Business Cases of Wireless eHealth and Challenges for Creating a 5G-enabled Health System

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Outline

1. Introduction of WTA
2. Business Cases of e-Health in China
3. Challenges for Creating a 5G-enabled Health System
4. Achievements
Wireless transmission and application (WTA) institute is located at Beijing university of posts and telecommunications.

WTA institute was founded in 2004 by Prof. Kang.

- Two Professors and one associate professors.
- More than 40 candidate PH.D and masters.

Two research directions

- Wireless communication technology
- Application of WeHealth.
The concept of Wireless electronic health (WeHealth) was proposed by Prof. Kang in 2005. WeHealth is an interdisciplinary research direction which combines the wireless technology, sensor technology and intelligence analysis of health data together.

- Health information is collected by Smart devices such as wearable devices
- Smart devices transmit the health data to server by public wireless communication network
- The server feeds back the health advises to users after intelligence analysis and early warning of big data.

Research 1: 5G communication technologies

<table>
<thead>
<tr>
<th>Machine Type Communications (MTC)</th>
<th>Non-orthogonal multiple access (NOMA)</th>
<th>High speed Wireless Local Area Networks (WLAN)</th>
</tr>
</thead>
<tbody>
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<td><img src="image" alt="Machine Type Communications (MTC)" /></td>
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<td>Low power consumption transmission / Massive connections</td>
<td>Power domain NOMA / Code domain NOMA / Hybrid multiple access</td>
<td>802.11ac / 802.11ax technology</td>
</tr>
</tbody>
</table>

Research 2: Application of WeHealth
Outline

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Business Cases of e-Health in China

Business case: Health diary

- Cooperate with the biggest medical examination center (MEC) in China
- blood fat; weight; hepatic adipose infiltration; uric acid; blood pressure; blood sugar

### White collar
- 白领: 血脂 41.8% 体重 40.6% 脂肪肝 29.7% 尿酸 11.6% 血压 10.5% 血糖 6.1%

### Finance
- 金融: 血脂 45.6% 体重 39.4% 脂肪肝 30.7% 尿酸 9.6% 血压 10.3% 血糖 9.7%

### IT
- IT: 血脂 43.4% 体重 39.0% 脂肪肝 28.1% 尿酸 16.3% 血压 8.7% 血糖 6.6%

### Retire
- 离退休: 血脂 65.6% 体重 54.5% 脂肪肝 47.8% 尿酸 14.7% 血压 35.2% 血糖 24.6%

### Average
- 平均值: 血脂 49.1% 体重 43.4% 脂肪肝 34.1% 尿酸 13.0% 血压 16.2% 血糖 11.8%
Business Cases of e-Health in China

Business case: Health diary (APP/WeChat)
Step 1: click the "add report" button and call the camera

Step 2: take a clear picture of physical examination report

Step 3: upload the report

Step 4: call the background algorithm and interpret the contents of the report

Step 5: feed back the results and proposals
Business case: Health diary (Big data predication)

- Systolic pressure:
- Diastolic pressure:
- Heart rate:

Prediction model training  Prediction
Business Case: Health diary (Comparison of examination results)

- weight
- diastolic pressure
- triglyceride
- cholesterol total
- low density lipoprotein
- hepatic adipose infiltration
Establish 158 blood collection stations and checkpoints in China.

200 thousands blood samplings.

Blood collection points for early cancer screening
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Challenges for Creating a 5G-enabled Health System

Main drivers and typical scenarios for 5G

Next surge of Mobile Internet

- Augmented reality
- Mobile online gaming
- Mobile Cloud
- Virtual reality
- Online UHD 3D video

Flourish of Internet of Things

- Smart house
- Industrial control
- Wearable Devices
- IoV
- Smart grids
Challenges for Creating a 5G-enabled Health System

WeHealth in 5G

![Diagram showing the integration of wearable devices, mobile terminal, relay, direct way, service platform, and base station in a 5G-enabled health system.]

- **Wearable Devices**
- **Mobile Terminal**
- **Relay**
- **Direct way**
- **Service platform**
- **Base station**
Challenges for Creating a 5G-enabled Health System

Low power consumption
- Narrow band IoT (NB-IoT)

Compatibility
- Forward compatible LTE/LTE-A systems
- Backward compatible 5G systems

Massive connections
- Uplink non-orthogonal multiple access
- Hybrid multiple access

Intelligent service
- Intelligent processing for big data
- Chronic disease monitoring and early warning
Challenges for Creating a 5G-enabled Health System

1. **NB-IOT**
   - Low power consumption guaranteeing 10 years battery life;
   - Ultra low cost terminal

2. **Uplink non-orthogonal multiple access**
   - Power domain, code domain and space domain
   - Maximize spectral efficiency

- Frequency
  - Subcarrier spacing = 5 kHz
  - 180 kHz = 36 subcarriers

- Pattern of $u_1$ and $u_2$
- Pattern of $u_3$ and $u_4$

- Dec SIC detection $u_3$
- Dec SIC detection $u_1u_1$
- $u_2$
- $u_4$
- $u_3$
- $u_4$
- $u_1$
- $u_4$
- $u_2$
- $u_3$

- Transmitter
- Receiver

- NR-IOT

- Frequency 180 kHz = 36 subcarriers
- Subcarrier spacing = 5 kHz

- Challenges for Creating a 5G-enabled Health System
Challenges for Creating a 5G-enabled Health System

3 Hybrid multiple access

Adaptively select orthogonal multiple access and non-orthogonal access

4 Chronic disease warring

Prediction model training

Original medical data

Data Pretreatment

Filter
Clean
Transfer
Modify

Classify

Normal
Class 1
Class 2
Class 3

Clarification model for Chronic disease

Model training

Model evaluation

Prediction

No risk
Low risk
Middle risk
High risk
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- More than 100 papers were published
- 17 authorized patents
- 8 contributions were agreed by ITU

"WeHealth" was selected as "leading-edge technologies" by U.S. National Academy of Engineer in 2011.

"WeHealth" was thought as the second largest applications in 2012 IEEE Healthcom international conference.

"Wireless e-Health (WeHealth) — from concept to practices", 2012
Multi-parameter information collection terminal

Remote medical treatment platform for disaster

Database for patients

Health diary

Some of them were applied to more than 20 hospitals in shandong and hainan province, and also used in Yushu earthquake rescue in 2010.
The team was invited by U.S. National Academy of Engineer ICT technology summit in Australia and China Mobile Medical Industry Conference to make reports.

Reported by CCTV, Xinhua News Agency, People's Daily, Liberation Army Daily, People, Phoenix and other media.
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Thank You!