Developing Iconographic Driven Applications for Nonverbal Communication: A Roadside Assistance App for the Deaf

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Abstract. Touchscreens allow interaction with icons and buttons for executing applications or selecting information. This can be used for non-verbal communication, enabling the deaf to communicate without the need for sign language translation and with a richer context than just using text. This paper explores the development process of iconographic driven applications for nonverbal communication following a user centered design approach. MyCarMobile, a mobile application intended to facilitate the communication of the deaf with roadside assistance services, is introduced as a case study. The application follows the iconographic driven interaction model allowing users to describe an occurrence, through the interaction with icons and buttons in a touchscreen device. Based on the implementation of the case study application and previous work a set of guidelines for implementing iconographic driven applications is proposed.

Keywords: deaf, mobile application, roadside assistance, iconographic interface, nonverbal communication.

1 Introduction

Information and communication technologies (ICT) can be perceived from the perspective of filling human needs [1]. Nowadays, ICT are ubiquitous in daily life, providing access to basic services and ensuring the satisfaction of basic human needs. However, ICT are not available to everyone. The access to ICT and their services are often exclusive to standard users. Therefore, the usage of technologies and access to services by people with special needs is usually restricted or closed off.

One of the obstacles is associated with the communication, namely, the communication channels used to access the services. Some of the services are available through a phone call, making them inaccessible to deaf and hearing impaired people. The aging of the population and the increase of hearing problems as they age heighten this problem. A possible solution for the problem is to provide an alternative nonverbal channel of communication for these people, as a short messaging service (SMS) line.

C. Stephanidis and M. Antona (Eds.): UAHCI/HCII 2014, Part III, LNCS 8515, pp. 762–771, 2014.

If on the one hand this would be a solution for elderly, on the other hand semantic communication problems arise when it is applied to deaf and hearing impaired people. In order to address this problem and provide a universal access solution for emergency services, the usage of iconographic interfaces was previously proposed [2]. The experiments revealed many benefits of this approach, and encouraged the development of a generic model for its usage.

The purpose of this paper is to explore the possibility of applying the iconographic interfaces to other situations and discuss their impact. Such an approach intents to be a starting point for the construction of a generic solution to enable access to a set of services for a population that was until now restricted from doing so. This work relies on a user centered design methodology in order to select and specify a case study application that can fill a gap in deaf' autonomy. Interviews with experts and a survey were conducted. A functional prototype of a mobile application for roadside assistance was developed: MyCarMobile. A discussion of the development process and a set of guidelines for developing iconographic driven applications for nonverbal communication are proposed and constitute the major contribution of this work.

The paper is structured as follows: to present the motivation for the research behind this study, we start by describing the current technological environment for deaf communication, providing a state of the art. This is followed by a discussion of the research methods applied, including the description of the survey presented to members of a deaf association. The empirical findings and the design space of MyCarMobile application are presented in the following sections. A discussion of our findings ensues.

2 Research Settings

Communication barriers often restrict access to basic services to the deaf. Reports[1][11] state that the deaf have difficulties to access daily life services as healthcare, education or even security. The difficulties are related to the provision of most services through verbalized channels, which have to be adapted regarding its usage by the deaf and people with hearing limitations. Consequently sign language, lip reading and text is common used by deaf to communicate with other people. There are several technological solutions trying to help break that face-to-face communication barrier. One such tool is HelpTalk[2] a mobile application that allows verbalizing particular situations, using iconographic representations. Another example is the Vox4All[3], a solution for alternative and augmentative communication. Other solutions, more traditional, rely on services of communication mediation, normally with sign language interpreters.

[1] http://www.population-health.manchester.ac.uk/primarycare/npcrdc-archive/Publications/GP%20D.access.pdf

[2] http://www.helptalk.mobi/en/

[3] http://www.imagina.pt/produtos/educacao-especial/auxiliares-de-comunicacao/vox4all/

The barrier becomes more obvious when the services are offered remotely, usually through a dedicated telephone line. Examples of such services are emergency, medical appointments, roadside assistance and information services. Some of these services refer to basic needs of citizens. Therefore, specific telecommunications channels are made available for the deaf, filling the audio restrictions through video calls with sign language [6, 7, 8, 9, 10] and text messages [3, 4, 5]. However, these two approaches have some flaws. Video calls commonly rely on mediation of communication for the translation into sign language, which depends on the availability of service and represents an additional cost, as sign language is a skill possessed by a few people other than deaf. Moreover, telecommunicating requires a data connection for video transmission, which is an expensive resource and often unavailable while travelling. Text messages are slow and intermittent, requiring several interactions that can interfere with conversation. The message delivery is not guaranteed and imposes technological restrictions due to the asynchronous nature of the service. In other cases, in order to overcome the voice communication limitation, services are available in multichannel platforms, allowing access via the web or mobile applications such as, for example, the case of banking services.

An approach to overcome the communication ineffectiveness of text and video in mobile devices is the use of interactive icons and buttons in smartphones with touchscreen. MyAXA app[4] is an application from an insurance company that allows users to report an incident. However the application falls back on the voice channel when extra information is needed and establishes a voice call with the company call center. In Spain, Telesor[5] is using a mobile application for generic accessible communication. The application enables real time communication through a mediation service for deaf and hard of hearing people. The service aims to ensure customer support for people with special needs in public institutions and businesses. Another sample application is Red Panic Button application[6] that ensures to its users a mechanism for sending emergency alerts using SMS, email or social networks. Within this scope the ubilert project[7], exploits mobile technologies to allow a simple and effective way of asking for help in an emergency situation (health, civil, criminal).

Previously, our research team has developed SOSPhone [2], a prototype of a mobile application that enables users to make emergency calls using an iconographic interface running in a touchscreen mobile device. The prototype implements the client-side of the application and was demonstrated and evaluated by a large number of users, including people without any disability, emergency services professionals and deaf people. Based on the experience gained in the development of this application, and the results obtained in the tests with users, it became clear the need of experimentation in other areas and the generalization of the concept.

[4] http://www.axa.pt/axa-mobile.aspx
[5] http://www.telesor.es/
[6] http://www.redpanicbutton.com/
[7] http://ubilert.pt.to/

3 Research Methods

Software development requires a more user-centered approach, but this does not prevent the products from having an excessive amount of features. It is essential that the users who indeed need the features and who want to, can actually use the software in an effective manner [12]. Among the various existing methodologies in human computer interaction, participatory design and user centered design following stand out as being based on a user-centered philosophy that seeks the users' engagement throughout the development process. Therefore, the development team is able to get a better understanding of the needs and goals of users, building a more appropriate solution [13]. Given the foregoing and the previous experience in developing universal design solutions using user centered design [14], this methodology was chosen for the development of this project. This decision also took into account the number of potential users who could actively participate in the development process and provide input.

The main purpose of this study lies in the generalization of the development process of iconographic driven applications for nonverbal communication. The first research stage of the study requires the selection of a case study, different from previous work. The process assessed the potential needs of users. The strategy underwent interviews with expert addressing the daily difficulties of the deaf. These interviews were held with two deaf users. During these interviews there was no need for interpreter services since the interviewed had the ability to read lips and could verbalize, which facilitated direct communication. Of the interviews carried out, several hypotheses of services that are only available thought voice channels have been presented. Among those, the highlights services were: scheduling of medical appointments; pharmacy medication request; and roadside assistance provided by an insurance company. The analysis of each of these hypotheses was made with each of the interviewees. The choice of roadside assistance service was consensual. The main reasons associated with such a choice are related with the context in which prospective users may require assistance. In such situations, users can stand alone, without the possibility of requesting help while on the other scenarios they are usually accompanied. Thereby, this application is an asset to the autonomy of the deaf, contrasted with the remaining options examined.

Based on this output, and once the case study was selected, a survey with the objective of understanding and knowing which are the major obstacles that the deaf face when communicating with roadside assistance services. The survey, entitled “survey on the calling of roadside assistance services by deaf citizens”, consists of nine multiple selection questions. The questions and possible answers were carefully prepared in order to be concise, simple, using careful and noticeable language. This care and the option of multiple choice questions in detriment of open response is associated with the limitations of people with hearing problems and their undeveloped level of literacy. Besides this care, deaf experts who cooperated in interviews reviewed the survey. The survey follows a traditional structure: a first section for user characterization and a second part with the survey questions. For their characterization users are not asked to provide personal information, ensuring their privacy and anonymity.

However, these data are important for the statistical treatment. The disclosure of the survey was performed through the Internet, for the Portuguese Deaf community.

In the following section the data obtained in the surveys is presented and analyzed.

4 Empirical Findings

The survey was presented to 27 deaf and hearing impaired users from the Portuguese federation of deaf associations through Google Docs survey platform. The surveyed were selected in order to represent a sample from the potential users' universe of the application. From the 27 surveyed, 25 have replied to the survey of which 14 male and 11 female. Respondents are in the range between 20 and 55 years old. As for schooling, this varies between secondary and higher education. About 56% of the respondents have a degree of profound deafness and 32% degree of severe deafness.

The first question of the survey was related with the entitlement to drive of the respondents: 80% said they had entitlement to drive and 20% indicated they did not. The results reveals in the second question that 36% of the users have already had problems with the vehicle, and 64% not. However, 44% declared that they had problems with the roadside assistance, and 56% not. According to the answers to question 4, the users have used several contact methods: 55% sent and SMS to a friend or relative; and 30% have asked another driver or passenger to make the call. Other options with residual choice were: contacted a sign language interpreter, sent SMS to the police, and contacted a deaf association through videoconference. The difficulty to communicate with the operator of the roadside assistance was evaluated in question 5 to which 56% replied that they had difficulties, 8% not, and 36% did not answer. From these, 20% had difficulties sending information to the operator and 40% receiving information from the service. Considering the difficulties, 40% of the respondents said that they did not have assistance due to communication problems and 48% were assisted. In order to solve the problems, 36% had asked a friend or relative for help and 40% did not answer. Finally, from the users inquired about support services for communicating with deaf and people with low hearing, 64% agree that they did not present any support services for communication, while a proportion of 32% did not agree.

The analysis of these inconsistent results can reveal that most respondents present qualification for driving, even though most of them have not had any kind of problems with their vehicle. However, when they needed to contact roadside assistance, and they always resorted to help from others, not directly from the support services due to communication problems. According to the answers given, we may conclude that insurance companies had not presented the most appropriate solutions to solve such problems, and many people are still not assisted because of the communications barriers.

These results confirmed the relevance of the application and the existing perception of the problem, encouraging the development of the alternative solution preconized for MyCarMobile. The combination of the results obtained was used to design and create a prototype of the application, as described in the next section.

5 Design Space

The needs identified by users were the foundation for the design of the application. Therefore, the need to communicate without resorting to the voice channel was taken into consideration as well as the use of a language tailored to their needs. One of the critical non-functional requirements for the application was the low literacy of the majority of the deaf population. Moreover, the context in which aid applications emerge was evaluated: abnormal situations in which individuals may be limited to their skills, to deal with it.

From the functional perspective, the objective of the application was to ensure a basic level of service provided by roadside assistance. Thus, two main situations were considered: accidents and breakdowns. These two situations were complemented with a set of complementary situations, categorized as "other situations". For the characterization of an accident, the accident report declaration used and regulated in Portugal by the standard "7/2006-r, august 30"[8] served as a basis for defining the requirements. Notice that in accident situations the application only intends to report material damage of the vehicle to the insurance company. Breakdowns are typically associated with one or more components of the vehicle. Thereby, blocks were considered as representative parts of the vehicle where the breakdown occurs, so that it is reported for the roadside assistance services. Additional details that could be provided upon the roadside assistance needs across a text conversation channel (live chat) were defined and included in the specification.

The application flow followed the requirements for the characterization of the situation, being divided into the above options. Based on the identified non-functional requisites, the icons were defined by searching for images that characterize each of the situations identified in functional requirements, and which guarantee easy identification to ensure recognition even when the reading of the written explanation is restricted. This approach enhances the need for easier access to the application by the population with hearing disability and its low literacy.

This specification has been implemented in a functional prototype: the MyCarMobile.

6 System Prototype

The MyCarMobile uses interactive graphical information such as icons, diagrams and buttons to allow users to describe problems with the car and report it to a roadside assistance service.

In the first phase, data are collected through various activities implemented in an Android app which originated a simple interface allowing the user to simply interact with the application through touching the screen buttons, describing the situation

[8] http://www.isp.pt/NR/exeres/8C7A83FE-4D1B-431D-90AF-29A7289EBCAD.htm (in Portuguese).

occurred with some detail. As specified, each occurrence can be classified into three types: breakdown, accident or other situations. In case of a breakdown, it is possible to select through illustrations the location of breakdown in the vehicle. In case of accidents, the same strategy applies to identify the damaged areas of the vehicle and the severity of the damage. In case of another situations is available a list of other situations that may have occurred (Fig. 1). Once all desired options are selected, a summary of the event description is displayed on the screen, giving the user an opportunity to review it. The navigation into the several steps of the description flow is available through a slide menu.

During the process of collecting information (ie, as the user selects the options, and menus are being covered) the values are stored in strings that are accessed by various application activities. After all options have been selected, a global string is obtained containing all the necessary information for describing the occurrence in an encoded format. At that same string are automatically attached the GPS coordinates of the location of the occurrence, available by accessing the location information of the device. When the description is complete, an SMS is sent to the operator. To help in collecting further information that might be needed, the application has a live chat functionality that keeps the user and the roadside assistance service connected with each other.

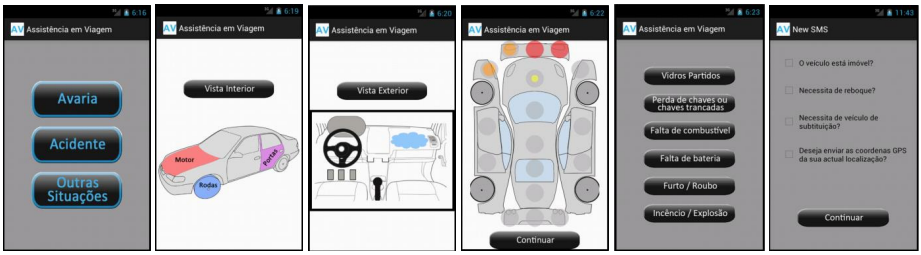

Fig. 1. Some interfaces of the MyCarMobile prototype (only in Portuguese, for now). The leftmost interface is the first screen, where the user can select one of 3 buttons corresponding to 3 basic situations: breakdown ("Avaria"), accident ("Acidente") and other situations ("Outras Situações"). If the first option is selected, the interface changes to the second one, which allows specifying the location of the breakdown: engine ("motor"), doors ("Portas"), inside view ("Vista interior") and wheels ("Rodas"). The third interface shows the inside view, and the fourth is the one for the case of accident, enabling to specify the damaged areas. The fifth and sixth interfaces show refinements in the description of the problem, such as reporting broken glasses, requesting hauling or sending GPS coordinates.

7 Discussion

The use of iconographic interfaces can represent a solution to solve some of the current problems of non-verbal communication, but face challenges in their design.

User preferences reveal the need to use technology they know to communicate, including SMS and videoconference. Moreover, the presented study, like previous studies, highlights the precariousness of solutions as well as the need for technologies

that enhance access to basic services. Often this access is closed off since the services make abusively use of verbal communication channels. Clearly the benchmarking analysis set that mobile applications are increasingly a wager of enterprises to create a closer relationship with their customers. This massification could increase new audiences and provide economies of scale in solutions that were addressed to small groups of the population. In this sense, the effort in the development of applications should follow good practice and ensure usability and accessibility solutions for a wide range of the population.

The results presented in the development of MyCarMobile as well as prior experience, give some guidelines for the development of such applications:

- Icon selection: the icons should be intuitive and represent the situation that is intended to describe / abstracting. The representation of objects is simple and direct. However the choice of icons to represent states of mind, actions and other everyday situations is often complex and dependent on the cultural context of the individual.
- Creation of interaction patterns: each situation can be a standardized set of graphic elements, which together represent it. Commonly, graphics are icons. In some situations there may be a need for other elements (eg in the case of a location on a freeway where it is necessary intuitively indicate the direction of movement to rectify the GPS information and mitigate the potential error).
- Application flow definition: the application requirements must be depicted as a flow of information that can be directly mapped to the application flow. The flow should be as close to the reality of their users and their habits in performing the tasks. Combining well-known interaction patterns can carry out the implementation of the application flow.
- Integration with traditional communication models and multimodal interaction options.

8 Final Remarks

This paper presented the development process of a functional prototype of MyCarMobile, a mobile application that allows deaf to contact roadside assistance. The development followed a user centered design approach and intended to collect guidelines for the development of iconographic driven applications for nonverbal communication. This kind of applications follow an interaction pattern, previously presented, that exploits the usage of touchscreens for interaction with icons and select the appropriate information to describe a situation.

The development process started with interviews with experts and selected a case study for the application of the interaction pattern. Following, a survey was conducted with deaf to help in the specification process, and confirmed the relevance interaction pattern. The prototype that was implemented used interaction with icons and buttons to describe the situation to be reported. A discussion of the lessons learned with the development process of this application was carried out. From this process resulted a

set of guidelines for the development of iconographic driven applications for nonverbal communication that were presented.

A formal specification of the development process and its application to other case studies will contribute to the validation of the discussed guidelines. This process will require a deeper analysis, reveal possible errors and inconsistencies usual in informal specification, and allow the improvement of the solution [15]. Tools and frameworks for enhancing and scaling up the development of universal access mobile applications that follow the iconographic driven pattern can also be explored using the proposed guidelines and the preliminary results of the work presented.

Acknowledgments. We would like to thank to the UTAD students Beatriz Baptista and Diogo Soares, who supported us in the development of the prototype.

This work is funded (or part-funded) by the ERDF – European Regional Development Fund through the COMPETE Programme (operational programme for competitiveness) and by National Funds through the FCT – Fundação para a Ciência e Tecnologia (Portuguese Foundation for Science and Technology) within project «FCOMP - 01-0124-FEDER-022701».

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