ICT for Healthcare Services for the Elderly

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Outline of Today’s Talk

• Ageing population and its impact on society

• ASTRI ICT for healthcare services related projects

• Key technologies

• Lessons learned & conclusion remarks
The World’s Ageing Population

**The World’s Ageing Population**

% of the population 65 years or over

- **Brazil**
  - 2006: 17%
  - 2011: 19%
  - 2016: 22%

- **China**
  - 2006: 22%
  - 2011: 26%
  - 2016: 28%

- **India**
  - 2006: 15%
  - 2011: 17%
  - 2016: 18%

- **Japan**
  - 2006: 42%
  - 2011: 44%
  - 2016: 45%

- **Russia**
  - 2006: 31%
  - 2011: 34%
  - 2016: 36%

- **UK**
  - 2006: 24%
  - 2011: 26%
  - 2016: 28%

- **US**
  - 2006: 30%
  - 2011: 32%
  - 2016: 34%

**2012 - 11% of the world’s 6.9bn people are over 60**

**2050 - 22% of the world’s 9bn people will be over 60**

Japan, Ireland and Cyprus face the largest jump in ageing costs over the next decade.

In 2050 one person in three will be over 65 and one person in ten will be over 80.

Between now and 2050 the fiscal burden of the crisis will be 10% of the ageing-related costs. The other 90% will be extra spending on pensions, health and long-term care.

**Percentage of the population over the age of 65**

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2041</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong’s Ageing Population</td>
<td>13%</td>
<td>30%</td>
</tr>
</tbody>
</table>

**Proportion of working population to retirees**

- Each Retiree is supported by 6 working age adults in 2011
- Each Retiree is supported by 7 working age adults in 2041

**Life Expectancy of Hong Kong People**

- Men Age: 80.1
- Women Age: 86.7
- Men Age: 84.4
- Women Age: 90.8

Source: MPF Authority
• 2011 HK Population Census
  Age 65 and up – 13.4% (closing to an Aged Society – 14%)
  Age 60 and up – 19.3%

• #1 Life Expectancy for HK Mean & Women in 2012
  Men : 80; Women: 86.7
Trends of HK Aging Population

- Increased percentage of elderly population
- Increased life expectancy
- Increased number of chronic diseases
- Increased (and) higher institutionalization rate
- Increased elderly dependency ratio (1:2 in 2033)
• **Rising Health Care Cost Subsidized**
  - CN visit: HK$220 per visit
  - Hospital stay: HK$3200 per day
  - Pay only 20% for subsidized Residential Care Services
  - Expenditure: 9.2% of GDP by 2033

It becomes an increasingly challenging problem to provide sustainable, accessible and good quality of health care to the elderly citizens!

• **Wait Time**
  - Care & Attention places: 22 months
  - Nursing Home places: 40 months
  - Day care service: 7 months
  - Home based services: 2 months

• **Acute shortage of registered nurses, enrolled nurses and health care workers**
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ASTRI/ECE Core Competence & Technologies
System & Software + Application Domain + Experience Design

Application Software Technology
- Proximity, Image, Light, GPS, Gyroscope
- Safety
- Health
- Education
- Infotainment

Embedded Computing Technology
- Sensors
- End User Device
- Android Plus & GPU & SoC Optimization, Mobile P2P XScreen, Personal Cloud

Cloud Service Computing Technology
- Proximity, Image, Light, GPS, Gyroscope
- Accelerometer, Bio Sensors
- Network
- WiFi, 3G, LTE, Internet

User Interface & Experience
- Motion Detection, Touch Panel, Gesture Detection, AR
- Cross-platform (Window, Mac, IOS, Android)

Contents & Services
- Mobile eLearning, Patient Monitoring, Video Analytics/Surveillance

Security
- BE-DRM, DRM, Cryptographic Biometrics
- Privacy Protection
Health Related Applications

iHome Showcase at Housing Society Elderly Resources Centre

Survey Questionnaires Collection System at Hong Kong Housing Society Elderly Resources Centre for Advocate of Ageing-in-Place

Community Care Identification System for TWGHs Elderly Daycare Centers

And Others …
• Elderly friendly interface design
• Instant health condition indication
iHome - User Interface for Elderly

1. Basic Information
   - Name: 老友記001
   - Sex: 男性
   - Age: 68

2. Physiological Data
   - Blood Pressure: 140/100
   - Weight: 43kg
   - Heart Rate: 60
   - Blood Oxygen: 97%
   - Body Fat: 60

3. Physiological Reports
   - Name: 老友記001
   - Sex: 女
   - Age: 68
   - Blood Pressure: 140/100 需注意
   - Heart Rate: 60 良好
   - Blood Oxygen: 97% 良好
   - Body Fat: 需注意
   - Body Fat Percentage: --

[Images of user interface screens showing the above information]
Housing Society’s Survey Questionnaire Collection System
TWGHs Community Care Identification System

- Audible Alert
- RFID Reader
- RFID Garment
- Control Centre
- Alert Notification Interface
- Care Centre Entrance/EXIT
TWGHs Video clip

ASTRI, HKRITA and LSCM collaboration
ASTRI Reflective Pulse Oximeter

**Pulse Oximetry Module**
(15x15x1.7mm)

**IP-protected Sensor Module**
(9x11x1.6mm)
Patent No.: US 2012/0176599
CN 102727220A

**Pulse Oximetry Done**
(57x27x14.5mm, 15g)

- **Reflective pulse oximetry module**
- **Continual measurement of blood oxygen saturation, pulse rate, breathing rate and heart rate variability**
- **Key features:**
  - Unaffected by nail polish or onychomycosis
  - Wireless connectivity
  - Easy integration with consumer electronics
- **1 US & China patent under application**
How to Identify Sleeping Apnea at Home?

Multi-parameter Sleeping Test in Clinic

- **Measure oxygen saturation and heart rate variability**
- **Record the seriousness, duration and frequency of low oxygen saturation**

ASTRI’s Reflective Pulse Oximeter

*Patent #: US 2012/0176599; CN 102727220A*
Relieve Mental Stress

- Measure **Breathing Rate and HRV**
- Monitor your Breathing Rate and HRV to let you easier to improve your HRV, relieve your stress, and improve your sleeping quality by controlling your breathing
Physical Fitness and High Altitude Training

• **Continual measurement of blood oxygen saturation and pulse rate variation**
• **Data will be transmitted wirelessly for trainer to monitor the performance and adjust training intensity**
• **Allow sports lovers to monitor their health status anywhere anytime**
Non-invasive Continuous Measurement of Blood Pressure, Arterial Stiffness Index and Pulse Rate at Wrist

Measurement without disturbing the Patients
ASTRI BME’s Technology Focuses

High Speed Digital Pathology System (Digitization and Diagnosis)
Multiple technologies:
• microscope automation
• image processing
• machine interfacing
• data management

Pain Distraction

Minimal Invasive Surgery

Mobile Medicine -- Goggle base

Pulse Sensing

Diagnostic Instrumentation -- Traditional Chinese Medicine
Healthy Ageing (WIP)

**Goals:**

**Enabling Technologies for Healthy Ageing**

- Smart sensors, algorithms, SiP, SoC, and integrated health & wellness monitoring devices, image recognition
- User-friendly gateway
- Cloud-based healthcare & wellness solution platform

**Devices**

- Assisted independent living Services system
- Elderly daycare center Services system
- Personal wellness service system

**Gateway & Backend Server**

- User-friendly gateway

**Devices/Technology from partners**

- Technologies/Devices from industry partners/universities/research institutes

**Customers/Users**

- Clinics

* For devices that are not yet developed by ASTRI, we leverage the technologies from partners, e.g., wheelchair, invasive blood glucose device, etc.
How Does Technologies Improve Life?

Can technologies help?

Source: “Global Age-friendly Cities: A Guide” by WHO
Preventive Healthcare

- Reduce public medical expenditure/burden
- Huge demand in aging population
- Lower risk and less regulation
What Are Needed in Preventive Healthcare – Devices & Sensors?

- Activity/exercise tracker
- Health sensor: continual heart rate, electrocardiogram (ECG), stress/tiredness, blood pressure, arterial stiffness, blood glucose

Daily life tracking

Community Centers

- Integrated health sensors: heart rate, electrocardiogram (ECG), pulse oximetry, blood pressure, arterial stiffness, blood glucose

Housing Estate/Health Club

- Integrated health sensors: heart rate, electrocardiogram (ECG), pulse oximetry, blood pressure, arterial stiffness, blood glucose
What Are Needed in Preventive Healthcare – Gateway & Big Data?

- Cloud-based Personal Wellness Solution Platform
- Elderly Healthcare Solution Platform
- Real-time health big data
Vision
• Act as a central hub of technologies for elderly and to facilitate healthy ageing in Hong Kong

Mission
• To promote healthy and active ageing in Hong Kong so as to enhance well-being and quality of life of elderly through the use of homegrown technologies

Objectives
• To serve as a platform for the promotion and sharing of healthy ageing technologies
• To create an innovative and market-driven care delivery solution
• To generate sustainable business model through open collaboration

Targeted Members/Stakeholders
• Industry partners: device manufacturers, ISP/Network providers, IT vendors
• Customers/users: NGOs, elderly homes
• Other stakeholders: universities, research institutes, pressure groups

Contact
• Vicky Lai (tel: 3406 2616, email: vickylai@astri.org)
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• ASTRI ICT for healthcare services related projects
• Key technologies
• Lessons learned & conclusion remarks
Key Technologies

Two major areas

• **User experience**
  - User interface
  - Operation & System

• **Security**
  - Data transmission
  - Device Security
    - Closed system approach
    - Secured Android
Target audience

• Who will use? patient, nurse etc.
• Education? elderly, professional etc.
• Auto or Manual entry?

Dedicated UI design

• PC, tablet, phone?
• Portrait or landscape?
• Online or offline?
• Normal or big fonts or even graphic?
• Manual or auto input?

Conduct target user survey

Scenario/view graph to customer before actual development (programming)
It's hard to imagine how unfamiliar, alien and complicated the technologies are to elderly users.

The Cambridge Lab Where They Test How Elderly People Use Technology

http://www.youtube.com/watch?v=kS1Pz7-ACis
UX for Elderly (2)

Button was supposed to be pushed, not to be slid

Slide buttons and slide-out hidden menus on touch screen are not intuitive for elderly
UX for Elderly (3)

The elderly all ask for a bigger font

Smartphone with elderly mode

http://geek.miui.com/content-14-202-1.html
UX for Elderly (4)

The elderly are not able to decipher the meaning of icons
UX for Elderly (5)

Teaching once is not enough
• simple function, clear guidance, big font, easy to understand illustration.
• instant feedback with plain language and easy to understand illustration.
UX for Elderly (8)

Only way to an elderly friendly design – User Research
Operation & system deployment is vital

- Mostly tight with security and organization guideline & workflow
- Network infrastructure
  - wire or wireless
  - firewall
- Device consideration
  - brand, battery, interface, support, etc.

Testing is vital

- Zero-fault tolerance (healthcare industry)
- Sophisticated test plan
- Auto and random test
- Risk management design (e.g. how to handle server or device error)
Security – Data Transmission

• Medical Device -> gateway
  - Wire/Wireless (e.g. USB vs BT)
  - Encrypt transmission (need vendor support)

• Gateway -> Server
  - Encrypt transmission (e.g. HTTPS)
  - Device registration (block unauthorized device)
  - Extreme case:
    - Medical Device direct transmit to server (through SMS/IP) (rare device support)
Security – closed system device

Secure system and app log-on
- Secured fingerprint device unlocking
- Application authorization via NFC
- Power-on or Time-out password

Data protection
- Patient data encryption, including text, drawing, and images
- Auto factory reset after pre-defined failed device or application access
- Device encryption

Admin control and application security
- Controlled Android application access and setting for security measure
- Admin control to restrict the access of external SD card and USB
- No user application installation and debug (prevent 3rd application, malware, intrude from day one)
Security – Secured Android Device

- Open system with closed system advantage (third party application coexist with enterprise one without sacrifice security)
- Increasing desire to use commodity mobile devices throughout enterprise (e.g., hospitals, elderly healthcare centers, government, etc.)
- What is Secured Android?
  - Enhance policy for attribute permission (fine-grain control)
  - Confines privileged daemons with damage limitation
  - Prevent privilege escalation
  - Strong separation among apps
  - Prevent general “Root” exploit
  - Multi-profile (personal/enterprise)
  - Private key protection
Secured Android Architecture

* File system enhancement, extend attribute, Linux security module and audit
** Policy Management, modified package, activity, content and resource managers
Flow of Healthcare Service (Simplified)

Data Collection

Data Analysis

Sharing & Notification
Data Collection (Multi-wireless Interfaces & Presentation)

- Various interfaces of medical devices, how to manage?
- A cast of thousands (from BT, ANT+, USB/serial etc.)

BLE vital sign measurement devices are coming!

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Device Type</th>
<th>Model Number</th>
<th>Interface Type</th>
<th>Interface Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonin</td>
<td>Oximeter</td>
<td>9560</td>
<td>BT</td>
<td>Proprietary/Continua</td>
</tr>
<tr>
<td>Omron</td>
<td>Blood Pressure Monitor</td>
<td>HEM-7081-IT</td>
<td>BT</td>
<td>Proprietary/Continua</td>
</tr>
<tr>
<td>Omron</td>
<td>Precision Health Scale</td>
<td>HBF-206IT</td>
<td>BT</td>
<td>Proprietary</td>
</tr>
<tr>
<td>A&amp;D</td>
<td>Blood Pressure Monitor</td>
<td>UA-767PBT</td>
<td>BT</td>
<td>Proprietary</td>
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<tr>
<td>A&amp;D</td>
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<td>Continua</td>
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<tr>
<td>FORA</td>
<td>Blood Glucose Plus Blood Pressure Monitoring System</td>
<td>D40b</td>
<td>BT</td>
<td>Continua</td>
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<tr>
<td>CLEVER</td>
<td>Ear Thermometer</td>
<td>TD-1261</td>
<td>BT</td>
<td>Proprietary</td>
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<tr>
<td>iHealth</td>
<td>Blood Pressure Monitor</td>
<td>BP7</td>
<td>BLE</td>
<td>BLE HDP standard</td>
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<tr>
<td>A&amp;D</td>
<td>Blood Pressure Monitor</td>
<td>UA-851ANT</td>
<td>ANT+</td>
<td>Standard</td>
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<td>Oregon</td>
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<td>PE912</td>
<td>ANT+</td>
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<tr>
<td>Oregon</td>
<td>Hart Rate Monitor</td>
<td>SE836</td>
<td>ANT+</td>
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<tr>
<td>Scientific</td>
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</table>

- Management & presentation to support various healthcare services
Dynamic Device Management from ASTRI

- Medical Device Profile could include devices related GUI display template, protocol, etc.
- The measurement data will not be parsed with semantic meanings in the client. Only the medical device profile can tell what it is.
- Adv: server can dynamically update client to handle as many devices as possible without predefined.
- Adv: server can update GUI template to dynamically support new application feature with the device. Also, using template mechanism in local client can enhance user experience vs. web browsing mechanism.
- Adv: minimize the effort to development / deployment of client.
Data Analysis

Clinical Data (e.g. eHR)

Behavioral Data (e.g. Mobility sensor data, Social network data, etc.)

Analyzer (e.g. Big Data analytic, Knowledge based analytic)

Point of care

Statistic

Research
Data Analysis (Knowledge based)

Score-based Risk Assessment (e.g., diabetic awareness)
## Sharing & Notification

### 1. Schedules
- Alerts

### 2. Health data upload

### 3. Health data
- Sharing/Notification

### Public notification servers
- e.g. Telco SMS server, Google/IOS push server

- Share/Notify with families members or
- Share/Notify with authorized parties like doctor/nurse
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Lessons Learned

• **Focusing on solution**
  – Workflow/Operations
  – User experience

• **Focusing on data protection**
  – Closed system approach
  – Secured Android
Conclusion Remarks

• Growth of ageing population is an inevitable trend

• ICT can play an important role, in particular of increasing smartphone/table penetration

• Mobile operator is an obvious important player

• Insurance company is a neglected important player

• Focus on Solutions, not Technology
Vision
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End of Presentation
Thank you. Questions are welcome.

Our corporate website: www.astri.org