Context-aware Communication in the Car

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ABSTRACT
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Automotive user interfaces, calling while driving, context sharing, driving safety, phone call.

INTRODUCTION
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RELATED WORK
TODO: put text here

CONCEPT
TODO: put text here

IMPLEMENTATION
We designed a simple and ordinary contacts app which is enhanced by displaying the context of the person you want to call. For our goal the term context means to consider mostly all of these information:

Context Information
Activity
Road Type
Destination
Remaining Travel Time
Position
Hands-free Speaking
Speed
Weather

Table 1: Context Information.

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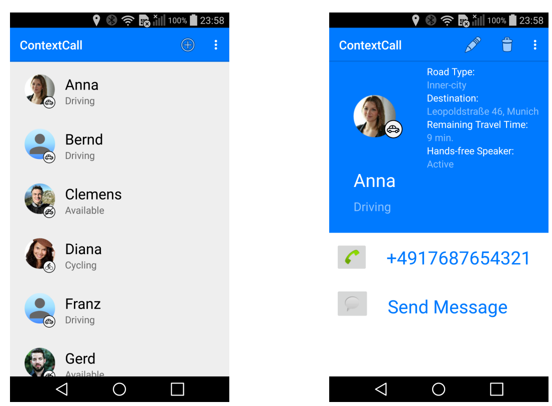
First of all you want to know what the person you want to call is doing at the moment. We distinguished between the activities *driving*, *cycling* and *still* where the latter means the person to call is doing nothing right now and his/her device is motionless on a table for example. Depending on if someone is driving you want to have the listed additional information. One would be the road type which lets you know if someone is driving e.g. in a city or on a highway etc. Another one is the destination the person is heading to and the remaining travel time. Therefore you need the person's position. This could either be a pinpoint GPS-coordinate, or if the user does not want to share his exact location, just a radius or a place name of his current position. Another very important aspect of the person's context is if hands-free speaking is enabled or disabled while in the car.

Besides information about the speed and the current weather situation are helpful to know. At the current state of our app all of these information can be accessed automatically except the destination and the remaining travel time, which have to be typed in manually.

App Design
The Android-App we build basically consists of two different views, an overview and a detail view (see figure 1).



(a) Overview (b) Detailview

Figure 1: Android Application ContextCall

On the overview on the left you see all your contacts as you know it from other contacts apps, but with the additional information about a person's activity, which is shown by the icons next to the image and the string below the name. By taping on a contact, the detail view appears and shows the additional context information mentioned in table 1. The particular case in figure 1b for example gives information about the road type, the destination and the remaining travel time. Furthermore you get informed that hands-free speaking is enabled. If you then decide to call 'Anna' although she is driving, a small alert pops up and gives you three options (see figure 2). You can either call her or not, or you make use of the '*remind me*'-option which notifies you when her status is 'still'.

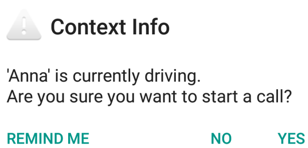


Figure 2: Alert Pop-Up

At the beginning we implemented most of the context recognition by our own. We used for example GPS to find out if someone is driving. If someone's speed was over 10 kilometers per hour we set the status to 'driving'. But in mid-May of 2016 Google released its new so-called *Awareness API*[1] which made things much easier for us as programmers. From this point on we were able to get the activity of a user by only a few lines of code and this API became the core of our application.

The Awareness API is part of the *Google Play Services* and is a unified sensing platform, enabling apps to be aware of all aspects of a user's context, while managing system health for you [**?**]. With this API your app is able to recognize the following 7 different context types [**?**]:

Location The user's current location as a latitude and longitude value.

Place A semantic version of a location that is called place (including the place type, e.g. a coffee shop).

Beacons What is around a user? Are there nearby beacons that can be detected and identified?

Time The local time of a user that can be combined with other context information to form a more complex condition.

Headphones' State Are headphones plugged in the device or not?

Weather Ambient conditions like the weather, which have an effect on the user's behavior.

Activity The detected user activity (e.g. walking, running, biking and driving)

The latter of these is the important one for the goal of activity and context recognition. All of these information can be combined using *AND*, *OR*, and *NOT* boolean operators to build complicated conditions that have to be met to trigger a notification. E.g. you can construct a condition that says that the user is driving in the car AND he is near a pharmacy AND it is during the opening hours of that shop. If these requirements are fulfilled, then you tell the user that he can pick up the wanted medication.

In particular, we used the *Fence API*[2], which is part of the Awareness API. The concept of *fences* is taken from Geo-Fencing, in which a geographic region, or "Geo- Fence", is defined, and an app receives callbacks when a user enters or leaves a region. Only that in this case it is not a region that is entered but an activity. So whenever the activity state transitions, it lets our app react to the user's current activity. For example, "Tell me whenever the user is driving". Once the conditions are met the app receives a callback and we can update the status of a user.

USER STUDY

To evaluate our concept and the actual implementation we invited a total of 25 participants to our user study. As the overall goal was to evaluate if users perceive the context information provided by our application correctly, we decided to generate 10 different use-cases (scenarios). We vocally discussed each scenario with the current participant, but all the context information had to be pulled out from the running app on a provided smartphone. Differing by the call trigger (meaning the reason why a participant had to call a person) and the context the person being called (callee) is in, the participants had to decide whether they would like to:

1. Make the call (or)
2. Not make the call (and)
3. Not make the call but send a text message (and/or)
4. Not make the call but get notified when the driver status changes

Following the scenarios we asked additional questions with the participants acting the role of the driver (the person being called). Goal of these questions was to gather inside in the willingness of potential users to share more or less specific information.

The following figures visualise the outcome of our user study. Figure 3 to 5 focus on the ten different scenarios which can be distinguished along the x-axis. As mentioned they differ in the status the callee is in (driving, cycling, still). Distribution of the answers given by our participants can be seen along the y-axis, while colours visualise the four possible choices.

[1]https://developers.google.com/awareness/

[2]https://developers.google.com/awareness/android-api/fence-api-overview

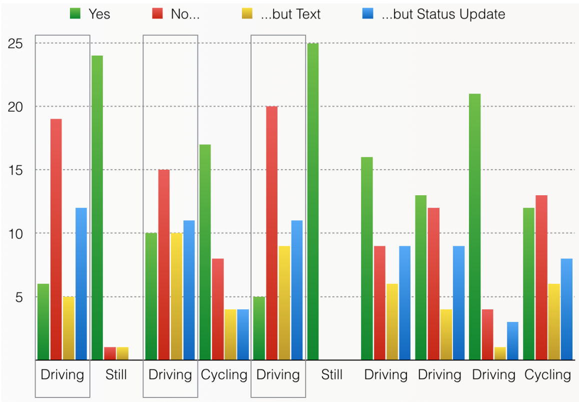


Figure 3: User Study: Would you make the call (status driving)

Highlighted in figure 3 you can see three different scenarios with the callee in the status 'driving'. As anticipated the majority of participants would not make a call in this situation (red bars). Moreover the majority would not like to send a text message straight away, or get notified if the status of the driver changes. Regarding our concept this outcome allows us to suppose that participants pulled the correct context information out of the app and that they consider the safety of the person they want to call.

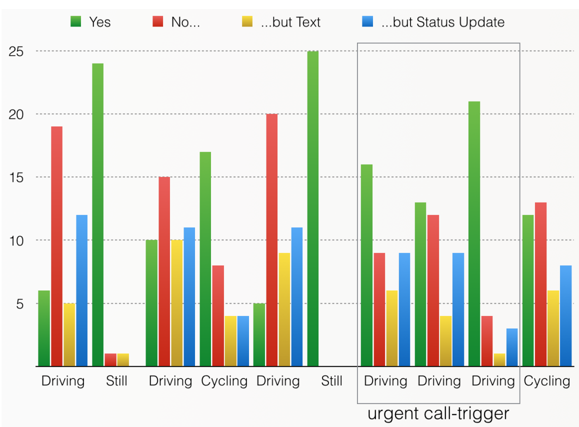


Figure 4: User Study: Would you make the call (status driving/with urgent call-trigger)

Contrary to the confirmed hypotheses shown in figure 3 (people will not make the call when they see the callee is driving), we found three 'driving' scenarios in which the participants would in fact make the call, although the callee is displayed as driving. Figure 4 focuses on these three scenarios with a majority of participants making the call (green bars). Discussion with our participants provided enough feedback to ensure that these decisions were based on the call-trigger (the reason they had to make the call). With call-triggers getting urgent (an emergency in the family for instance), people tend to ignore the context of the callee. Consulting with the participants we decided that users should always have the possibility to make calls in case of emergencies and that blocking calls completely is ineligible.

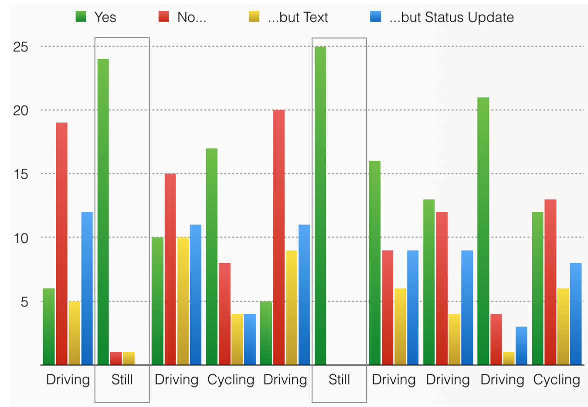


Figure 5: User Study: Would you make the call (status still)

To gain even more proof of our concept we generated two scenarios with the callee being in the status 'still'. Figure 5 focuses on these two scenarios and provides assurance that participants perceive our provided context information correctly and make their call straight away.

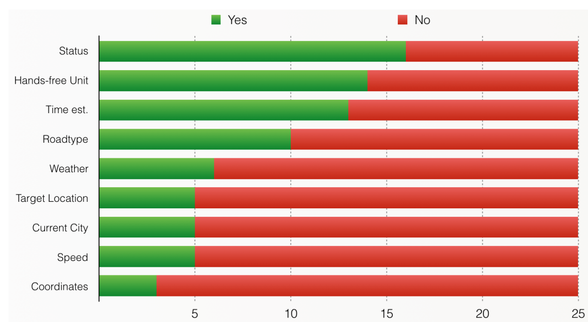


Figure 6: User Study: What information are you willing to share

With figure 6 we try to visualise the willingness of our participants to share context information with their phone contacts. After running through the previous ten scenarios we made sure that the participants understood the importance of the provided information and that more information might lead to a better understanding of the callee status (traffic situation, stress level and so on). Regarding the figure, the y-axis shows different information we would be able to provide in our concept app, the x-axis shows the amount of participants willing (green) or not willing (red) to share this information. As we can see, the willingness to share information is to be considered. While basic user information like the status (driving, cycling, still) or the availability of a hands-free unit is likely to being shared, more specific information like the target location or the precise user coordinates are not want to be published throughout the users contacts. Again consulting with our participants we found out that the willingness of information sharing increases, if the users were able to decide with information is provided for which contact in their lists. Carrying on this thought, participants ask for a grouping options (for instance 'family', 'friends', 'work') to adjust information sharing by hand.

CONCLUSION

Concluding our user study we can say that the visual processing of the context information provided by our application is perceived correctly. The currently implemented degree of information, as seen in figure 1 is regarded as sufficient to distinguish between the three main statuses driving, cycling and still. In addition we figured out, that the reason why calls are being made might in fact make calls more important than safety concerns with the callee being in a driving situation. Moreover we had interesting insights in data privacy concerns of possible users, which make concept adjustments necessary to improve willingness to share information.

TODO: Conclusion of Concept and App?

FUTURE WORK

To analyse user behaviour more closely we could think of reworking part of our application so it can be published in the Android app store. As this would exceed our current server capacities we would have to switch back-end strategies, as well as implement an appropriate logging tool to keep track of the generated user data.

TODO: Whats left to do?

ACKNOWLEDGMENTS

Sample text: We thank all the volunteers, and all publications support and staff, who wrote and provided helpful comments on previous versions of this document. Authors 1, 2, and 3 gratefully acknowledge the grant from NSF (#1234–2012–ABC). *This whole paragraph is just an example.*

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