CSE494/598 Mobile Health and Social Networking (Sp2009)
Takehome Midterm
Due on Tuesday, April 14, 2009
[cse494: 130 pts + 20 Extra credit, cse598: 140 pts + 10 Extra Credit]

Submission procedure: email to **cse494sp09@impact.asu.edu** before the class AND submit hardcopy in class.

Note: You are expected to work on this midterm all by yourself – no collaboration. Cite all sources you consult for coming up with your answer.

1. [20 pts] Provide a brief written narrative for the class. [See http://www.units.muohio.edu/technologyandhumanities/nardef.htm for what a narrative is.]

2. [20 pts] Human-Centered
   a. Why is it important to take a Human-Centered approach for developing applications in the domain of mobile health and social networking?

   Sample solution:
   - Definition of human-centered design
   (Reference: Distractions and Context-Aware Computing and Human-Centered Distributed Information System Design)
     - Human is the part of systems.
     - Human resources become more expensive than technology as fast advances in technology.
     - Human-centered computing focuses on understanding of humans both as individual and in social groups) and developing applications tailored to users.
     - Human centered approach eliminates user's effort to accept technology and minimizes user attention.
   - Characteristics of mobile health and social networking
     - Resource limited mobile devices: Instead of having more generic features, they should be personalized for specific purpose.
     - Wide range of user groups: Users in these applications have different levels of education, capability, and technical skill. The applications should be easy to use and learn.
     - Pervasive computing: These applications are used to make day-to-day life more convenient. It needs to minimize distraction.
   - Needs of human-centered design in mobile health and social networking
     - To develop personalized and intuitive application with minimal distraction, identifying human activities and interactions between artificial and human agents in the application is required. So, the human-centered approach is important in mobile health and social networking.

   Grading Rubric:

3 pts	Understanding of a human-centered approach
3 pts	Understanding of mobile health and social networking
4 pts	Clearly justifying the importance of a human-centered approach in mobile health and social networking

b. What is the importance of ethnography in developing Human-centered application design?

Sample solution:
- Definition of ethnography
(Reference: Slides on An Ecological Approach to Design: netWORK and ContactMap)
  - Human behaves differently in different environment.
  - Ethnography is the branch of anthropology studying the scientific description of individual cultures.
  - It includes the characteristic of the patterns of human activities and interaction in different ethnic group and culture.
- Human-centered design
(Reference: Human-Centered Distributed Information System Design)
  - The system should be tested and verified in the real world, not in the lab environment.
  - An application designed with human-centered design should do exactly what users want, need and expect.
  - It addresses the problem to evaluate the system's usability which traditional approaches do not generally address.
- Ethnography is one way to validate the application with human-centered design in the natural environment.

Grading Rubric:

3 pts	Understanding of ethnography
3 pts	Understanding of human-centered design
4 pts	Clearly justifying the importance of ethnography in developing human-centered application design

3. [20 pts] Personalized social networking and People-Centric Sensing
   a. How can ContactMap work be adapted to mobile platforms?

   Sample solution:
   - Basics of ContactMap
   (Reference: Integrating Communication and Information through ContactMap)
     - ContactMap visualizes personal social networks.
     - It allows users to model and arrange their own social networks in maps of individual contacts and groups.
   - Adaptation to Mobile platforms
   (Reference: slides on the mobile computing)
     - User Interface: User interface should be adapted to the small screen of mobile devices. One example of representation is to show icons of groups first and then show the visual map of the selected group.
     - Various communication tools: Contacts can be extracted from various communication tools, such as calls, emails, text messages, and voice mails.
     - Client-server model: Due to the resource constraint of mobile devices, ContactMap for mobile platforms can be designed as the client-server

model. The server processes heavy works such as analysis and send the results to the mobile client.
- Connectivity: Mobile ContactMap application should be sensitive to the connectivity of wireless networks. So, the application can switch the client-server mode to the local processing mode.

Grading Rubric:

2pts	Understanding of ContactMap applications
2pts	Understanding of mobile computing and design challenges
6pts	Applying ContactMap to mobile platforms properly and providing some interesting features

b. How can CenceMe (people-centric sensing) and ContactMap (personalized social networking) be used in the domain of mobile healthcare applications?

Sample solution:
- Basics of ContactMap and CenceME
(Reference: Integrating Communication and Information through ContactMap and Sensing Meets Mobile Social Networks: The Design, Implementation and Evaluation of the CenceMe Application)
    - ContactMap provides the technology to arrange the user's personal social network in a visual map of individual contacts and groups.
    - CenceMe provides the technology to sense what a user is doing at any given time.
- Adaptation to mobile healthcare application
    - Remote monitoring: CenceMe could be applicable for remote monitoring of patients in mobile health care applications. There could be additional medical sensors to monitor patients' health condition.
    - Alerting: When there is abnormal activity or extreme condition, the application can send the alert to doctors and nurses.
    - Intelligent emergency contacts: ContactMap can be used to contact to patient's family in emergency case. Based on the patient's location information from CenceMe, ContactMap can decide who should be contacted based on his/her family's location.
    - Synergy: CenceMe or ContactMap itself does not meet all requirements of mobile healthcare applications. Combining these two applications can be very useful for mobile healthcare system.

Grading Rubric:

2pts	Understanding of ContactMap and CenceMe
2pts	Understanding of mobile healthcare applications
6pts	Applying applications to mobile healthcare systems properly and providing some interesting features

4. [30 pts] Context awareness and pervasive computing
    a. One could argue that, to a context-aware application, a "context" is just another input parameter—it is just not given by the user. Can you give two

different and simple examples of context-aware applications that support this argument?

Sample solution:
- Reference: slides on context-aware computing
- In location-based services, location context can be considered as another input parameter.
- The users, instead of asking "what are the banks within a 2 mile radius from Dobson & Broadway", they simply ask "what are the banks within a 2 mile radius" and the application get the other parameter (location) from the GPS service.
- In travel planning, the current traffic context can be considered as another input parameter in estimating the travel time. The user, instead of asking "what is the estimated travel time under an average speed of 50 miles per hour", they simply ask "what is the estimated travel time if i leave now".

Grading Rubric:

3 pts	Understanding of context-aware computing
7 pts	Providing two proper examples and clear explanation

b. Taking a second thought on (a), how would you argue that there is more to context than it just being a parameter not given by the user?
[Hint: think i) how context information is organized and represented ii) what design considerations exist for context-aware applications that are not for context-oblivious applications]

Sample solution: There are design considerations that give greater non-triviality to creating a context-aware application to do the following:

- Context information discovery and retrieval: it is possible that the context information is not readily available, and the application has to actively seek for it using the available software and instrumentation. Also the information may be distributed and it has to be gathered from many sources. This raises many considerations, including handling different formats, accuracy, and resolution levels, as well as dealing with incomplete information.
- Context level and synthesis: the context information retrieved can be at a raw, low level (e.g. raw GPS data), where it needs to be of high level (e.g. a street address or connotational information such as "my home", "my work" etc). Also, some context information may need filtering to remove user-irrelevant information.
- Creating a pervasive environment of acceptable level. As the user is potentially unaware of the context information, decisions based on the context may be perceived as non-intuitive or intrusive to the user (e.g. an application that directs the driver through an online-posted detour while the logical or usual route is to drive straight can be considered as untrustworthy).

Grading Rubric:

3 pts	Understanding of context-aware computing

7 pts	Identify some of design considerations and justify your answer clearly

c. The automatic transmission in cars can be perceived as a pervasive intelligent agent, which makes the shifting of gears transparent (i.e., the driver does not have to shift gears). Describe the various active contexts and construct a context-driven (event-driven) gear-shifting state transition diagram.
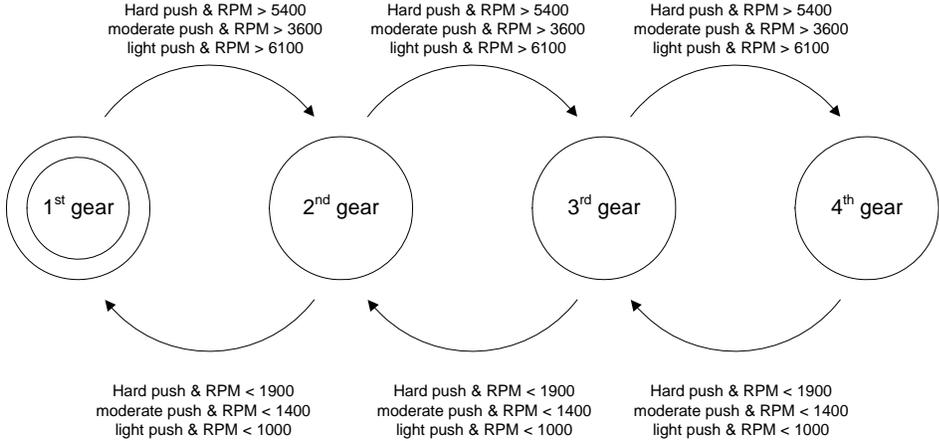
Sample solution: Automatic gear transmission is generally based on three inputs: engine RPM & speed, gear umber, and gas pedal position. The following graph shows typical nominal relation between RPM and speed:
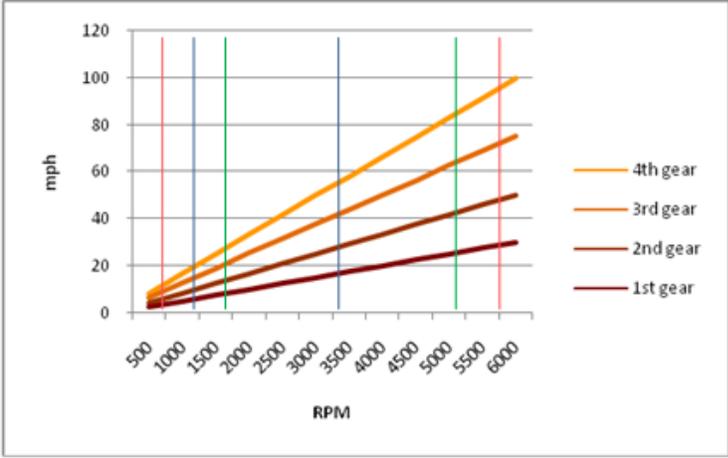
In the graph above, the red vertical lines define the engine-safe RPM range, the green vertical lines define the "performance" RPM range, while the blue lines define the "economy" RPM range. The pedal position shows how hard the engine needs to try according to the driver. The pedal position can be categorized into three levels:

a) Light push or no push
b) Moderate push
c) Hard push

Hard push signifies a performance demand from the driver, moderate push signifies an economy push from the driver, while the light or no push signifies that the driver is slowing down.

5. [30 pts] Localization, location management and caching
   a. In wireless computing, ***localization*** and the ***search operation*** are both about finding where wireless nodes are. Can you identify the differences between the two operations?

      Sample solution:
      - Reference: Location Management Services and Localization
      - The main difference is that localization refers to finding the physical position of the nodes, while search refers to finding the topological location (i.e. the "point of attachment") of a node. Moreover, localization usually assumes stationary nodes, while search usually assumes moving nodes (in fact, predictive search schemes assume a mobility model to make predictions of a user's location). Lastly, from an agent's point of view, a localization agent uses signal information from nodes, which means that the nodes have some active connection with the localization agent, while a search agent does not have an active connection and it needs to discover their topological location.

   b. In contemporary cellular networks, there is a lot of packet-switched data traffic in addition to the traditional call-based circuit-switched voice traffic. Using the traditional call-to-mobility ratio definition to analyze the performance of a location management scheme in a mixed voice-data network makes little sense. How would you revise the definition of call-to-mobility ratio to accommodate the mixed nature of traffic?

      Sample solution: There are two ways that CMR can be redefined: convert the data traffic to call-like traffic or convert the call traffic to data traffic.

      For the first option, we can consider the data session set-up requests as calls. Then, the CMR is redefined as:
          (1) CMR = (Calls + sessions) over updates (from calls over updates).
      For the second option, we can consider the calls as data traffic. Then, everything can be defined on packet traffic, thus:
          (2) CMR = packets (or bytes) over updates.
      However, to fully answer the question, we have to consider the underlying network infrastructure. In circuit-switched networks, a CMR makes sense because it captures the cost of contacting an HLR and then setting up a circuit (virtual or not). In packet-

switched networks, such as IP, there is no cost of a circuit setup, as all traffic can be packet-switched through the home agent. If the underlying technology is circuit-oriented, then we need to use the definition 1; otherwise, it makes more sense to use the definition 2.

c. [Extra Credit for 494/Required for 598] Two client nodes, A and B, access the same data item. Node A reads the item with Poisson process of a rate of r_A, and writes it with a rate of w_A. Node B reads the item with Poisson process with rate of $r_B = ar_A$ and writes it with Poisson process with $w_B = (1/a)w_A$. There is the option of either globally using a pull mode (ask for the freshest copy before every read) or globally using a push mode (write-through to the other node with every write). A data communication between the nodes costs d. For what values of (d, a, r_A, w_A) is the pull mode more efficient than the push mode?

Sample solution: We estimate the cost of the pull mode and push mode with respect to the parameters:
1. Pull mode:
   i. Node A: $d\ r_A + 0*w_A$
   ii. Node B: $d\ \alpha\ r_A + 0(1/\alpha)\ w_A$
      $Cost_{pull} = d\ (1+\alpha)\ r_A$
2. Push mode:

   i. Node A: $0\ r_A + d\ w_A$
   ii. Node B: $0\ \alpha\ r_A + d\ (1/\alpha)\ w_A$
      $Cost_{push} = d\ (1+1/\alpha)\ w_A$

Pull mode is mode efficient when:
   $Cost_{pull} < Cost_{push} => d\ (1+\alpha)\ r_A < d\ (1+1/\alpha)\ w_A =>$
   $(1+1/\alpha)/(1+\alpha) < r_A/w_A => \alpha\ r_A < w_A$

6. [30 pts] Health Care and Social Networking
   Consider a recurring street market setting (i.e. a bazaar), where merchants gather at frequent intervals and sell their seasonal merchandise. The availability and stock of merchandise items is not persistent, i.e., items that appear at one market "instance" may not be available next time the market occurs (examples of street markets are farmers street markets or artisans street markets). Also, merchants may choose not to participate at a market instance. The computer application in question is based on the work of "Designing A Smart Shopping-Aid System Based on Human-Centered Approach" (as discussed in class) and, in

addition to providing features to shoppers, it will provide functionalities and features to the participating merchants.

a. You are asked to consider any desirable functionality and features for the shoppers (that enhance their shopping experience) given the nature of this market, and any desirable functionality and features for the merchants (that enhance their services and chances of sale).

Sample solution: For merchants, the software should provide a means to register their products and prices, as well as provide form of "store page" with announcements and merchant info. The merchants can add specific comments or customized descriptions to their products if they wish. For customers, the software should provide a means to search for a merchant or a product, and show their location(s). It should also provide sorting and filtering capability according to various criteria, such as price, origin and specific content.

Enhancing the traditional reputation-based rating of street markets, the application can provide rating and commenting ability, as well as the ability to view (and dispute) those comments and ratings.

A fancy functionality could be to calculate a "shortest travel route" to buy all products in a shopping list. This functionality relates to the well-known "traveling salesman" problem.

Grading Rubric:

2 pts	Understanding of a smart shopping application
5 pts	Providing some interesting functionalities and features

b. [Extra Credit: 10 pts] Continuing from (a), provide a user analysis (and distributed user analysis), and a functional analysis (and distributed functional analysis) of the application, as identified by the features you described.

c. How would you enhance the application if:
- shoppers came grouped (e.g. family or group of friends)
  Sample solution: The application could provide a functionality to split the duties and help track group members in case a member went out of sight. It can provide some ephemeral group capabilities, such as joining and leaving a party.
- the market is considered an opportunity of social gatherings.
  Sample solution: This is an extension to the previous sub-question. The application can provide a rendez-vous point for people to meet at (which can be set up while they are still at home), or view available friends that are shopping and then set up a rendez-vous. Moreover, it could assist shoppers in providing a list of attractions and events that can be attended after the shopping activities end.

Grading Rubric:

2 pts	Understanding of a smart shopping application and related concepts
5 pts	Providing some interesting functionalities and features

d. The market is a crowded place, where accidents are likely to happen, and many people (especially the merchants) are out-of-towners. How would you enhance the application to assist paramedics offer their services in such an environment?

Sample solution: There are three aspects that an application (and the end-point device) can be enhanced to help with medical emergencies:
- **Patient**: the device can gather health information, perhaps trigger an audible alarm signal to signify that the device bearer needs medical attention.
- **Paramedics**: the application can provide the location of the patient, shortest route, as well as possible health information.
- **Rest of the crowd**: the application can direct the shoppers to make way for the paramedics so that precious time can be saved.

In a similar manner, the application can be useful in directing the evacuation of the market area in case of emergency.

Grading Rubric:

2 pts	Understanding of related concepts
2 pts	Identifying user groups properly
2 pts	Explaining ideas clearly