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HELP: Handheld Emergency Logistics Program for Generating Structured Requests in Stressful Conditions

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Abstract

Large-scale disasters usually entail serious damage to life and property. Effective response to such disasters requires rapid reaction and efficient, accurate processes. Since disasters often strike without any prior warning, first responders have very little time to train and prepare for Humanitarian Assistance and Disaster Relief operations. These operations can span from several weeks to several months. This puts first responders in rather stressful conditions; they may not be trained to handle the task they have to, fatigued, and working in rather austere conditions. We are developing a system called HELP - Handheld Emergency Logistics Program – to enable first responders to rapidly request resources without the need for advance training. HELP runs on commercial-off-the-shelf mobile phones and tablets. We focus on the first responder's ability to use HELP in stressful conditions by minimizing the chance of error, reducing the need to pull information from memory, minimizing manual data entry, and by providing multiple redundant modalities for performing the same action. We present the design principles and architecture of HELP in this paper.

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1. Introduction

When disasters strike, there is rarely any warning. Responders must face the resulting challenges with the training and equipment they have on hand, not the training or equipment they ideally want. A key challenge while dealing with any disaster is to understand the size and scope of the area as well as the population effected. To make matters worse, every large-scale disaster, natural or man-made, results in casualties that can easily top tens of thousands. In recent times, the 2004 Indian Ocean tsunami [9], the 2008 earthquake in Sichuan China, and the 2010 Haiti earthquake [1] are examples of such large-scale disasters. While many of the injuries are easily treated, most basic medical services are destroyed or cut off from a vast majority of the population. This means that many easily treatable injuries can quickly escalate into more serious problems the longer treatment is delayed. For large-scale disasters, a large number of first responders are needed but not all are fully trained to deal with the need on the ground. Despite best intentions, this leads to inefficiencies in the process.

We want to leverage smartphone capability with the use of mobile applications to enable untrained individuals to easily and rapidly request for resources for Humanitarian Assistance and Disaster Relief (HA/DR) missions. These requests could range from logistics requests for food and water and medical evacuation requests for injured individuals to explosive removal in disasters caused by terrorists. With the smartphone capabilities and the application logic, injured individuals in affected areas could be attended to more quickly than before.

We have developed a suite of applications that run on Android handheld devices. During the development, we paid particular attention to making the applications simple to use in stressful conditions. We want even the most inexperienced user to be able to submit complex requests correctly. As stress will likely be associated with many types of requests (think medical evacuations), we employed various techniques to help combat the negative effects of stress when using our applications. Our application suite uses request formats that are fairly standard throughout the Department of Defence and NATO. In most large disasters, military is invariably requested to respond to the need. Our suite of applications can easily be used in disaster situations to help improve the response time for resources needed in an emergency situation.

Nomenclature	
CASEVAC	Casualty Evacuation
COTS	Commercial Off-the-Shelf
EOD	Explosive Ordnance Disposal
HELP	Handheld Emergency Logistics Program
HMI	Human-Machine Interface
HVHF	High Velocity Human Factors
MEDEVAC	Medical Evacuation
NATO	North American Treaty Organization

The Handheld Emergency Logistics Program (HELP) is intended to provide an application suite for first responders in an operational environment to call for resources from supporting headquarters. The application walks the user through several standard formats for calling resources, such as medical/casualty evacuation (MEDEVAC/CASEVAC), rapid logistics request, and Explosive Ordnance Disposal (EOD) support. The application suite operates on a smart device capable of running the Android operating system, and utilizes the sensors embedded in the device. The smart device currently employed is a smartphone, which is compact enough to carry while conducting dismounted operations.

The application is simple enough so that a first responder with little to no prior experience with standardized message formats can submit a request for support with all required information in a timely manner. To begin, the user simply opens the proper application corresponding to his needs (MEDEVAC/CASEVAC, Rapid Logistics Request, EOD Request) and populates the required information.

The client side HELP suite is written in native Android code utilizing the Android Software Development Kit (SDK). A Java-based desktop system acting as a server is required for connectivity and digital data transmission.

Due to the varying message formats of the three sample requests (MEDEVAC/ CASEVAC, Rapid Logistics Request, EOD Request), separate applications are created for each type of request.

The decision to develop the application using native Android was swayed by the open-source nature of the operating system coupled with the wide variety of development tools available for use. Additionally, any smart devices running Android will generally have several sensors and capabilities available for the system to draw from. The capabilities we were interested in exploiting are the global positioning system (GPS), camera, internal database storage, and Wi-Fi. These tools will assist the user populate the necessary information for the request to be transmitted and acted upon by their higher headquarters.

2. MEDEVAC Format and Procedures

Effective response to any HA/DR mission these days requires the ability to communicate with the outside world. This enables the front-line first responders to request for a variety of support. In most cases, requests for support are standardized to streamline processing. Support can range from time sensitive requests like medical evacuation to routine resupply requests. Regardless of the request, the format is usually standardized across all branches of the military (as well as many NATO allies) to ensure all relevant information is passed in a timely and efficient manner.

In order to have a casualty evacuated off the scene, an individual must send a MEDEVAC request to higher headquarters elements. From there, the higher headquarters make the appropriate decisions on what type of platform (ground or air) to deploy to evacuate the casualty in addition to which medical treatment facility is most suitable to deal with the injuries the casualty has sustained. Because time is critical during any evacuation, the request sent to higher headquarters must contain enough information to make an informed decision while not wasting time transmitting useless information.

The standard NATO MEDEVAC 9-Line request [4] for all services is as follows:

Line 1 – Location of Pickup Site
Line 2 – Radio Frequency and Call Sign
Line 3 – Number of Patients by Precedence
      A-Urgent
      B-Urgent Surgical
      C-Priority
      D-Routine
      E-Convenience
Line 4 – Special Equipment Needed
      A-None
      B-Hoist
      C-Extraction Equipment
      D-Ventilator
Line 5 – Number of Patients by Type
      A-Ambulatory
      L-Litter
Line 6 – Security of the Pickup Site
      N-No enemy in the area
      P-Possible enemy in the area
      E-Enemy troops in the area (approach with caution)
      X-Enemy troops in the area (armed escort required)
Line 7 – Method of Marking for the Pickup Site
      A-Panel
      B-Pyrotechnic signals
      C-smoke signals

    D-None
    E-Other
Line 8 – Patients Nationality and Status
    A-United States Military
    B-United States Civilian
    C-Non-United States Military
    D-Non-United States Civilian
    E-Enemy Prisoner of War
Line 9 – Presence of Nuclear, Biological, or Chemical Contamination
    N-Nuclear
    B-Biological
    C-Chemical
    None

A sample MEDEVAC 9-Line is as follows over the radio for an emergency in which four individuals are require medical evacuation with three injuries being classified as urgent and other as a priority:

Eagle this is Wolverine stand by for MEDEVAC request, break.
Line 1 – 11U GS 123 456, break
Line 2 – F123, Wolverine, break
Line 3- A-3, C-1, break
Line 4 - A, break
Line 5- L-3, A-1, break,
Line 6- P, break,
Line 7- C, break,
Line 8 – A-3, B-1, break,
Line 9 – None, over

Following this transmission, the unit that received the MEDEVAC request will read the request back to the requesting unit to ensure all information was correctly received.

A MEDEVAC 9-Line is generated in one of two ways. The individual that creates the MEDEVAC request typically references a 9-Line template and writes the information out on a separate piece of paper; alternatively, the individual has a laminated MEDEVAC 9-Line template that they circle and fill in the blanks with a map pen. Either way, the user is required to write the information down before sending the information up to higher headquarters because of the length and particular format required.

Once ready, the request is transmitted to higher elements. This is typically accomplished over a radio. Upon receiving the request, the receiving unit will read back the request to verify all information is correct. The information is then entered into a tactical chat window on a computer that is monitored by all units in theater. If a receiving unit lacks a computer to enter the request into the chat window, the request is passed via radio to the next level until it reaches a unit with the proper equipment. From there, the request continues to travel up the chain of command until it has reached the appropriate level to make the decision on what type of resources can be dedicate to the MEDEVAC request. After the platform decision has been made, the requesting unit and the evacuation unit are notified of the decision and passed all relevant information.

3. Stress in HA/DR Environments and the Need for Tailored Interfaces

Stress is best described as interaction between three elements: perceived demand, perceived ability to cope, and finally the perception of the ability to cope with the demand [8]. It is well known that combat is stressful and so is dealing with HA/DR. However, the level of stress and how stress physically and mentally affects the solider has only been scientifically studied over the last 60 years.

It is well known that stress adversely affects judgment and reaction time. The studies have been able to quantify how much stress affects humans both physically and mentally. Up to 80% of individuals in a stressful situations

experience what is known as the tunneling effect or tunnel vision [2]. This effect makes the surrounding environment seem smaller and they are unable to process all of the stimulation for the environment. Next, over 80% of individuals have experienced time distortion whether it is slowing down or speeding up [2, 3]. It has also been shown that in stressful conditions there is degradation in manual dexterity and fine motor skills [8]. Individuals lose their ability to write, hit a small button, or shake uncontrollably regardless of how scared they become [2, 3, 8]. Furthermore, studies have shown that individuals' judgment in stressful situations is worse than when they are intoxicated or given powerful sedatives [5]. Additionally, factors such as loud noise, sleep deprivation, fatigue, and poor nutrition levels can amplify the negative effects of stress on the human body [2, 8].

The military has used this information when it comes to designing interfaces and procedures that are used in combat. Some may consider the military to be an expert in the realm of designing systems for use under stressful situations.

Even with the information from the studies and the knowledge on stress, we face challenges with today's technology. Due to the fact that most systems are becoming more technology-based and have the ability to perform multiple functions, physical buttons and levers have started to disappear from system interfaces. The classic interfaces have disappeared even though these physical buttons and levers have been proven in studies to be easier to find and manipulate under stress [7]. Furthermore, the military as well as first-responder organizations are starting to acquire more Commercial Off-the-Shelf Technology (COTS) instead of more traditional specialized or purpose-built technology. While this is not necessarily a bad thing, challenges arise when using civilian devices in highly stressful conditions.

The primary challenges that COTS technology brings is how the user in stressful conditions interfaces with the system. Lacking physical buttons or levers increases the likelihood of mistakes. Furthermore, the more options or modes the interface has, the more is the information overload [6, 7]. Systems that are not designed to be simple and easy to use, run the risk of failing the user in a critical time of need. While undoubtedly smartphones, coupled with their applications, can increase effectiveness of a first responder, they also have the ability to become a burden. Their effectiveness or burden on a first responder will be judged by whether they are able to use the system in stressful situations.

While the technology industry has very good knowledge and experience in building interfaces for the normal user, it lags in the development of interfaces for users in stressful situations [6]. On the other hand, the military has an excellent understanding of stressful situations yet it lags behind in the use of the latest technology. The development of a technology interface for stressful situations has undoubtedly lagged behind because of the small number of individuals that are affected by this and the financial gain. However, there is some research available to guide the development of technology for use in stressful situations. Rahman [6] has proposed the following seven guidelines or "laws":

1. *The Law of Relevance*
  The human-machine interface (HMI) should aid the human agent to sense, perceive and lock-in on relevant cues (data\information) and make irrelevant cues, irrelevant.
2. *The Law of Acceptance (of Relevance)*
  An HMI shall not aid or abet the agent from going into total lock-down (cognitive\visual tunneling) at the expense of becoming immune to relevant signals or all together missing newly emerging and relevant cues in the environment.
3. *The Law of Transparence*
  An HMI shall not become a barrier to information that could and should be sensed directly from the immediate environment.
4. *The Law of Clairvoyance*
  The HMI should assist the agent in imagining the future state of the world for a given course of action, or for an event that is already unfolding in real time.
5. *The Law of Absoluteness*

The HMI shall provide instant access to vital functions that need to be accessed in a split second by providing dedicated physical and tactile controls – including rapid cognition of relevant information – with a one-to-one mapping to the specific element that it would control.

6. *The Law of Intelligence*

Technology should be smart and adaptive and offload the human based on situation, context, and workload in a reliable manner. The agent should be "invited" back into the loop of action at appropriate moments when decision-making becomes the prerogative of human intelligence and not that of technology.

7. *The Law of Reliance*

A solution, system or technology should be trustworthy and reliable almost to the point of being treated with reverence.

The seven laws described above are guidelines that can lead to better interfaces for users in stressful conditions.

4. System Design and Architecture

The design of the HELP suite is divided into two distinct parts. We label these two parts as "before the emergency" and "during the emergency". All requests, regardless of type, have information that the user can prepopulate before the request is needed, which in turn could be used to speed up the generation and submission of the request during the emergency. To gather this information we created a HELP setting application. This application is used before the emergency to allow the user to set their current identification, call sign, unit, and radio frequency etc. This information is easily known to all members in a unit and, for a particular mission, it almost never changes. It is entered and verified before leaving on a mission. All of the other applications use this information to prepopulate as many fields as possible in the request. While this information is prepopulated, the user always has the choice to change it in the request application during the emergency.

HELP enables the user "during the emergency" to access and use sensors in the phone to speed up the generation of the request. For example, all requests are automatically tagged with the location of the user which is pulled from the phone's GPS. In GPS denied environments, the location information can be entered manually. Furthermore, the applications use the phone's vibration to provide tactile feedback to the user. We are currently incorporating the phone's camera as a scanner to leverage QR codes to populate information.

Automatically populating information speeds up the overall process, but the user is still required to enter information that will only be known at the time the request is made. Many of these requests will be made under extremely stressful conditions. To compound the matter further, there is no guarantee that the individual making the request has had the proper training to populate the request format. To help overcome these issues, we took into careful consideration the layout and design of each application. Research has shown that individual's manual dexterity, fine motor skills, and decision-making can be negatively affected by stress [2, 8]. Our goal was to reduce the effects of stress that could negatively impact the user while populating the request. To accomplish this, we designed the applications to lead the user through the process and reduce the probability of entering incorrect information. To accomplish this, at every opportunity we eliminated the user's need to enter information by automatically populating information from the setting application, automatically pulling information from phone's sensors, and by creating lists of options from which to select. Additionally, when a list was not practical, we implemented simple button-based interface in which information is entered. We boldly display important information on the screen to draw the user to particular area on the screen and provide visual and tactile queues to the user to ensure information is accurate and in the appropriate format. In areas where inexperienced users may have trouble with definitions, we provide helpful hints to give them the necessary information to make a decision.

Generating the information quickly and accurately is important, but the request is useless until the appropriate headquarters agency receives the request. Once the required information is collected, the user is presented with a final request for review, enabling the user to confirm the information before sending the request using one of two methods. The user can choose to send the request via radio by reading the information in the format provided. However, if the phone is connected through a wireless data service to the supporting headquarters, the user can press a button at the bottom of the screen to transmit the request. The messages are transmitted much like text messages to supporting headquarter in the proper military format. At the supporting headquarters, a server listens for these

requests. When a request is received, the watch officer simply forwards the request to the appropriate agency to make the decision on how to best service the request. Furthermore, the user is provided with a response to show that their request was received by the server at the supporting headquarters. With the ability to send the request with the push of a button, the process of transmitting the request greatly increased. Using traditional means of radio transmission, the user must make a request and the receiving unit must reread the request back to ensure the request was properly received. With wireless capability, requests can be submitted and received almost immediately.
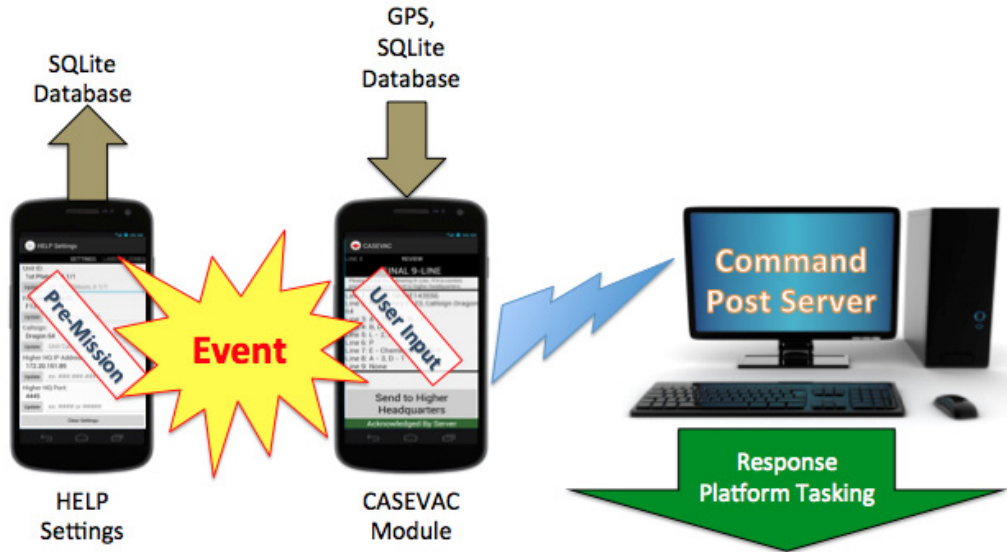
Fig. 1. System Architecture Diagram.

Example Screenshots

The following screenshots depict the CASEVAC application. The first nine screenshots depict the user-input portion, while the final shows a 9-Line having been submitted to higher headquarters.
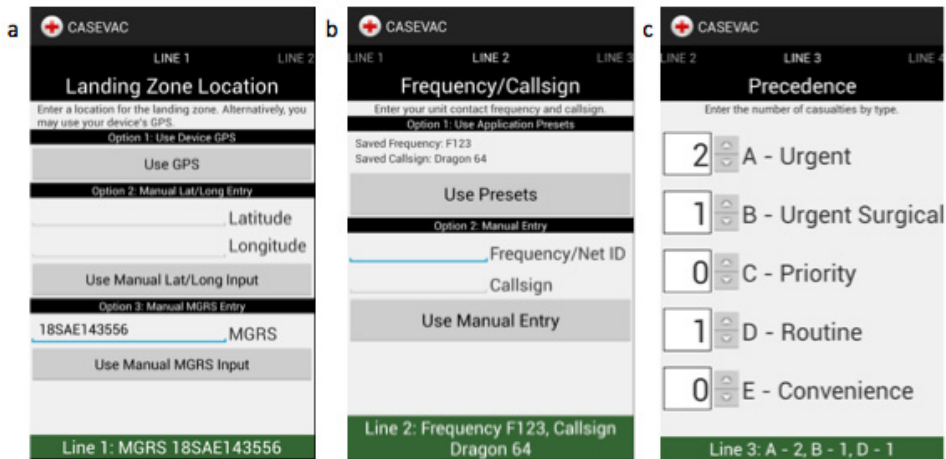

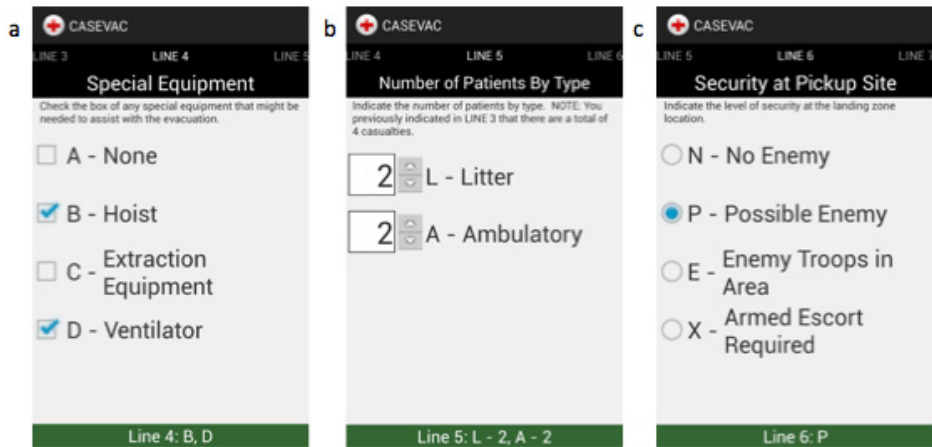Fig. 2. (a) Line 1: LZ Location; (b) Line 2: Frequency/Callsign; (c) Line 3: Precedence.

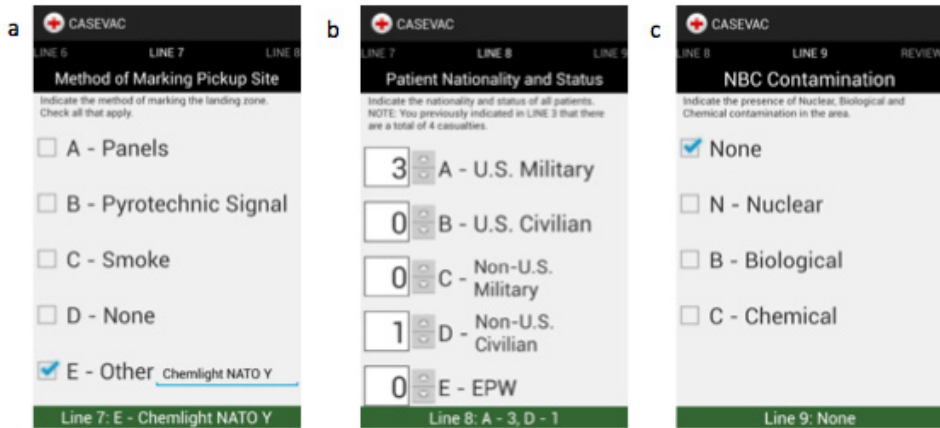Fig. 3. (a) Line 4: Special Equipment; (b) Line 5: Patient Quantity; (c) Line 6: Security.

Fig. 4. (a) Line 7: Marking Method; (b) Line 8: Patient Status; (c) Line 9: Contamination.
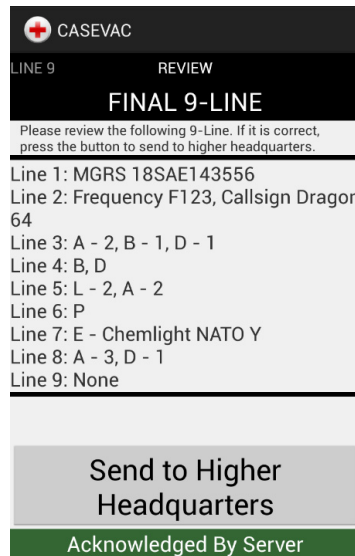
Fig. 5. Completed 9-Line.

5. Conclusions

First responders participating in HA/DR missions operate in rather stressful conditions. Stress can affect their memory, manual dexterity and judgment. On top of this, often they have to perform important, urgent tasks in a time-compressed manner. HELP, a COTS mobile phone based system, is designed to enable first responders to rapidly request resources without the need for advance training. We have implemented a prototype of HELP and are in the process of extending its functionality. We plan to test it with typical first responders to gauge its suitability for the purpose for which it is designed. These tests will be conducted in June/July 2014 in Camp Roberts, CA.

Acknowledgements

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