GuardDV: A Proximity Detection Device for Homeless Survivors of Domestic Violence

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Abstract

Research in homelessness points to a recent increase in the population of homeless women. Survivors of domestic violence who become homeless as a result of their flight from an abusive situation seem to comprise an increasingly significant segment of this group. GuardDV is a system that seeks to address the safety concerns of domestic violence survivors who do not possess a stable residence. The system warns the potential victim and the corresponding law enforcement organizations about the physical proximity of the aggressor. For this project, an interdisciplinary team committed to improve the quality of life of DV homeless survivors employed qualitative accounts as part of a participatory design [10] effort.

Keywords

Domestic Violence, Homeless, Proximity Detection, Safety, Participatory Design, RFID, GPS

ACM Classification Keywords

K.4.1 [Public Policy Issues]: Human Safety. H.5.2. [Information interfaces and presentation]: User Interfaces---User-centered design.

Background

The ranks of the poor in the United States have historically included a large number of people who

become homeless as a result of their economic limitations. Since the 1980s, the ratio of women to men who are homeless has increased reaching a rate of 2:3 [8]. Women who leave abusive relationships have come to represent a significant segment of this population. The purpose of this study is to provide a solution addressing the needs of women who become homeless as a result of their escape from an abusive partner.

According to Byrne and Arias [1], 1.3 million women are physically assaulted every year in the United States. Rosenheck [7] states that domestic violence (DV) is a "major factor" in causing women to become homeless. Concomitantly, the National Law Center on Homelessness & Poverty reports that "between 22% and 57% of homeless women report that domestic or sexual violence was the immediate cause of their homelessness" [6]. Moreover, in its February 2007 report, this organization states that "domestic violence victims frequently are evicted because of violence against them" [6].

Research Problem and Rationale

While DV survivors have multiple concerns such as housing, employment, and pressing economic needs, according to the DV experts we interviewed, their topmost concern is to remain safe. This project seeks to provide a technological solution addressing this problem. In order to assess the needs of their clientele, we established an ongoing consultation with five DV activists and shelter managers who interact with homeless survivors from the Midwestern U.S. on a daily basis. These informants were instrumental in providing initial input and feedback throughout the design process.

Approach and Uniqueness

This design project is intended to tap into Sengers et al.'s [10] take on critical theory. In this project we support these researchers' move toward critical reflection as a core design goal in HCI [10]. According to Sengers [10], "a critical reflection frame of reference promotes questioning the values currently embodied in technology design to produce technological systems which are meaningful to users" [10]. Critical reflection then is an integral part of participatory design (PD) as a design method and goal by propitiating the end user's involvement in the design of a solution addressing her own needs [10].

GuardDV is the result of a PD process that has proven to be successful in previous studies. One of these efforts is that of UTOPIA, a computer based tool to aid union workers in designing newspapers [10]. In this case, the organization in charge of technology development actively sought to obtain an understanding of the users' potential interactions with the technology while taking their skills and experience into consideration. Friedman et al. provide another example: "the redesign of the open-source Mozilla browser to provide peripheral awareness of cookies, as well as just-in-time information and management of individual cookies and cookies in general" [10]. According to Sengers [10] this redesign balanced privacy and informed consent with the importance of minimal distraction.

The accounts resulting from a technological needs assessment carried out through in-depth interviews with five experts on the issue of DV provided the design team with direct insight from those offering support to DV survivors.

Thanks to the insider's perspective provided by our informants, we concluded that a major concern for homeless DV survivors is safety. Our informants agreed that, in situations where the victim flees the home, many times the threats and aggressive actions become exacerbated. According to one of our informants, "batterers become good at whatever they need to so that they keep track of their victims." Furthermore, these experts asserted that loopholes in the legal system make it difficult for the survivor to keep updated information about the aggressor's location. Guided by the emerging themes evidenced in the transcripts of our conversations, we propose that DV survivors, and the organizations addressing this issue, will welcome a solution that would help avert the possibility of an estranged partner causing physical harm to a DV survivor.

Although Institutional Review Board constraints deterred our team from carrying out interviews with DV survivors themselves, the information obtained from DV shelter managers and activists grounded the design of a solution which addresses what these experts considered the most pressing needs of the end user. GuardDV is a system designed in response to the safety needs of the intended end-user as expressed by expert informants who are intimately familiar with the living conditions of DV survivors. Moreover, this study represents an ongoing conversation with our informants. In a second stage of this project we will present GuardDV to homeless DV survivors themselves in order to gauge their reception and elicit opinions regarding shortcomings in the design. Finally, we are in the process of obtaining feedback from law enforcement and legal experts about the viability of our design.

Results and Contributions

Global Positioning Systems
Global Positioning System (GPS) technology allows for tracking the location of individuals [2]. It has also been used to track executives in the event of kidnapping in Latin American countries [8] and the technology has even been embedded in children's jackets in case they go missing [9]. More specifically, GPS tracking has been used to ensure that a tracked parolee does not violate terms of his or her parole [2]. A limitation of using GPS in this way is that it fails to protect a mobile victim.

Radio Frequency Identification
Radio Frequency Identification (RFID) technology has been used widely in industry as a replacement for barcodes [11]. It has seen a wide range of applications from storing and retrieving private medical records [4] to inventory management at multinational retailers such as Wal-Mart [5]. It has also been used to track individuals, such as Alzheimer's patients and prison inmates [13]. For tracking over large distances, the falling prices for active RFID hardware, including tags with on-board power sources, provides a viable solution.

GuardDV: A Proximity Detection Device
Existing products allow for tracking offenders using Global Positioning Systems (GPS) technology alone. These systems provide the capability to alert authorities if an offender enters a particular area, such as a victim's home or office, but they do little to protect a victim while she is mobile. Our solution combines the power of GPS with the ability to detect when an offender comes within range of a person, as opposed to a location. The particular aspect of homelessness that is

Figure 1. *The sequence of events when the offender comes within range of the victim*

better served by this solution is precisely the DV survivor's lack of stable residence.

The proposed system is conceptualized as a GPS-enabled cellular system designed specifically for proximity notification. The device iteratively searches for a specific RFID tag at a certain range. If the device recognizes the RFID tag, it automatically places a phone call to 911, the hotline in charge of assigning emergency tasks to police officers throughout the United States. The device plays a pre-recorded message to the 911 operator indicating the name of the offender/suspect and the name of the potential victim. The enhanced-911 system can then track the location of the victim and the operator would direct officers to that location.
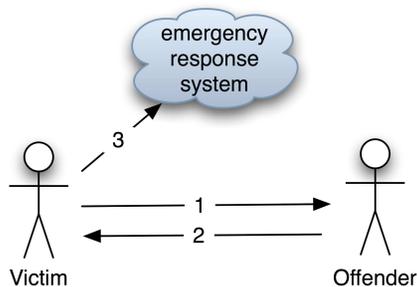
An RFID tag will be inserted into an existing ankle bracelet design which the legal system would mandate the aggressor to wear. We will discuss the ethical implications below.
GuardDV consists of the following components:

- Modified ankle bracelet with RFID tag

- Cellular device with RFID reader and GPS functionality, programmed with the ID number of offender's RFID tag

- Existing 911 system

These components are connected as illustrated in Figure 1. We considered that legislating changes to the emergency response system would be difficult and problematic, therefore our solution is intended to work without modifications to existing call center hardware or the need for re-training.
GuardDV could be funded through private non-profit organizations with fundraising capabilities.

Alternatively, the funding model for GuardDV could mirror that of the existing electronic monitoring bracelets. Our proposed design will look like a pager but it will be very specialized. Not only will the specialization help cut costs, but it will reduce the potential for theft.
The prototype design incorporates existing technology to test our proposed product. Our prototype includes the following components, this off-the-shelf components which are readily available:

- A Motorola Q Smartphone device with Microsoft Windows Mobile 5.0 technology.

- A HP iPAQ PDA with Microsoft Windows Mobile 2003 technology and an available Compact Flash (CF) expansion slot.

- A SocketMobile CF 6E RFID reader card [12].

The steps during a convicted abuser's breach of his restraining order follow those outlined in Figure 1 and play out as follows, using our prototype. First, the CF RFID card recognizes the aggressor's RFID chip by its unique identification number. The PDA which holds the CF card then connects to the Smartphone device via Bluetooth and passes along this information. The Smartphone then automatically dials 911.
The prototype system is currently in the early stages of development. While the prototype is functional, there are several component that need further testing and development. First, the current CF card only reads passive RFID which has a very small range compared to active RFID. We designed the system to utilize the Identec Solutions i-Card CF active RFID CF card [3], with a range of up to 100 feet in the future (pending funding). Second, the current system only dials 911. While this is sufficient for the 911 service to locate the

subject (DV survivor) using the embedded GPS system in the smartphone (DV survivor), we intend to implement a voice recording which will inform the 911 operator of the situation including the victim's and potential attacker's names. During our discussion of sensitivity issues we considered certain additional features that could result in an improved user experience. These ideas included labeling the device to prevent theft and including pepper spray for aid in case self defense is necessary.

Our research provides both novel contributions as well as improvements over existing technologies. The following list provides an overview of some of these contributions.

- Our product provides added safety to victims in need.

- The system provides portable RFID-based protection in addition to current stationary GPS-based protection.

- GuardDV allows for integration with the current 911-based emergency telephone system.

Discussion

Domestic violence is a basic human rights issue. On the other hand, we understand and have extensively discussed the privacy and human rights issues related to GuardDV. In considering the various stakeholders who could have a vested interest in this design (the aggressor, the survivor, legislative bodies, the legal system, law enforcement, the general public, and the media), most of the moral and ethical concerns that could stem from GuardDV's implementation do not seem to exceed those raised with the advent and instituted use of the the bracelet currently used to track parolees. Specifically, with respect to the DV survivor,

ethical considerations about its proper functioning need to be addressed through a training script that will be developed at later stages of the development process. In addition, little is known about the health risks associated with long-term exposure to RFID technology. We believe that the potential benefits to the victim (safety and increased sense of freedom) outweigh the previous concerns.

Because a similar, legally viable device (electronic monitoring bracelet) is currently in use, we foresee legislation enabling the mandate for a convicted abuser to wear our proposed device to be feasible.

Acknowledgments

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