

Smart Deaf Emergency Application Based on Human-Computer Interaction Principles

Thowiba E Ahmed, Naba Abdulraouf Almadan, alma Nabil Elsadek
 Haya Zayed Albishi Norah Eid Al-Qahtani Sarah Khaled Alghamdi

Computer Science Department
 College of Science and Humanities- Jubail
 Imam Abdulrahman Bin Faisal University-Saudi Arabia

Abstract

Human-computer interaction is a discipline concerned with the design, evaluation, and implementation of interactive systems for human use. In this paper we suggest designing a smart deaf emergency application based on Human-Computer Interaction (HCI) principles whereas nowadays everything around us is becoming smart, People already have smartphones, smartwatches, smart cars, smart houses, and many other technologies that offer a wide range of useful options. So, a smart mobile application using Text Telephone or TeleTYpe technology (TTY) has been proposed to help people with deafness or impaired hearing to communicate and seek help in emergencies.

Deaf people find it difficult to communicate with people, especially in emergency status. It is stipulated that deaf people In all societies must have equal rights to use emergency services as other people. With the proposed application the deafness or impaired hearing can request help with one touch, and the location will be determined, also the user status will be sent to the emergency services through the application, making it easier to reach them and provide them with assistance. The application contains several classifications and emergency status (traffic, police, road safety, ambulance, fire fighting). The expected results from this design are interactive, experiential, efficient, and comprehensive features of human-computer interactive technology which may achieve user satisfaction.

Key words:

Smart Deaf Emergency, Human-Computer Interaction, TTY, Impaired hearing.

1. Introduction

The expansion of mobile devices in the last two decades widened the opportunities for developing mobile applications that support the users effectively in several everyday activities. A situation that helped the overall humanity was the higher availability of emergency calls since they became available on any mobile phone.

However, it is still hard for some people to make an emergency call because of disability situations. One noticeable case is one of the deaf people, who are unable to communicate through a voice call. [1]

A TTY is a special device that lets people who are deaf,

hard of hearing, or speech-impaired use the telephone to communicate, by allowing them to type messages back and forth to one another instead of talking and listening. A TTY is required at both ends of the conversation to communicate. [2]

The proposed application deals with using TTY technology through mobile applications which serve deaf people and people with hearing disabilities to make their communications easier since they face difficulty in communicating with others and explain what they want especially in emergency cases. Thus, this technology helps deaf people to contact emergency centers directly through the application by sending a message or select icons, which defined emergency cases. Then, it arrives in the form of a signal that indicates the user is from deaf people. Moreover, there are many experiments and studies had completed obtaining a real result about using TTY technology and evaluated the result to make proper improvement.

This application attempts to bridge the technological gap and help deaf people have direct and equal access to emergency services easily without help from other people and give them the same rights to participate and effect in their community with other people via technology which could improve their life.

2. Literature Review:

In [3], the authors have addressed the problem of communicating with emergency centers for deaf people and people with hearing disabilities. The main technique applied in this paper is the TTY technique, which needs to install on phones, the deaf user should contact the emergency agency through this application when the message reaches the required entity, it arrives in the form of signals indicating that this user is deaf then the TTY technology is activated to send and receive messages where these messages resort encoded the text, and when

they are received, the decoded is made and displayed in the form of a text message. The main findings showed that 65% of phones provide the same language that is used in this technique. The system is important to help people especially deaf people to guarantee their human rights. In [4], the authors discussed the problem of deaf and hearing-impaired access to the emergency. The main technique applied is TTY phone was introduced. It allows users to call centers, communicate directly with the emergency operators. This app only is loaded onto a commercially available cell phone that is compatible with the current infrastructure. The main finding was the decoding of characters sent from the PSAP and cellular phone and 1% error or less seems a reasonable goal.

In [5], the authors have been concerned about the problem of hearing-impaired people in a case of an emergency case. The technique of this study is based on four cycles for design, evaluation, and development. The goals of the developed system are based on two main parts, a mobile application that records and sends the details of an emergency event, and a central management system that handles these calls from the side of the emergency services. The main screen of the application has three options for emergency calls: police, ambulance, and civil defense, also there is an option for tracking the event location by using GPS. The application is set to be tested by a testing group of 20 deaf users (ages 24-61) using the same scenarios and data collection procedures. 39 new participants to evaluate the whole system. The main finding of this study is that the system showed effective use above all the participants with a success rate of 100%. The system is fast, easy to use, and direct to access emergency services without any need for intermediate people in this process.

In [6], the authors have discussed the problem of deafness or impaired hearing as the inability to hear something either completely or partially. Hearing loss can drastically affect a person's life in communicating with the people around them. The main technology implemented is an emergency calling application that can assist people with hearing impairment in their presence emergencies with the mobile application, the user only needs to select an icon that is appropriate to the situation the touch screen mobile device is facing. The results were analyzed using four emergencies scenarios events with a total score of 87% and average user time less than 0:42 seconds indicates that the study was a successful emergency call application as per user requirements. The authors designed a deaf emergency communication application using a user-centered design method (UCD).

In [7], the authors have addressed the problem of communication between emergency medical responders and deaf people. The main technique applied was a mobile system to communicate between emergency responders and deaf people. It allows the responders to browse some

emergency sentences quickly and shows videos of the corresponding translation in sign language to deaf people. The main finding of this paper the technique is applied on 10 emergency medical responders and 10 deaf people, the result of the evaluation was the system is useful. The system is very important to help deaf people communicate with medical emergency agencies

In [8], the authors have discussed the problem of inequality between deaf citizens and other citizens in access to making emergency calls in both Norway and Sweden. The methods that have been used to make emergency calls to deaf citizens in Norway and Sweden via telephone typewriters TTYs, short message service, and video relay service. The results of the study stated that deaf citizens do not have equal ability to issue emergency warnings like other citizens in Norway, while in Sweden the status of deaf citizens can be considered equal compared to other citizens. The study focused on the rights of deaf citizens and compared deaf citizens and other citizens but there must be freedom from restrictions in emergency services to achieve equality for all citizens.

In [9], the authors have been concerned about the problem of the communication between deaf people and emergency medical (EMS) responders. The medical responders should ask deaf patients some fundamental questions to distinguish between different pathologies and administer the right treatments, some activities have to be described by EM responders to deaf patients before being performed, and deaf patients should properly understand some life-critical instruction. The resulting language called Signed English is a hybrid between English and (ASL) American Sign Language and might be useful for deaf people who have learned English, while it is confusing for deaf people who always use ASL which they are using forms of communication without signs. The evaluation carried out on ten emergency medical responders and ten deaf users showed that the system is useful to support communication with deaf people during medical emergencies.

In [10], the authors have discussed the use of text telephone technology TTY in the daily lives of deaf people and its effect on their communication habits. The study was the deaf community in Sweden who consists of 13,000. There are two dimensions of communication that are relevant to the study: (1) online versus offline communication; and (2) distant versus non-distant communication. Earlier studies focused on communication technologies used by deaf people have and on issues such as the kinds of technologies used by deaf people to communicate either with each other or with hearing people. This study focused on three concepts, psychological empowerment, personal control, and a critical awareness of one's socio-political environment. Data were collected and analyzed through four steps, which lead to show the importance of the empowering processes. Generally, TTY

technology has contributed to personal control and independence, it also a proactive approach to life and language use, also to a critical awareness of one's socio-political environment.

Methodology:

We propose this system which aims to serve people with special needs and those who have difficulties in speaking or hearing, by communicating with emergency telephone authorities, through this system. TTY technology will be employed, the communication with emergency authorities is made through the application that makes deaf and dumb people speak by phone via a keyboard or machine.

We use Norman's interaction model to formulate the phases of the proposed system. Norman's interaction model one of the most important methods that can guide to make a good smart interactive product, it focuses on human beings and thinking about how people are making the decision when they interact with something. Norman's main idea is that devices, things, computers, and interfaces should be functional, easy to use, and intuitive. [11]

Norman considers these seven stages: [12]

1. Formulation of the goal – think in high-level terms of what it is you want to accomplish.
2. Formulation of the intention – think more specifically about what will satisfy this goal.
3. Specification of the action – determine what actions are necessary to carry out the intention. These actions will then be carried out one at a time.
4. Execution of the action – physically doing the action. In computer terms, this would be selecting the commands needed to carry out a specific action.
5. Perception of the system state – the user must then assess what has occurred based on the action specified and execution. In the perception part, the user must notice what has happened.
6. Interpretation of the system state – having perceived the system state, the user must now use her knowledge of the system to interpret what has happened.
7. Evaluation of the outcome – the user now compares the system state (as perceived and interpreted by her) to the intention and decides if progress is being made and what action will be needed next.

These seven stages are iterated until the intention and goal are achieved – or the user decides that the intention or goal has to be modified.

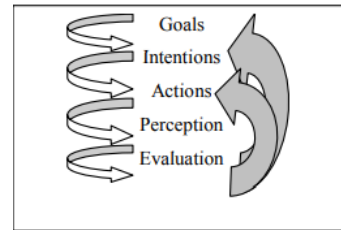


Figure 1: Norman's HCI Model

Norman defines two issues with these seven stages: the gulf of execution and the gulf of evaluation. The gulf of execution is a mismatch between the user's intentions and the allowable actions in the system. Based on Norman's HCI Model the proposed application goes through five goals:

1. Make the user sign up before he uses the application.
2. Save the user's information.
3. Check for the emergency statutes.
4. Give the user review about which emergency agency he has requested.
5. Notify the user about the expected arrival time.

The interaction model for each goal:

First goal:

1. Make the user sign up before he uses the application.
2. Log in to the program.
3. First when entering the application, the first interface appears, and to log in, the user must fill in the following data: Full name / National ID
4. Clicking the Sign-up button.
5. Sending system verification messages to the user.
6. Registering the user in the system is done.
7. User is now a part of the system.

Second goal:

1. Save the user's information.
2. User information has been saved in the database.
3. The information must first be entered by the user in the Sign-up interface, then he checks on the check box asking if the user wants to save his registration information (remember me).
4. Clicking the remember me check box.
5. The remember me check box will be checked as long as the user wants to save his information in the system.
6. User information is saved in the database.
7. The user can enter the program next time without filling in the login information.

Third goal:

1. Check for the emergency status.
2. The user chooses emergency service.
3. The user must check for emergency service he needs; he could choose more than one service at the same time.
4. Confirm the choices of emergency service.

5. The current state of the system is that it saves the emergency service which the user needs.
6. Send the case to the emergency service.
7. Confirm sending the service.

Fourth goal:

1. Give the user review about which emergency agency he had requested.
2. Confirm the user request.
3. The user can modify the emergency service by clicking on the modify button, then return to the emergency status interface.
4. Clicking the Confirmation button.
5. The system will show a message to the user that the request has reached the required emergency service.
6. The status of the emergency has been reached to the desired destination.
7. The emergency team moved.

Fifth goal:

1. Notify the user about the expected arrival time.
2. The user knows the expected time for the emergency team to arrive.
3. The interface contains the expected time and a map through which the user can track the emergency team.
4. Click on the map to track the emergency team.
5. View the map and see the remaining minutes.
6. Follow the location of the emergency agency through the map.
7. Follow up on the emergency team and know the expected time of the team's arrival.

Scenario(s) for each goal:

1. The user should first sign up in the sign-up interface to be able to use the application, he should put his full name and his national id then click on the sign-up button.
2. When the user check remember me check box in the sign-up interface he will be able to enter the application every time without any need of signing up every time.
3. The user should choose the emergency service he needs depending on the emergency status he suffers from; he could choose more the one service at the same time.
4. If an error occurs in the selection of the emergency services, the system allowing the user to modify through the editing button, so he could return to the emergency status interface, then press the confirmation button. if the user may accidentally press the cancellation button so the interfaces were supported by error preventing messages for the situation of canceling. When the user clicks the confirmation button the system will give him a message that the request has reached the desired emergency service.
5. The user is informed about the expected time of arrival through the appearance of an interface for the remaining time as well as he can follow the location of the

emergency agency through the map.

Proposed interfaces:



Figure 2: Application Icon



Figure 3: Sign-up Interface



Figure 4: Location Interface



Figure 5: Information Confirmation Interface

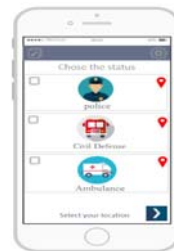


Figure 6: Status Chosen Interface



Figure 7: Modifying Interface



Figure 8: Cancellation Interface



Figure 9: Emergency Authorities



Figure 10: Sending Confirmation Interface



Figure 11: Arrival Time for Emergency

The evaluation process:

The evaluators' team evaluates the usability of the designed interfaces through the expert analysis method and they selected the Heuristic evaluation approach [13] because is a flexible, relatively, and cheap approach.

The evaluators also assess the severity of each usability problem, based on four factors: how common is the problem, how easy is it for the user to overcome, will it be a one-off problem or a persistent one, and how seriously will the problem be perceived. These were combined into an overall severity rating on a scale of 0–4.

They mentioned only one problem, the absence of a help icon, but we think our system is very easy to have a help instruction icon.

Expected Results

Deafness or hearing loss is a condition that greatly affects a person's life in communicating with people around him and is difficult when he wants to communicate with an emergency.

We expected that; our proposed application will help the deaf and people with hearing disabilities to make their communication easier with emergencies. The main technology applied to the phone is TTY, which allows users to communicate directly with emergency operators and their location is determined directly through a number the national identity associated with its national address.

References:

- [1] Paredes, Hugo & Fonseca, Benjamim & Cabo, Miriam & Pereira, Tania & Fernandes, Filipe. (2013). SOSPhone: A mobile application for emergency calls. *Universal Access in the Information Society*. 13. 1-14. 10.1007/s10209-013-0318-z.
- [2] About TTY - What is a TTY?
- [3]. Zafrulla, Z., Etherton, J., & Starner, T. (2008, October). TTY phone: direct, equal emergency access for the deaf. In *Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility* (pp. 277-278).
- [4]. Zafrulla, Z., Etherton, J., & Starner, T. (2008, October). TTY phone: direct, equal emergency access for the deaf. In *Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility* (pp. 1-15).
- [5]. Constantinou, V., Ioannou, A., & Diaz, P. (2017). Inclusive access to emergency services: an action research project focused on hearing-impaired citizens. *Universal access in the information society*, 16(4), 929-937.
- [6]. Risald, R., Suyoto, S., & Santoso, A. J. (2018). Mobile application design emergency medical call for the deaf using UCD method. *International Journal of Interactive Mobile Technologies (iJIM)*, 12(3), 168-177.
- [7]. Buttussi, F., Chittaro, L., Carchietti, E., & Coppo, M. (2010, September). Using mobile devices to support communication between emergency medical responders and deaf people. In *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services* (pp. 7-16).
- [8]. Warnicke, Camilla. 2019. "Equal Access to make Emergency Calls: A Case for Equal Rights for Deaf Citizens in Norway and Sweden." *Social Inclusion* 7 (1): 173-179
- [9] Buttussi, F., Chittaro, L., Carchietti, E., & Coppo, M. (2010, September). Using mobile devices to support communication between emergency medical responders and deaf people. In *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services* (pp. 7-16).
- [10] Carin Roos & Åsa Wengelin (2016) The text telephone as an empowering technology in the daily lives of deaf people—A qualitative study, *Assistive Technology*, 28:2, 63-73, DOI: 10.1080/10400435.2015.1085923
- [11] Victor, Obarafor. (2019). ICUpject. 10.6084/m9.figshare.9757229.v1. <https://www.researchgate.net/publication/335611396>
- [12] Norman, D. 1986. *Cognitive Engineering in Donald Norman and Stephen Draper (Eds.) User-centered design: new perspectives on human-computer*
- [13] Jakob Nielsen, 10 Usability Heuristics for User Interface Design (nngroup.com) 26-2-2021,2:44