Healthcare Today

Opportunities
- Telemedicine
- Clinical Decision Support Systems
- Smart home-based healthcare system
- Wireless and wearable medical sensors
- ...

Challenges
- Limited resources in healthcare (e.g., nurses, physicians)
- Healthcare provisioning anywhere & anytime
- Healthcare practitioners as decision makers
- ...

Motivation

Online PHR Systems
- Online platforms that record the health information of clients such as health condition, medications, allergies and lab results.
- Big players: Google Health & Microsoft HealthVault
- Direct access to Personal Health Services such as:
  - Import medical records
  - Explore medications and treatments
  - Convert paper records
  - Find personalized tools
  - Copy and share records

Google Health

Motivation

Personal Health Services

Health Information
- Collect patient’s health data such as blood pressure, blood sugar, etc.
- Upload the collected data into websites or an online PHR system.
  - E.g., Microlife’s BP monitors

Mobile Devices

Contextual Information:
- Collect client’s context such as location, temperature, timing, etc.
- Store the collected data into their internal memory.
- E.g., iPhone Apps
Motivation

Fitbit

- Tracks the calories burned, steps taken, distance traveled and sleep quality.
- Records the person’s motion in three dimensions and converts it into information about daily activities.
- Transfers the recorded data to Fitbit.com.
- Can upload the collected data into the client’s Google Health account.

Virtual Remote Nursing System

Objectives

- Provides a virtual nurse (vNurse) agent that is installed on client’s personal computer or smartphone and performs different tasks assigned by healthcare practitioners.
- Task is defined as a function on client’s health and contextual information to generate health-relevant information for both clients and healthcare practitioners (e.g., health reports, warnings).
- Healthcare practitioners are the decision makers. No decisions are made by the vNurse.
- Generic task definition mechanism for health care practitioners. Any healthcare practitioner with a basic level of computer knowledge can define tasks for the vNurse.

High-level Overview

Generic Task Definition

- We define “Task” formally as:
  Task = <Task Schedule, Task Model, Task Knowledge, Task Data>

  Task Model: what to do (Business Process Model)
  Task Knowledge: how to do it (Business Rules & Actions)
  Task Data: resources (Business Data)

- In VRN:
  Task Model  Medical Workflow
  Task Knowledge  Medical Guidelines
  Task Data  PHR & Context

Task Example

- A physician assigns to vNurse a task to report the general health status of a client every week (task schedule).
  To perform this task, the client’s vNurse follows a medical workflow consisting of three steps: first, checking the patient’s blood pressure; second, checking the patient’s body temperature; and finally make a report (task model).
  Each step corresponds to a set of medical guidelines that define the patient’s status for each range of blood pressure or body temperature, which can be low, normal, or high (task knowledge).
  Finally, the information obtained is reported in a specific medical format (task data).

Task Example ...

- Task Schedule:
  Task Model
  Task Knowledge
  Task Data
16-01-02

VRN Version 1.0

- Developed in Java (J2EE 1.5) for PC
- Google Health as the on-line PHR system
- vNurse has a built-in Drool business rule engine (v5.0) to run business processes (apply business rules and execute business actions)
  - Medical workflows: Rule Flow (converted in XML)
  - Medical guidelines: Business Rules and Business Actions (converted in PMML)
  - Task Data: Java Beans (serialized in SOAP messages)

- Provided by two Java packages:
  - Task Definer: provides graphical APIs and widgets for a medical practitioner to define tasks and send them to a virtual nurse.
  - vNurse: provides APIs to install the virtual nurse and connect it with local and remote clients.
- VRN App for mobile devices is under construction

VRN Version 1.0

Virtual Nurse basic functions stored in the internal knowledge base.

<table>
<thead>
<tr>
<th>Name</th>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>pHeS (F, HbA1c, Glucose)</td>
<td>F, HbA1c, Glucose</td>
<td>Checks the values of the PHR fields in the PHR system.</td>
</tr>
<tr>
<td>pHeM (F, HbA1c, Glucose)</td>
<td>F, HbA1c, Glucose</td>
<td>Checks the average of the PHR fields over a defined period.</td>
</tr>
<tr>
<td>changePHeS (F, HbA1c, Glucose)</td>
<td>F, HbA1c, Glucose</td>
<td>Returns true if the PHR field just changed more than its corresponding threshold.</td>
</tr>
<tr>
<td>pHeSum (F, HbA1c, Glucose)</td>
<td>F, HbA1c, Glucose</td>
<td>Returns the requested information about the client.</td>
</tr>
<tr>
<td>call (Phone Number Message)</td>
<td>Phone Number Message</td>
<td>Makes a call to the defined phone number and tells the message. It uses a textSpeech function to convert the message into a voice message.</td>
</tr>
<tr>
<td>send (Email Address Message)</td>
<td>Email Address Message</td>
<td>Sends the message to the defined email address.</td>
</tr>
<tr>
<td>actionTime (Period Start Date End Date)</td>
<td>Period Start Date End Date</td>
<td>Returns true if the current time matches with the expiration time of the action. For example, actionTime (&quot;multiple&quot;, 2, 0, 0, 0, 0, 0, 0, 0) says the expiration time for the next action is every two days from Start Date to End Date and at the Time.</td>
</tr>
<tr>
<td>makeReport (Report Template)</td>
<td>Report Template</td>
<td>Makes a report based on the retrieved template that specifies the required PHR information in a proper format.</td>
</tr>
</tbody>
</table>

VRN Version 1.0

Case Study

Scenario

- Sherry is an elderly woman with type 2 diabetes. She has a vNurse installed on her smartphone and a blood glucose sensor.
- Her physician wants to ensure that Sherry stays on her diet until her next regular monthly appointment and how well the prescribed medications work during this period. Since, Sherry is at the risk of hypoglycemia (i.e., low blood sugar level) that could result in losing consciousness. Consequently, the doctor wants to make sure she receives emergency medical services promptly in the case of extreme hypoglycemia.
- The pharmacist wants to make sure Sherry does not forget the right dosage, time, and frequency of her medication that are prescribed by her doctor. Moreover, since the prescribed medications could cause side effects, he wants to have Sherry's doctor informed if the medications cause any complications.
- In a case of an emergency situation, the emergency center needs to access the latest information about Sherry's health condition.
Case Study: Hypertension

Check Blood Pressure Task  Emergency Task  Weight Management Task

Hypertension Diagnosis Task  Diet Management Task

Hypotension Task  Treatment Evaluation Task  Treatment Change Task

Future Work

Interactive Virtual Remote Nursing system where an assigned task can be accomplished through the collaboration of the patient and the virtual nurse.

Smart Virtual Remote Nurses system where healthcare providers will also be able to assign some simple decision making tasks to the virtual nurse.

Next Version – Smart VRN

- Each behavioral pattern is a relationship between patient’s PHR and context.
  PHR Fields * Context Fields --> PHR Fields
- Healthcare practitioner assigns a task to the vNurse where task knowledge is partially patient’s behavior.
- Example: vNurse learns the situations when the client experiences high BP; then the client’s physician assigns a task to the vNurse to remind the client to take BP medication at those situations.

Thank You