ME, Design Division

IDEO (http://www.ideo.com) CEO Tim Brown

PhD 1992, Stanford, ME, Design Division

HASSO PLATTNER Institute of Design at Stanford

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Internet of Things, Artificial Intelligence, Big Data…

- Publish / subscribe / topic ➔

  IoT is a Line/WeChat group

- M2M (Machine to Machine) communication

- The light started to have some AI…

- The bed started to collect big data…
Supporting the caregivers --
Use smart technologies to provide real-time status and long-term patterns of the older adults
Transfer familiar artifacts in the homes into IoT devices

- **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**
• We recruited 254 participants who were at risk of bedsores from the ICU of a hospital, with 127 in the control group and 127 in the intervention group.

• In addition to the standard nursing care, participants in the intervention group used the motion-sensing mattress, which can detect the bed activities during their hospitalization.

• 13 (10.2%) participants in the control group developed bedsores while only 2 (1.6%) in the intervention group developed bedsores, showing a significant reduction of 8.6% (P=0.003).

• After adjusted for some confounding variables, we found that the likelihood of development of bedsores in the intervention group was reduced by 90% (OR=0.10, 95% CI: 0.02, 0.51, P=0.005) compared with that in the control group.

• The average timing to develop bedsores in participants using the motion-sensing mattress was 7.5 days and was postponed by 2.3 times than that in participants who received standard nursing care which was 3.3 days.
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: NeuralNet model deployed on chip
  ◦ Testing accuracy: 96.0% (360 test examples)
• Individual patient management
  ◦ 3-stage leave bed alert
  ◦ Long pressure area alert
• Using 2 AAA batteries
• Amazon Web Service (AWS) for data storage and Cloud AI: Daily living pattern, sleep quality…
Daily living pattern obtained from WhizPad

- 64.58%
- 55.55%
- 59.72%
- 42.36%
- 46.52%
- 47.22%
- 43.05%
Accumulating the norm for in-bed activities

- 1 week
- In-bed 51.09%

- 2 weeks
- In-bed 45.88%
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

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

AI: Learning ➔ Prediction
Motion sensing WhizCarpet: Fall detection and mobility monitoring

- 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
Bluetooth devices cannot M2M: *WhizConnect* to integrate Bluetooth products

- **WhizConnect**
  - Environmental data
  - Vital signs
  - Real time status and event alerts

**WhizSeries**

Long term health and living pattern
**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.
- **LPWAN**: Sigfox, LoRa?

**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…
2015: Internet of Things!

- Consider B2B2C business model

2017: NB-IoT

2019: Big data / AI

Cloud AI: pattern recognition

- AWS IoT
- AWS ML
- AWS DB
- AWS Lambda

Edge AI: event identification

Commercial Bluetooth healthcare products

3rd Party service cloud

Restful API, MQTT API

Cloud web services

edge Ai:

event identification

Vital signs

Blood oxygen

BP/BG

Wearable

Body Temp.

Environment

Temperature/humidity

WhizConnect

WhizPad

WhizTouch

WhizCarpet

Far Eastone

FCM (Android)

APNS (iOS)

NB-IoT

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Banciao veteran dementia nursing home

Old Days

Train Station

Music Corner

Life Trees

Old Theatre

Activity Room

Interactive Wall
We are designers!
UX: User Experience Design

The world needs transdisciplinary talents

Find that Trigger — Caregivers are the best designers!

“Design” is our common language!
Design starts with a problem. Design ends with a solution.

Thank you

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YZU d.schoool
Gerontechnology

Transdisciplinary learning
Real world problem and experience

DESIGN IS A PROBLEM SOLVING PROCESS