SARA: Reducing Vehicular Fatalities via an Automated Signal

Theodore Lee
Cornell University
Ithaca, NY 14850, USA
TTL22@cornell.edu

Jaeil Lee
Cornell University
Ithaca, NY 14850, USA
JL2729@cornell.edu

David Choi
Cornell University
Ithaca, NY 14850, USA
DHC225@cornell.edu

Zhe (Maggie) Nan
Cornell University
Ithaca, NY 14850, USA
ZN45@cornell.edu

Motor vehicle accidents claim unnecessary lives. Thus, the promptness of emergency medical services and 911 operators is crucial. In this paper, we discuss a cost-efficient, technological solution, specifically designed to curb the response time by 911 operators and emergency services by reducing false positive signals and improving the text of emergency signals. Following contextual interviews of drivers and 911 operators, a revised design is proposed and implications for emergency signaling is discussed.

Author Keywords
Emergency, Interaction styles, User-centered design, Voice I/O

ACM Classification Keywords
H.5.2 User Interfaces; H.5.m. Information interfaces and presentation.

Abstract

Introduction

In the United States, there have been approximately 6 million reported car accidents and about 40,000 fatalities annually over the past two decades [11]. There are several ways to reduce the number of vehicular fatalities. First, it is possible to reduce the time necessary for emergency responders to get to affected drivers [8]. Literally, every second counts [7]. Second, the type of information shared with emergency responders can be improved [9]. Of course, any changes to the 911 system is wrought with political and legislative nuances [2].

Table 1. Comparison of emergency systems.	**SARA**	**OnStar**	**eCall (EU)** [10]
Automatic Crash Response	✓	✓	✓
Increase response time by up to 50% [6]	✓		✓
Voice Interface	✓	✓	
User pre-recorded message [9]	✓		
Payment Schedule	One-Time	Recurring	Taxes
NPV (3-Year)	$220	$625	N/A (Taxes)

SARA is a cost-efficient solution to reduce the waiting time for an emergency response by providing relevant information to emergency responders and meeting the needs of 911 operators. SARA accomplishes this by calling 911 on drivers' behalf immediately after an accident occurs, whether or not the driver is conscious. At the scene, SARA plays a pre-recorded message from the driver that includes relevant medical details, e.g. allergies or medical history.

In comparison to other emergency systems such as OnStar (www.onstar.com) and eCall [6, 10], SARA has several benefits (See Table 1). First, whereas OnStar requires a subscription and a human intermediary before reaching 911 (therefore extra time to response), SARA features a direct-to-911 voice call. This voice call is different from eCall's digital message, which requires municipalities to upgrade their hardware in order to process eCall's signals, thus effectively dealing with certain political hurdles [2].

Objectives

SARA is instrumental to society by addressing humanitarian concerns, conserving lives, and a renewed awareness regarding emergency interfaces in cars. This project continues SARA's development as an automated system. Specifically, we aim to reduce the time it takes emergency services to arrive after an accident occurs. This can be accomplished by producing a legitimate and accurate signal for 911 operators. In particular, we focus on the a) exact text that quantifies a legitimate 911 phone call and b) reducing false positives inherent with any automated response system. In this case, we focus on the design of a "cancel" button to terminate SARA's automated response in cases where sensors have misdiagnosed a threat. This combination of message design and false positive reduction enhances the reliability of SARA's message, leading to a subsequent decrease in emergency services' dispatch time, and ultimately reduced fatalities.

Design

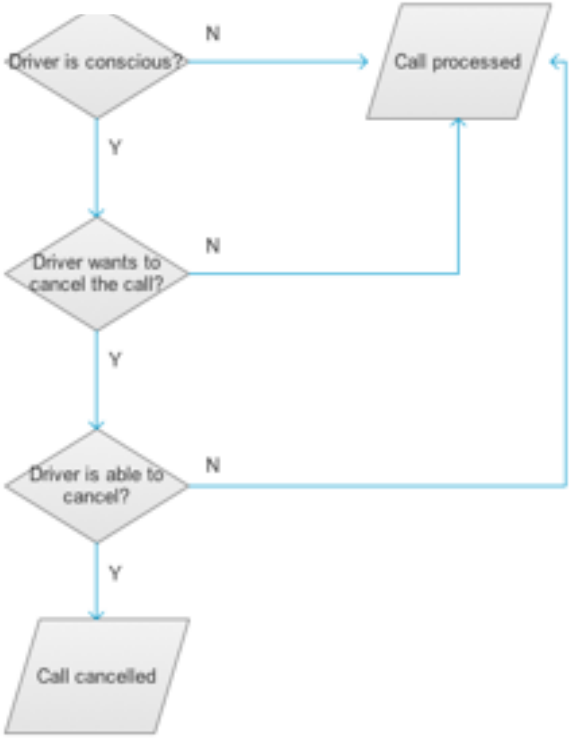
SARA has several unique design features. One is the automatic translation of factors in the accident into a voice message that will be transmitted to the 911 operator as soon as the accident has transpired. This is better than OnStar's emergency calling method, which requires the driver to press a button because the driver may not be conscious. Also, SARA will directly contact the 911 operator as opposed to OnStar, which contacts their operator before informing 911, unnecessarily lengthening overall response time.

Because SARA's proprietary advantage relies upon its automatic voice message, it is necessary to ensure that that message is legitimate and reliable. As such, a cancel button to reduce the number of false positives is prudent in order to eliminate unnecessary demand on 911 operators, emergency responders, and municipalities [2]. The size, shape, location, and sophistication of this button were all important factors to consider [5].

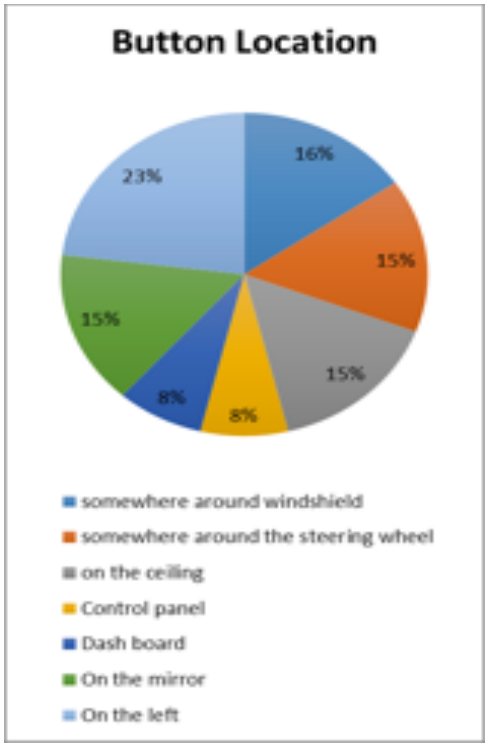
Previous work on emergency interfaces and stop buttons have included buttons of different colors (red being the most common) and types, e.g. twist-turn [4, 5]. As those button options have gone through series of tests and errors in real life, we thought it would be a good place to ground our design. It was surprising how present emergency buttons could be difficult to operate [1].

However, our project is an interesting departure from traditional emergency interface design. While most emergency buttons are used to signal an emergency,

Flowchart of SARA's



our cancel button negates such a signal. Thus, we had a slightly different set of concerns. Specifically, the cancel button needs to be easy enough for people to cancel in case of false alarm so emergency operators' time and resources are not wasted. Simultaneously, the button has to be difficult enough to operate so people who are unknowingly injured cannot trigger it too easily (See Figure 1).



One example of why this consideration is important comes in the form of death by second-impact syndrome [3]. Essentially, death occurs after a second impact to the head. In many cases, patients are unaware of the first impact and thus continue about normally despite the danger to their lives. In the context of driving, it would be understandable that a driver could be hit, feel well, but actually be injured, and subsequently brake hard at a stop sign, and die from the second whiplash. Alternatively, a driver could be inebriated and unable to make an accurate judgment call about their physical state. In either case, a "just difficult enough" button is desirable to adequately frustrate incapacitated drivers' ability to kill themselves.

We came up with an initial design based on features of already existent emergency services, e.g. eCall and OnStar, past designs, and our experiences of driving a motor vehicle. Our initial design for the cancel button was a glowing yellow, 1 to 1.5-inch diameter, circular button, which would be located just underneath the driver's seat. In order to trigger the button, the driver would have to reach down, press, and turn the button, akin to a child-proof medicine cap. We settled on this design because the button was 1) obvious (glowing yellow) in an emergency, 2) was somewhat difficult to reach, and 3) featured a two-step triggering mechanism, which hopefully is sufficient to detect and frustrate an unknowingly injured driver.

Method

We performed contextual analysis and interviews with drivers and 911 operators in order to test whether or not our design would be sufficient to improve the

legitimacy and accuracy of SARA's signal (see Appendix for detailed study procedures and questions).

Drivers

We performed a contextual interview with 11 subjects to solicit opinions and obtain feedback for a revised design.[1] Subjects' age ranged from 20 to 33 (*M* = 23.9), were 55% male (45% female), and were ethnically diverse. Subjects encompassed a gamut of driving experience, both in terms of vehicle type, ranging from sedans to U-haul tucks, driving time (0.5 to 13 years, *M* = 5.6 years), and number of accidents (0 to 2, Median = 0).

Following informed consent, subjects they were directed to a legally parked vehicle where a semi-iterative contextual analysis took place. First, subjects were asked to visualize driving and being involved in a light accident that triggers an emergency response, e.g. grazing a car while parallel parking. Next, they were asked to cancel that emergency response, we debriefed them on why they chose what they did. Before concluding, we presented our initial design, its reasoning, and asked for their feedback.

911 Operators

Following the brief introduction about this project and securing informed consent, we observed two 911 operators for approximately half an hour.[2] Second, we conducted an interview, inquiring about their experiences as an operator, their reactions to calls received, and their criteria for determining the legitimacy of calls. Last, we described our initial design and solicited their comments, feedback, and concerns.

Results

Drivers

Figures 2 illustrates drivers' opinions regarding button design. First, in discussing the location of the cancel button, a majority of our subjects (23%) indicated they preferred the button somewhere on the left. If we put the button on the left, near the steering wheel and windshield, that would match the preferences of 54% of our sample. Nearly every respondent hated the idea of a button on the floor. It appears we did not account for how height would make it difficult, even while sober, to press a button on the floor. Second, there is a clear preference for a simple push-down button (55%) rather than the push-turn button as we originally proposed (9%). Third, not diagrammed, respondents indicated a preference for red (67%) rather than yellow. Lastly, there is a clear preference for the button to sound when pressed (73%). Upon further elaboration, respondents indicate this is a result of verifiability – they wanted to know that they successfully triggered the cancel feature.

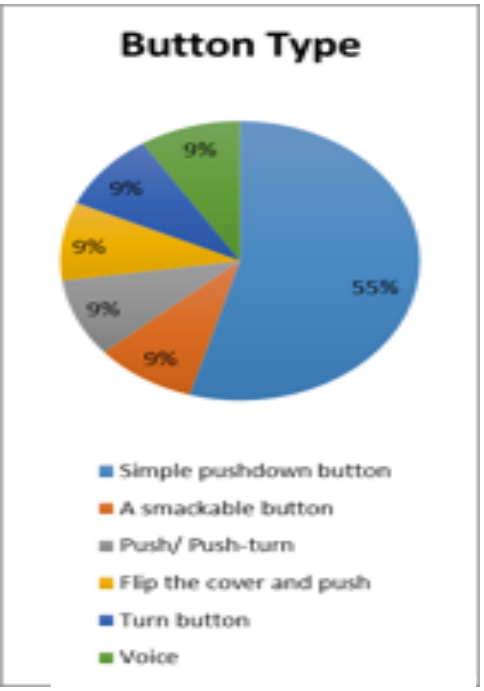


Figure 2. Drivers' opinions regarding button location and button type

[1] Due to IRB delay, we were unable to use SONA to recruit larger numbers of subjects nor perform the 3-step iterative process originally proposed.

[2] Due to time constraints (3 days between IRB approval time and the date of this paper), we were only able to interview two of the three 911 operators at CU Police.

Figure 3. Initial and Revised Button Design.

In summary of respondents qualitative comments, they agreed that the cancel button should be visible but not somewhere someone can easily touch on a regular basis and that there is a need to address false positives. They also brought up some issues that we did not initially consider. For example, they expressed concerns about the button being confused with other buttons, how much strength was necessary to push the button, and suggested that SARA check on the driver 20 minutes after a cancellation to make sure the driver is still okay.

It is interesting to note that many drivers (88%) indicated that they would like to be able to use the cancel button to call for help. Although this is not part of SARA's functionality, perhaps it should be.

911 Operators

Several themes emerged from our interviews with 911 operators: legitimacy, severity, accuracy, and find out is "*type of emergency, where, and a call-back numbe*r". Afterwards, they will inquire about specifics, e.g. number of people, severity of injuries, etc. Because of their sense of responsibility, all calls are treated as "*legitimate until proven otherwise… and even then, sometimes we still wonder*".

In discussing SARA, they are supportive of an automated system that helps to save lives. They also recognize the utility of a button to reduce false positives, in order to reduce their workload, as well as prevent an overload of the 911 system. However, they do not trust a button to verify that the driver is safe. Legally, a recorded verbal refusal of treatment from a person who is "*conscious, alert, and breathing*" is sufficient to terminate an emergency response. That said, they can only truly rest easy upon "*human-to-human*" verification.

The 911 operators provided some suggestions. First, they reported that a male computerized voice is best because they are more easily identified in the midst of chaos. Second, they suggested a brief delay of 10 seconds between incident and SARA call in order to reduce false positives. Third, they reported that providing exact GPS coordinates is not a first priority because the U.S.' enhanced 911 system automatically culls GPS data from the phone call itself. Lastly, they also wanted to be involved in any design of any emergency service or technology.

Revised Design

The basic premise of SARA has met with approval from drivers and 911 operators alike. Taking their feedback into account, our revised design features a red, circular, push-based button that will be located on the driver's left, near where the emergency brake often is (See Figure 3). The button will remain unlit during normal operation. Should an accident occur, the button will glow red, and SARA will ask the driver whether or not they wish to cancel a 911 call. If the driver wishes to, they will press the cancel button once. Afterwards, SARA will prompt them to enter a preset code into their radio dashboard. Upon successful cancellation, SARA will report that the call has been cancelled. However, if this is not successfully completed within 10 seconds, SARA will call 911 with the text, "*This is SARA reporting a vehicle accident at [location], call-back may be possible at [driver's number]. [Additional information as available, including GPS coordinates]…*"

We believe this design meets our objectives of producing a reliable and accurate signal that can decrease overall emergency response time. Future work in this area could benefit from prototyping, especially under realistic circumstances.

Design Implications

This project bears implications for the design of emergency interfaces. In particular, that they should be obvious, simple – but not too simple, and provide feedback upon interaction. Reiterating feminist HCI principles, any emergency service or technology design should include a variety of stakeholders, including 911 operators, emergency responders, and government officials.

Acknowledgements

We thank all of our participants and our INFO 4400/6400 classmates for their time and comments. The authors especially thank their instructors, Dr. Gilly Leshed, Emily Sun, and Taylor Landis-Miller for their help in conceptualizing this project and paper.

Works Cited

[1] ABB, Inc. (n.d.). Training Manual No. 2: Emergency Stops. http://www05.abb.com/global/scot/scot260.nsf/veritydisplay/e32f367d17642f29852575d20068205e/$file/1sxu150186x0201.pdf

[2] Braucher, J. (2002). When your refrigerator orders groceries online and your car dials 911 after an accident: Do we really need new law for the world of smart goods. *Wash. UJL & Pol'y*, *8*, 241.

[3] Cantu, R. C. (1998). Second-impact syndrome. *Clinics in Sports Medicine, 17* (1), 37-44.

[4] Carver, R. (2012). The Emergency Stop Button. The button of last resort. http://www.hs-compliance.com/uploaded/documents/THE%20EMERGENCY%20STOP%20-%202012%20ver%202.0.pdf

[5] EAO Switch Corporation (n.d.). Emergency Stops: What Designers Need to Know. http://www.newark.com/pdfs/techarticles/eao/EAO_Emergency_Stops-What_Designers_Need_to_Know.pdf

[6] European Commission (2014). eCall: Time saved = lives saved. http://ec.europa.eu/digital-agenda/en/ecall-time-saved-lives-saved

[7] Peters, J. & Hall, B. (1999). Assessment of ambulance response performance using a geographic information system. *Social Science and Medicine, 49,* 1551-1566.

[8] Pettersson, M., Randall, D., & Helgeson, B. (2004). Ambiguities, awareness and economy: a study of emergency service work. *CSCW 13(2)*, 125-154.

[9] Schooley, B., et al. (2009). Integrated Patient Health Information Systems to Improve Traffic Crash Emergency Response and Treatment. *HICSS '09.*

[10] Stojaspal, J. & Visser, M. (n.d.). Pan-European eCall and beyond. Telematics Update and White Paper. http://www.gemalto.com/brochures/download/M2M_WP_eCall.pdf

[11] U.S. Census Bureau (2012). Statistical abstract of the United States, 2012. https://www.census.gov/compendia/statab/2012/tables/12s1103.pdf