ABSTRACT
Context Messages is a system that allows the user to send messages when they are most relevant to the receiver’s context. The context could be based on location, weather, time, availability, activities being performed, traffic, etc. We describe an implementation of the system using some of these contexts on the Google Glass platform. We conducted user studies to evaluate the easy of use and learnability of the system. The system received an average score of 6.3 out of a 7 point Likert scale in terms of learnability with a small variation of 0.23 points between users. From the user study, we uncovered concerns of privacy and of false triggering of menu prompts. We introduce a privacy web interface and redesign our menu system to address these concerns.

ACM Classification Keywords
H.5.2. User Interfaces: Miscellaneous; H.5.2. Interaction styles

Author Keywords
interface design; privacy; context-based; messaging; wearable computing

INTRODUCTION
The always-on always-ready vision for wearable and ubiquitous devices has been described as almost essential for smooth interaction with them [5]. Ubiquitous devices have to be constantly available, but they also have to not get in the way [4]. An important aspect of not getting in the way is by only presenting information to the user when it is relevant to their context. It may be frustrating for users to receive untimely messages, especially if they cannot act upon the messages at that moment. In addition, users may desire to send messages to others only in certain contexts of themselves. In our previous work, we created a system on the Google Glass which aimed to follow this principle. The purpose of the system was to allow users to send messages based on contexts. The interface that we developed is shown in Figures 1 and 2.

This time, to evaluate our system, we conducted a user study with our system. From the lessons in the user study, we added privacy options to our system. We also changed the user interface to aid in ease of discoverability. In the next section, we briefly discuss related work. Following that we provide results of our user study, description of the privacy options and interface changes. The following two sections are for discussion and future work.

RELATED WORK
To our knowledge, there is no pre-existing context-based messaging system for the Google Glass. However, a system was created that sent context-based reminders to a wearable computer [3]. The contexts were based on time, location, and activities of the user, but required pattern recognition for identifying these contexts. Our system allows the user to decide the context of when a message should be sent. This is similar to a reminder system which allowed users to choose the context of when the reminder would be received [1]. This, however, was for reminders and not messages. Finally, a system was created that sent context-based messages to all people under a certain context for an ad-hoc networks [2]. For example, a network could consist of a group of firefighters, and a message could be sent saying where the fires were most prevalent. This system was not created for directing messages towards specific users, though.

USER STUDY
In order to evaluate our system we conducted a user study with 10 participants, 30 minute session each. Users were first asked whether they were familiar with Google Glass. If the user was not familiar with the device, they were given a short tutorial on the interaction styles of Glass, such as swiping the touchpad and using spoken commands. Next, the user was asked to start the demo. They were encouraged to explore the application by sending multiple messages to two other people (dummy contacts) and sending themselves self-notifications. Subjects were free to send as many messages as they wanted within the 30 minute time frame. Once users were comfortable with how the system worked, they were given a brief survey to take. The survey contains 8 questions related to the experience of using the system, and a free response area for any other comments the subjects wanted to include. Users were asked to rate different aspects of the system using a Likert scale. The participants were also asked about their familiarity with Glass on scale of 1-5, 5 being most familiar and 1 being not familiar at all.

Below are the questions we asked the users in the survey. The directions given for the survey were "Answer questions with a 1-7. 1 for strongly disagree and 7 for strongly agree".
1. Overall, I am satisfied with how easy it is to use this system
2. It was easy to learn to use this system
3. The cascading menu scheme made sense to me
4. I am concerned about the privacy implications of this system
5. The information provided for the system is easy to understand
6. The information is effective in helping me complete the tasks and scenarios
7. The organization of information on the system screens is clear
8. This system has all the functions and capabilities I expect it to have

There results of the study were generally positive, with an average ease-of-use rating of 5.6 out of 7, and a learnability rating of 6.3 out of 7. The users’ familiarity with the device varied greatly, with a mean rating almost midway through the scale (3.6) but with a high variance of 2.04 points. There was a correlation between having familiarity with glass and how high the user rated the system, with users who were more familiar with the device giving higher ratings overall. One exception to this was participant 7, who had almost no familiarity with Glass but rated it highly. This may be due to the fact that although participant 7 is was not familiar with Glass, they were familiar with wearable technology and a student in a technological field. Also noteworthy are the ratings for our cascading menu interface, in which all participants rated it a 5 or higher. Comments that were made about the system include “originally didn’t work as expected because I was saying the wrong phrase”, “the prototype automatically began picking options based on ambient noise”, “Glass recorded messages when someone next to me was speaking”, and “overheating”. Although one user reported that it was “simple to use”.

After the user study, we noted that some users were concerned with the privacy of the system. Without privacy settings, the user’s contacts can use our system to “keep tabs” on the user. For example, suppose one of the user’s contacts asks her if she received a particular message. The user’s response could...
Figure 4: Web interface for adjusting user privacy settings

provide the contact with information about her whereabouts at a particular time or her activities.

Thus, we developed a website that will allow users to control the privacy settings for their device, as shown in Figure 4. The website requires authorization from the user through their Google accounts. Once the authorization is received, the user can choose which contexts she shares with all of her contacts. In particular, she can provide access to when she is free, when she is at a certain location (home, work, store, near the contact), and when she is awake. If a contact tries to send the user a message based on an unauthorized context, the message will be sent to the user immediately.

INTERFACE CHANGES

Based on the feedback from the user study, we made changes to our Glass application user interface. The users’ generally like the cascading menu style top level interface, but some of them indicated that the options would frequently false trigger. This could happen due to ambient noise triggering a menu command the user never spoke, or one of the commands getting confused with another. In order to reduce the number of false triggers and hence improve the user experience, we redesigned the menu prompts to be longer and more distinct from each other. Longer phrases will prevent false triggering from ambient noise and more phonetically distinct commands will aid the speech recognition software in disambiguating between the phrases.

Some of the phrases we changed are compared before and after the user study in Table 1

<table>
<thead>
<tr>
<th>before</th>
<th>after</th>
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<tbody>
<tr>
<td>Now</td>
<td>Immediately</td>
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<tr>
<td>later</td>
<td>later on . . .</td>
</tr>
<tr>
<td>only if they are . . .</td>
<td>only when they are . . .</td>
</tr>
<tr>
<td>here</td>
<td>over here</td>
</tr>
<tr>
<td>near me</td>
<td>near my location</td>
</tr>
<tr>
<td>when it is . . .</td>
<td>when the weather is . . .</td>
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Table 1: Glass menu command voice triggers, before and after the user study.

In addition modifying the trigger phrases to be more distinct, we now re-order menu commands according to the frequency of use by the user. This includes contacts and contexts commands so the user will see the people they talk to the most often, and the contexts they set most often at the top of the menu. We believe this will help the user in understanding the cascading menu structure. It will reduce the initial effort required to memorize the positioning of all menu items and allow the user to grasp the interface quickly.

DISCUSSION

As seen from the results of the user study (Table 5), the cascading style menu was considered easy to use and allowed the users to make sense of the interface (Q3). It received a rating of 6.3/7 and with a variance of only 0.68 among the users. Due to this strong result, we decided to keep the menu interface intact from the previous project. Though, some of the users mentioned difficulty in using the system due to false triggering from ambient noise and recognition confusion between the phrases. We redesigned our phrase set to be more phonetically distinct from one another and to be more robust to false triggering from noise. Some of the users indicated privacy concerns (Q4), although the answers varied much over the users (mean 3.6, and variance 3.82). Privacy is an important feature of any ubiquitous system and in this project we set out to investigate how this could be integrated into the system. We decided on providing the user with a web interface where they could chose which context information to share with the system. The user could change these privacy settings at any time and messages accompanied by context that is not available would be delivered immediately. In the future, we can apply different privacy setting to different friend circles of the user obtained from their social network.

FUTURE WORK

There are many possible extensions to this work. We could conduct new user studies that would measure how user’s felt about the privacy settings and the new interface for the device. We could also implement new features and include questions about them in the user study. One enhancement would be to make the system more of a feature-rich messaging application, as it currently only allows sending text messages. To improve it, we could allow sending multimedia messages as well. Another useful feature would be to allow the user to send messages for multiple contexts, for example when it is sunny and the user is free. Much thought must be put into this feature, as many of the contexts could conflict with each
other. Also, we would need to consider what these logical operators would mean for the user. If the sent a message tomorrow night and when it was sunny, for example, would this mean to send a message when it was both tomorrow night and sunny? Or should the message be sent at the point of tomorrow night and at the point of sunny weather? Another interesting direction is to explore more contexts for the system. For example, we could incorporate traffic data or more information from the sensors in Google Glass. For now, all of the permissions the user sets will be applied to all of her contacts. In the future, we will allow setting permissions for specific contacts. Finally, we could have behaviors for different contexts. For example, the user might ask the Glass to send a message containing directions home only when traffic is free.

CONCLUSION
We have shown a system that allows sending messages based on contexts. We conducted a user study that shows that our system is easy to use, although false-triggering did occur, and as with many ubicomp devices, privacy was a concern. In response, we modified the interface to reduce false-triggering and incorporated privacy settings. Future work will indicate through user studies how well these features enhance our system.

REFERENCES