Red Cross Triage App Design for Augmented Reality Glasses

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ABSTRACT
The authors of this article go through the process of designing of Triage System using a *Google Glass* Application prototype, based on the procedure used by adjunct emergency hospital personnel to classify the injured in an emergency (Fernández, 2006). This application can help personnel in charge of an emergency to locate which hospital has rooms available for every type of patient delivered by ambulance, which is a very important factor for effective emergency medical care (Martínez, 2001). The main objective of this paper is to establish necessary and sufficient requirements to develop an efficient user–friendly procedure by the use of augmented reality glasses and controlled by voice commands. The prototype design comes from a categorization of information obtained by observing and interviewing active adjunct emergency hospital personnel from the Red Cross performing an actual application of Triage in an emergency scenario. Once the functional prototype was designed, a usability test was performed on 6 volunteer paramedics. The results of this test revealed that even though the general experience would benefit the categorization and distribution of victims injured in a real emergency, a detailed analysis is required to establish the words needed as voice commands to navigate through the interface and to establish visual feedback principles for various commands of the system.

Categories and Thematic Descriptors

H5.1 Multimedia Information Systems – Artificial, augmented and virtual realities.

H5.2 User Interfaces – Graphic User Interfaces, Interaction styles, Prototyping, User experience centered design.

General Terms

Documentation, Design, Human Factors.

Keywords

Augmented Reality, medical emergency, Triage.

MexIHC '14, November 03 - 05 2014, Oaxaca, Mexico, Mexico
Copyright 2014 ACM 978-1-4503-3285-9/14/11…$15.00
http://dx.doi.org/10.1145/2676690.2676697

1. INTRODUCTION
Red Cross personnel who work in the main office receive a tremendous number of calls daily. If there were an incident with two or more injured people whose lives are at risk, it is considered a major emergency. The personnel must identify the exact location of the accident. Upon arrival, paramedics must categorize the injured according to their immediate health status. The process of categorizating is known as Triage (Soler, 2014). Triage requires difficult decision-making, based on incomplete information, often performed under hostile and dramatic scenes, under emotional pressure, in front of an undetermined number of injured patients of pluripathological characteristics accomplished with limited resources (Álvarez, 2001). Once Triage has been performed, the paramedics proceed to transfer the injured to the ambulance, depending on the state or category assigned to each patient. Given the significance of this proceedure, this article presents a system proposed to aid Red Cross personnel in correct assessment of various scenarios.

This project uses Google Glass, a device with a Heads Up Display (Hill, 2013), which is a transparent screen at eyesight in which we see the potential to combine virtual elements superimposed on a real context (i.e., augmented reality). It is expected that the use of this technology will help the injured using a protocol from the moment that the Red Cross personnel receive a call, to the moment the injured victim is admitted to a hospital.

2. BACKGROUND
The critical goal behind the triage is to increase survival rate of the injured in the case of an emergency. When the paramedics arrived at an emergency scene, they need to perform the correct categorization of the injured according to their physical condition to give them a better chance to survive according to their needs; then in almost every case the paramedics have to send the victims, in the most efficient way, to a hospital with the equipment needed to treat patients correctly.

The use of this technology can help to perform this task by managing the data categorized by a system that already knows the different affordances of ambulances and hospitals. With this option the system can make the best decision for every patient, helping to manage a single information registry for all instances. We decided to explore the use of augmented reality with *Google Glass* because it can adapt intuitively to various scenarios, allowing a hand free

interaction and at the same time, showing an extra information layer over the real scenario that can help paramedics to register data and can assist them to perform these tasks effectively.

3. THEORETICAL FRAMEWORK

3.1 Augmented Reality

The main function of augmented reality is to create in the user the perception of interaction with the real world through the implementation of virtual elements that seem to coexist with natural context (Azuma, 2001). This system has three main characteristics. (1) It superimposes virtual elements and reality over a real environment sight. (2) There is a real time interaction. (3) It has a 3D registry, which refers to a precise alignment of the real and virtual elements. Our proposed technology allows immediate access to information related with the real context in which the action occurs. Access allows the paramedics and the office personnel to decide on immediate steps in any emergency scenario, decisions that can initiate lifesaving treatment for the patient.

3.2 Google Glass

Google Glass (Hill, 2013) is a project conceived as a new generation of technology for augmented reality capable to overlay images within the normal vision range of a person trough a screen of frontal visualization (HUD, Heads up display).

One of the most significant differences from other kind of mobile devices is its capacity to display a layer with information at user´s sight, being glasses allows them to follows the sight at every moment. This information can be navigated trough voice commands which opens the possibility to create user´s interaction experiences in scenarios where the use of hands may be inconvenient or even impossible. In the case of the mentioned problem, the affordances of this device become ideal to use in an emergency scenario given its characteristics.

3.3 Analogous Cases

We found some applications that are currently being use for the triage categorization process and we present the following comparison table:

Figure 1.1 Comparison of analogous cases

	Objectives, Format and User Segment	**Scopes and Opportunity Areas**
Gvet Triage	Teaching and learning of Triage trough an e-Learning platform. Developed for any user who wants to learn the Triage method	It generates different scenarios of injured people, correcting the user decisions indicating which parameter is wrong but for an exclusive learning use
Medrills Triage	Reinforce concepts about how to evaluate situations and patients, triage techniques, first aid and transportation protocols. Application for mobile devices for users that are looking to reinforce first aid basic techniques.	It counts with a 3D environment to illustrate the injured people scenario. It includes an instructional animation from start to end.
Fast Triage	Classification of victims in emergency situations. Mobile device applications for medic and perhospitalary personnel.	It allows the storing of data of every patient but it requires that the user has knowledge of the procedure and it doesn´t indicate if there is errors during the process.
Virtual Triage	Triage practice, web and mobile device software for professionals	Scenarios according reality. Exclusive use for learning.

After the analysis we can found that the main object of this applications is to reinforce the triage proceeding knowledge. In addition we see that none of them is designed for its use during a real emergency and either of them focused its use in hand free interaction devices.

3.3.1 Possibilities for Augmented Reality

If we adapt the augmented reality on wearable technology (the one that can be carried by an user at any moment), among some other benefits we can find out the followings: Monitoring the vital signs to benefit both the treatment and the costs of health control (important objectives for the creation of this kind of technology); Interactive games designed to reduce the pain in uses with certain sicknesses; Detecting algorithms trough a camera, that identify the eye movements creating markers for a great variety of diagnostics of mental sicknesses like alcoholism, Alzheimer and schizophrenia (Wiederhold, B., 2013).

On the other hand, companies like Drcrono Inc., experts in the development of health applications, have already identified the following qualities of augmented reality for medical use, specifically for devices with characteristics that are similar to Google glass: taking pictures at any environment without touching the patient, recording videos of meetings with patients, sharing data of patients with other people, accessing data of patients on the frontal display, obtaining notifications in real time and reviewing medical data without using their hands.

4. METHODOLOGY

On a first stage, after analyzing analogous cases, we performed: interviews, an emergency simulation and a brainstorming along with the prehospitalary personnel of Cruz Roja, whom offered a large outlook of their needs.

The interviews set the guideline to know the user's needs and what they think can help to cover them. The emergency simulation made with *playmobil* toys allowed us to understand how they perform the triage activities on a real emergency. With the information obtained we created: a profile chart know as Persona (Saffer, 2007), an activity chart (Kaptelinin, 2012), and a brainstorm. From the results obtained we created the categories according to their needs to stablish the design principles as possible solutions for the prototype.

After this we materialize a set of sketches for the visual look of the screens and perform with them a usability test to 6 possible users to obtain the feedback that would allow us to adjust the necessary changes to achieve our main objective: to have the proposal of a tool that allows a better performance of the paramedics on an emergency. As a last step we made a detailed description of a scenario that explain how the user would make use of the proposal in a specific case, and with this as a script we produce a video explaining its functionality on a real case.

5. DESIGN PROCESS

During the investigation stage, it was found that the prehospitalary personnel couldn´t operate any device manually because of the fact that their hands are their principal tools to aid the injured. The opportunity of using a device such as Google glass came from the brainstorming. We noticed that a potential benefit of this technology lies in how the device is constantly showing information to the user directly at his sight. Thanks to the integrated

camera and the GPS, it offers the opportunity of sending and receiving information regarding the environment in which the event occurs and it gives the user the ability to perform this activities without using their hands (Hill, 2013).

Then the following design principles were stablished:

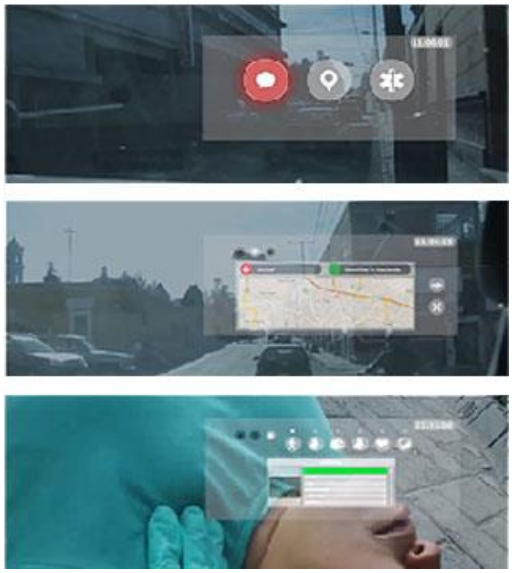
1. The application will serve to improve the translation in ambulances and the reception of patients in the hospitals during an emergency case.
2. The application must count with a guide of the Triage process that allows categorization of the injured so they can locate the available and hospitals according to a database.
3. The color codes of the Triage classification are universal so the must be maintained.
4. The use of hands limits the activities performed by the personnel, for which we propose the use of an augmented reality device.

Fort the prototype design we took as a base the user interface of Google Glass and its invocation methods: the tactile sensor and the voice commands (Hill, 2013). The visual elements were designed thinking that the screens displays as static or dynamic cards; the static cards refers to the visual elements that don't suffer any changes throughout the structure of the interface (for example the use of a watch); the dynamic cards refer to all the elements that chance according in respond to any invocation methods and that in this proposal, represents all the different functions that can perform such as: taking pictures, triage analysis, data logging, location searching and communication with other devices.

To cover for the following needs: classifying the injured in the case of an emergency, improve the translation in ambulances and the reception of the patients in hospitals; three principal icons were created representing: location, messages and triage. This elements are shown all the time so the user can know what he can do and what he is doing at every point.

This interface was designed taking into account that it must be seen over the real environment in which the user have he's sight, so its proper visualization implies the use of light colors and transparencies. All of this must allow its clear identification in any context they perform taking into account that it must not obstruct the vision of the environment they have in front of them.

Figure 1.1 Design of the Final Interface



In the Triage Process App section you can see the following icons that make reference to the walkthrough of each of the steps used for the categorization process: the first one make reference to a walking person, in this case if the patient can walk on his own, he can be categorized as green. The second one makes reference to ventilation through the nose, if the patient can breathe it jumps to the 4th icon, but in the case that he can´t it goes to the 3rd; the third icon requires the paramedic to open the respiratory tract. In this case we have 3 possible results: a) if the patient breaths it goes to the 4th icon, b) if he doesn´t breath but after opening the respiratory tract he breathed it continues to the next icon, c) if he doesn´t breath and after opening the respiratory tract he still doesn´t, it means he goes to the black category.

The fourth icon, makes reference to the ventilation process and how many breathings per minute the patient has, if he has over 30 ventilations it is a red patient; if there is less than 30 ventilations per minute, it continues to the 5th icon: perfusion, where if he's capillary refill is above 2 seconds, we have a red patient, but if it is below 2 seconds, it continues to the final icon which needs to check if the patient responds to simple voice commands, in this case if he doesn´t we have a red patient, but if he does respond, we have a yellow patient.

6. USABILITY TESTING

A usability test was applied to 6 emergency technicians of the Cruz Roja, to confirming the viability of the software and the usability of the interface. It consisted in the following: first filled in a questionnaire of general data, then they performed a set of tasks and in the end they filled another questionnaire that helps to evaluate each of the tasks performed.

The goal of the test was first to see if they could navigate the interface and complete the tasks trough voice commands, however as this last weren´t established, the test also worked to register which words could be used to invocate the actions, depending on what they wanted to do according the information displayed.

The tasks that they were asked to perform were the following:

1. You are in guard in the cabin and you receive a call mentioning there has been a crash in *Galaxy* colony but you don´t know the location, but you need to know it to send the closest ambulance, What would you do?
2. You find yourself on an ambulance, and you receive a message from the cabin. What would you do?
3. You are the first ambulance that arrived to the place of the crash and you see there are 5 injured people. What would you do?
4. You have an injured that doesn´t walk, breaths, but his but below 38 per minute. Of which color would you classify him?
5. You don´t have the necessary equipment to help the patient so they ask you to take a picture, save the patient´s data and send it to the 286 ambulance who will take care of the his translation. What would you do?

The test was performed to 6 emergency technicians of Cruz Roja Puebla. A laptop was set in front of them displaying the application. It is important to mention that before the test started, the use of Google Glass was briefly explained to them because they didn´t know about its function. As they were asked to do the tasks, they needed to mention, through verbalization, the word they felt convenient to say to the system to perform according to the action, at the same time we were watching their performance in completing

the tasks. We obtain the following voice commands as a result of this test:

U	Task 1	Task 2	Task 3	Task 4	Task 5
1	Ubicación - Buscar colonia	Leer mensaje	Triage	No camina - Ventila - Mayor a 28 ventilaciones	Tomar foto
2	Solicitar Mapa	Solicitar carácter del servicio	Triage	No camina - ventila - 38 por minuto	Fotografía
3	Ubicación de la colonia	¿Qué se cubre?	Triage	Rojo	Tomar foto
4	Ubícame Colonia	Muéstrame mensaje	Escanéame e cada lesionado	No camina - ventila - no, es mayor	Tomar foto
5	Mapa - pedir ubicación	Mensaje	Triage	No camina - hiperventila	Tomar foto
6	Ubicación	Mostrar mensaje	Triage	Rojo	Tomar fotografía

6.1 Test Results

Because this application is pretended to be used for emergency situations in which users can need to use their hands to aid the injured, it's use is centered in voice commands invocation methods to help the perform with Google Glass in a hands free way. According to the test results, this are the initial suggestions for its future implementation in this kind of scenarios:

- The voice commands should focus in evoke the concrete action needed instead of the tool to perform it. It is preferred to use *"Glass Take a picture"*rather than *"Glass use camera"*.
- Minimize the time between intention and action in the displayed data.
- Get to the desired action the easiest possible way.
- Use colloquial and easy words known by the user related to the actions.

We found an opportunity area in the evoking voice commands because of the huge variation founded from user to user after the test, so we purpose that a future study should stablish a set of commands that work for every case and then to perform more tests to stablish the system feedback given in the following scenarios: 1. The user say the registered word, 2. The system doubts about what has been said, 3. The system didn't understand the given indication.

7. CONCLUSION

With the final result we were able to see that this kind of tools would be a great aid for medical emergencies especially when the triage process needed to be implemented. The visual aid allows the paramedics to keep a track of their actions and to gather important data that could represent a significant difference in the patient treatment.

Also this kind of ideas demand a change in the information system management for an effective communication between ambulances and health centers, for which this contribution must be extended further from just a visual interface for augmented reality devices.

Although we found that the use of mobile devices such as cellphones, that require the use of hands for its interaction, will not be useful to perform in this kind of emergencies, even though the touch screen has increased significantly in human-computer interaction in the last few years. This was a big deal when we try to stablish interaction through voice commands showing that is not a very intuitive for the users when they try to communicate with the system. The touch paradigm have a direct gestural response when you select certain task, however when the linguistically variable appeared, a lot of factors came in play, especially the ones related with the language and the culture (slangs) that must be considered for the options of the action calls.

Given all this we conclude that the development of interaction paradigms through voice have a big challenge trying to find intuitive commands for an optimal experience, especially if we consider that the way we express ourselves may vary depending on the sociocultural context of every person. As a possible solution, other kind of action calls can be proposed and proved, such as eye tracking or another kind of sensors that can be attached to hand movements.

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Along with all this we created a video where we show the use that would be given to the device in the case of an emergency, which can be seen in the following link and QR code:

http://goo.gl/W0pvyg