Smartphone Applications for Medication Management

Introduction and Overview:
The objective of the Computer Science Design Laboratory this semester is to provide exposure to a wide range of emerging technologies related to biomedical informatics, focusing on:

- Personal Health Records (PHR) such as Google Health (https://www.google.com/health) and Microsoft HealthVault (http://www.healthvault.com/).
- Electronic Medical Records (EMRs) specifically the General Electric Centricity EMR (www.gehealthcare.com/usen/img_info_systems/centricity_clin_info/products/phyoffice.html)
- Smartphone applications for multiple platforms (e.g., Android, Blackberry, iPhone, and Microsoft) with an emphasis on having these applications interact with PHRs and EMRs to store and retrieve patient health information.

The objective this semester is to bring all these technologies together into an integrated environment, with the Smartphones integrated via an emulation/simulation model (which is available in each of the different products’ development platform). In doing so, you will be working with existing software that interacts with Google Health, and working at times with graduate students who are focusing on projects related to health information exchange (HIE).

The Robert Wood Johnson Foundation has sponsored Project Health Design which is targeting the use of PHRs to improve patient care (http://www.projecthealthdesign.org/). Specifically: “Project HealthDesign stimulates innovation in the development of personal health record (PHR) systems by transforming the concept of PHRs as data collection tools to PHRs as a foundation for action and improved health decision-making.” Their Round 2 proposal last year (http://www.rwjf.org/applications/solicited/cfp.jsp?ID=20762) focused on whether and how information about patterns of everyday living can be collected and interpreted such that patients can take action and clinicians can integrate new insights into clinical care processes. Such patterns are called **Observations of Daily Living (ODL)** and focus on information that patients can provide on a daily basis that could assist in their care and treatment of chronic diseases (e.g., congestive heart failure, diabetes, obesity, asthma, osteo-arthritis, etc.) by having this information available for use in individual and summary forms to physicians. The key issue will be to determine the appropriate technologies and platforms to utilize to collect ODLs on chronic diseases, which for our purposes this semester will be: Google Health, GE Centricity, and multiple Smartphone Platforms (Android, Blackberry, iPhone, and Microsoft). The applications that are to be developed for ODLs are in general very limited in terms of functionality. However, we want to explore the bound and limits of the technologies, so ODLs such as accelerometers (general movement) or pedometers (walking) which may be possible for some smartphone platforms are also of interest.

### Observations of Daily Living (ODLs)

There are two types of ODLs: passive and active. **Passive ODLs**, like an accelerometer or pedometer, once enabled, collect data for a pre-determined (or user defined) time period; at the end of the period, the data collected from the passive ODL must be uploaded in an appropriate form to a PHR and/or EMR. Passive ODLs are initiated by a participant, but after activation, there is limited involvement. There are many examples. First, using a pill bottle that sends a time-stamped message to a Smartphone that the bottle has been opened, and recording all instances of opening the bottle. Second, installing a accelerometer application on a Smartphone that can passively send information on movement for each participant, which can be set up to occur at a specific time. **Active ODLs** require specific input from patients, related to a particular chronic disease (or diseases), collecting relevant information on a periodic basis (e.g., daily, twice daily, hourly, weekly, etc.); this information is actively entered by a patient and also uploaded to a PHR and/or EMR. This longitudinal information on a patient’s condition can
be instrumental as health providers seek to assess their patients over time, seeking to refine
treatments, notice potential problems before them require hospitalization, and so on.

Active and passive ODLs will be employed to gather information from participants on a
scheduled basis (e.g., daily, weekly, etc.). Sample active ODLs include: We anticipate that
these measures will include such items as fatigue, pain, functional status and adherence to the
management plan for individuals with osteo-arthritis, chronic fatigue, or some other diseases;
pulse, blood pressure, and weight, for individuals with heart or blood pressure problems;
glucose levels and insulin injected (for each time the glucose is checked), and weight (on a
different schedule) for individuals with diabetes; and so on. Note that some of these ODLs may
be regularly schedule (e.g., the smartphone beeps a reminder), triggered as the result of a
contact to the patient (e.g., an automated call or email to the smartphone), or initiated by the
user. The numerical values are tracked for each individual to capture all of the values entered.
In addition, there may be more advanced ODLs that involve the collection of information on
medications that are being taken to cope with pain. There are a few possibilities in this regard:
using a scanner on a Smartphone to “record” the medication when it is being taken by scanning
the label; or, using a camera cell phone to take a “picture” of the medication that can be then
uploaded to the web or sent as a text message. Alternatively, a user may be provided with an
application that is a series of screens to allow prescription information to be entered, and that
information is then synchronized with the PHR and/or EMR.

Technical Approach, Feasibility, and Viability

Our technology approach will be three-fold: user-centered design and requirements definition for
to obtain vital input from patients in regards to ODLs as realized in Smartphone applications;
providing a platform and associated technologies that results in a seamless integration of
access by patients and their health care providers to all facets of the system. The PHR will
serve as the remote storage repository for active and passive ODLs that are collected from each
patient, that is maintained by a third party (Google), which dramatically reduces the functionality
requirements for our solution, and places the onus on the vendor to support privacy, secure
communication, storage, and other requirements.

Platforms and Technologies: The platforms and technologies chosen to support the collection
and storage of ODLs, are summarized from a software architecture perspective in Figure 1. In
tracking ODLs, we must ensure that all of the ODLs are stored to allow historical tracking of this
information and facilitate generation of reports or displays to collate information over time. From
a technical perspective, Google Health’s application programmer interface (APIs) and web
services which are primarily Java-based, and use the continuity of care record standard, CCR
implemented in XML Schema (http://www.astm.org/Standards/E2369.htm,
http://www.centerforhit.org/online/chit/home/project-ctr/astm.html).
Smartphone Applications for Medication Management

At the patient side, access to the active ODLs (scripted solicitation on ODLs to-be-determined by patients) will be through a SmartPhone. As shown in Table 1, assembled from http://www.gartner.com/it/page.jsp?id=910112, http://360degreesolution.spaces.live.com/default.aspx?sa=818879934, and http://blog.techneos.com/blog/research-in-a-mobile-world-6, there are five different platforms of SmartPhones. In the US, BlackBerry, iPhone, and Windows Mobile phones dominate the market. From a development perspective, we have the potential to collect data on multiple ODLs simultaneous (e.g., a patient has a pedometer application running while accessing a lifeline).

Table 1: SmartPhone Varieties and Market Share.

<table>
<thead>
<tr>
<th>Platform</th>
<th>Symbian</th>
<th>BlackBerry</th>
<th>iPhone</th>
<th>Windows Mobile</th>
<th>Android</th>
</tr>
</thead>
<tbody>
<tr>
<td>World market share</td>
<td>47.10%</td>
<td>19.50%</td>
<td>10.70%</td>
<td>12.40%</td>
<td>&gt; 1%</td>
</tr>
<tr>
<td># US users</td>
<td>888,535</td>
<td>9,668,977</td>
<td>5,258,254</td>
<td>6,807,554</td>
<td>427,914</td>
</tr>
<tr>
<td>US market share</td>
<td>3.9%</td>
<td>41.9%</td>
<td>22.8%</td>
<td>29.5%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Development</td>
<td>C++</td>
<td>Java</td>
<td>Objective C</td>
<td>Windows</td>
<td>Linux</td>
</tr>
<tr>
<td>Dev Environment</td>
<td>Visual Studio</td>
<td>Blackberry/Java</td>
<td>Mac OSX</td>
<td>Visual Studio</td>
<td>Linux</td>
</tr>
<tr>
<td>Resolution</td>
<td>various</td>
<td>various</td>
<td>480x320</td>
<td>various</td>
<td>various</td>
</tr>
</tbody>
</table>
PHA iOS Application

Main Menu & Settings Menu

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Wellness Diary

Observations of Daily Living

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