Seeing through the Eyes of the Citizens during Emergencies

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ABSTRACT

Availability and access to information is critical for providing a highly effective response to an ongoing event – however, often information reported by citizens over the phone may be unclear, inaccurate, biased or subjective, based on the context of the reporter. This can often lead to inadequate response to an emergency, which can in turn result in loss of property or worse, lives. On the other hand, excessive response to an emergency can also result in a highly expensive exercise. Our solution to address this problem is to make the citizen act as a camera for the control room by exploiting the user's mobile camera. The system is designed to provide a live view of the citizen's immediate surroundings, while control room personnel can provide instructions. In this paper, we introduce the system and share initial insights from a focus group evaluation conducted within a separate but closely related domain.

Keywords

Mobile Camera, Emergency Response, Control Room technologies.

INTRODUCTION

Emergencies are highly stressful events occurring unexpectedly during every day life. Such events are highly challenging and demanding for both citizens and emergency responders. Often, this can impact how information is relayed from citizens and observers to decision makers and emergency responders. This can lead to a significant misunderstanding of the exact situation in question, thereby generate an inaccurate response [Quarantelli, 1975]. Citizens and observers also do not share similar terminology and interpretation of events as Emergency Responders do and hence, may often result in incorrect reports. Citizens, for example may interpret surface water as flooding, which can be discounted by knowledgeable responders. At the same time, potholes on access roads can be more accurately assessed by decision makers as compared to descriptions by residents. Furthermore, local residents are aware of regular events and hence expect situations that may be misinterpreted by citizens not familiar with the locality. For example, a visitor unaware of the regular depth of the river may not realize an impending danger. Hence, certain situations need decision makers to observe by themselves to formulate a better understanding of an evolving situation, thereby resulting in the most appropriate response. Moreover, citizens may be confused about their actual locations if they are unfamiliar with the area (or simply confused by the emergency).

We present a real-time live platform 'Eyes on the Ground', that aims at providing a flexible way for operators and decision makers to view an area and communicate with citizens. Communication is initiated either by citizens or control room operators using several approaches such as clicking on URLs sent via texts and emails or dedicated applications. We plan to extend the mobile application with a geolocation-based capability that can alert the user when he/she arrives at a particular location[1] such as [Szczytowski, 2015; Mazumdar, 2015]. The alert can then trigger a call to the control room, which can then initiate a live video feed. This system was developed in the WeSenseIt[2] project, originally aimed at understanding how citizens and authorities can communicate during emergencies to help improve situation awareness. In this paper, we further describe our approach and discuss lessons learned from a focus group evaluation with Occupational Therapists in Sheffield Northern General Hospital[3]. We believe our findings are highly significant and can inform a variety of aspects that solution developers need to consider while creating solutions for the Emergency Response domain.

REQUIREMENTS

The requirements derived from user studies, evaluations and discussions over the past projects (as well as the WeSenseIt project) are as follows:

1. Enable uni- and bi-directional audio/video communication between citizens and control room
2. Run on a large number of phones without pre-installation of an app
3. Simple to use and avoid further confusion for citizens already impacted by the emergency
4. Degrade gracefully if limited by the bandwidth
5. Automatically display location of the caller
6. Enable control room operator to create a multimedia record of the call including time-stamped and geo-located report containing notes, screenshots and video recording of the conversation that can be accessed on demand.

EYES ON THE GROUND

The 'Eyes on the Ground' system is a cross-platform application that turns a citizen's camera into a street camera for the Emergency control room. The system facilitates connecting with citizens via Android, iOS devices and personal computers running a web-browser. Control Room operators can see through the camera of the citizens while simultaneously communicating with them via audio and on-screen messages (e.g. to give instructions or ask questions). Control room operators can take notes, screenshots and record videos, as well as fully control the citizen camera (displaying alternatively front or back camera), hide themselves to reduce bandwidth or show themselves to clarify instructions with body language.

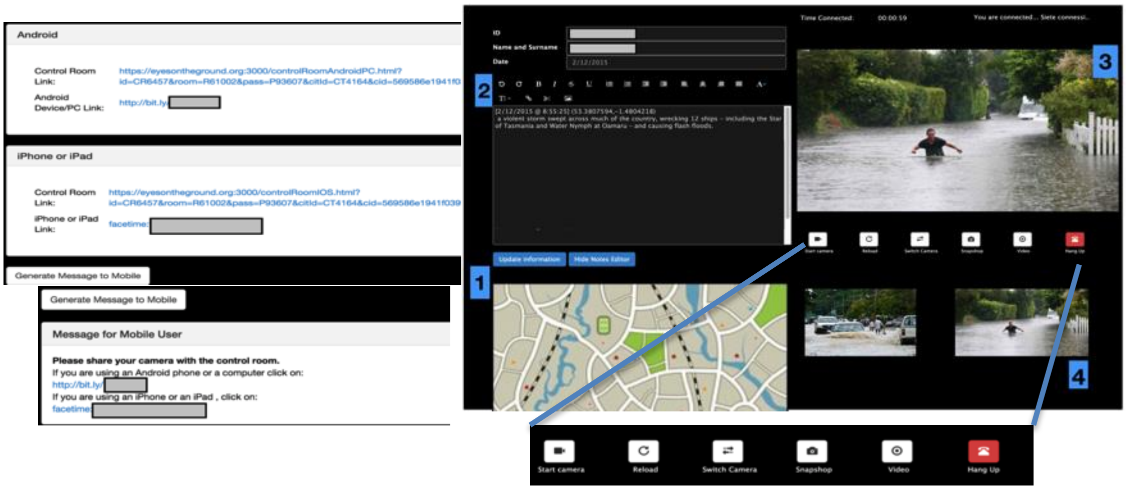

Figure 1. Eyes On the Ground Control Room.

1 http://irevolutions.org/2011/08/21/geo-fencing-crisis-mapping/

2 The WeSenseIt (http://wesenseit.eu/) project is aimed at developing Citizens' Observatories for Water

3 http://www.sth.nhs.uk/our-hospitals/northern-general-hospital

Interaction

The responder, being alerted regarding an event by a volunteer citizen (who for example has called the emergency number 999, 112 or 911) decides to initiate video-communication to see in-person the situation. He/she logs-in the system via a Web-browser; they are provided with a scripted message to send to the citizen including a URL that will – with the agreement of the citizen – activate the camera and provide the phone location by accessing its GPS. (Figure 1, Left bottom). Clicking the link opens the communication. The responder in the Control Room (CR) will receive a callback and a session is opened. The CR session is analogous to a one-directional video chat-room where a one-to-one link between the responder and the citizen is established. The use of https protocols and strict control over the participants in the call to provide confidentiality against intrusion by external parties. The CR session runs in a browser and contains four major sections (Figure 1, Right-Top): (1) map referring to the exact location of the caller; (2) a logging/notes section to capture any relevant details; every entry is time stamped and every communication with the citizen is geolocated (3) a live feed of the user's camera (Figure 1, Right-Bottom) with a few controls: the responder can choose to show/hide themselves, reload the feed or switch between the front/back camera, take screenshots, record audio/video and hang-up the call; and (4) the screenshots and videos stored for future reference. While not presented in the Figure 1, the CR session also provides additional features such as approximately measuring the distance between two objects or the dimensions of objects the citizen displays via their phone (starting from objects of known length shown in the image – e.g. a car of known brand and model or a shoe)[4].

All conversations and information shared between the responder and citizen is preserved within the context of the session and can only be accessed by the responder (using their own login credentials). The session can also be saved to automatically generate a report of the conversation, and any audio/video recording can be attached to the report. The audio/video communication is initiated in multiple ways: (a) control room responders can pro-actively contact citizens with a link via email or text messages; (b) a mobile application designed in the WeSenseIt project (made available to volunteers and citizens) facilitates two-way communication that can be started from the control room; (c) Web URLs can also be shared and advertised by authorities.

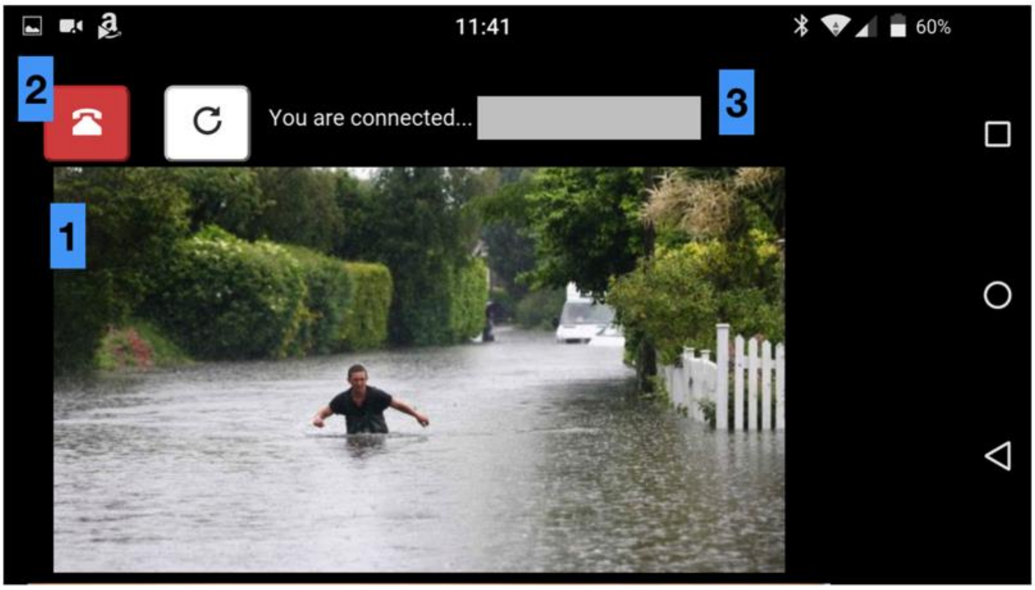

Figure 2. Citizen Camera view. 1: The user is presented with a view of the content being streamed by the front/rear camera; 2: The user can choose to disconnect the call (left button) or toggle between the front/rear camera (right button). 3: A live text messaging area can provide instructions to the user

Clicking on the link opens the phone's browser and loads the relevant page generated by CR. This page connects to a server used to open a streaming feed via HTML5 WebRTC[5], a recent standard for video

[4] While not critical to Emergency Response, this task is explored later in the paper during the evaluations with experts from a different domain.

[5] https://webrtc.org/

communication. The citizen can view on-screen the video being streamed to the control room (1) and can choose to toggle streaming from the front/rear camera (2, Right button). The user is also provided with the option of disconnecting the call if needed (2, Left button). The control room responder will normally communicate with the citizen via audio but should the need emerge to show themselves (e.g. to show how to perform an operation and even to soothe and calm the citizen); in this case the image in (1) is replaced with the image from the control room.

Implementation

The system is implemented as a client-server architecture, hosted on a Node.js server[6]. The CR session runs in Chrome or Firefox. On Android, the Chrome browser is used to share the video while in iOS, Facetime is activated. For applications where an app can be downloaded in precedence (e.g. the person using the phone is a civil protection volunteer), a mobile application is provided for Android and iOS developed in Apache Cordova providing further functionalities.

EVALUATION/ USER STUDIES

Eyes on the Ground has been developed in the WeSenseIt project, aimed at exploring how citizens and communities can collaborate to establish a shared situation awareness during emergencies. In this section, we discuss a first evaluation conducted with the technology with personnel of a local hospital. A further project-wide evaluation is planned in the next months.

Background and Motivation

Given the need of preliminary evaluation before performing a fully-fledged emergency evaluation (planned for the next months), a decision was taken to identify a proxy domain that can serve as a first test bed. Hence, certain commonalities between a target domain and Emergency response needed to be established: in an Emergency Response scenario, the solution is expected to have a command and control structure instructing citizens and volunteers to carry out tasks; cost of sending experts to locations is expensive, hence relying on local residents/citizens to carry out tasks is necessary; tasks need to be simple, but providing precise information that the citizen is not necessarily used to provide; moreover it must provide a potential gap between the terminology used by the control room and a casual citizen. We did not select in this case a situation where the user is stressed for a preliminary evaluation. The Occupational Therapy[7] domain was identified as a good alternative. Occupational Therapists (OTs) are trained experts who assess and treat patients with a physical, mental or cognitive disorder in order to develop, recover and maintain daily living and work skills. A specific issue with regards to the Occupational Therapy domain is the assessment of patient homes following their release from a treatment facility.

Assessing patient homes requires a trained expert (mostly OTs) to physically visit each location, measure access spaces, dimensions of furniture, identify need for assistive technologies (e.g. grab rails) and understand if their homes can provide a safe and healthy environment for the patient. This can be an expensive process, requiring hours of travel and time on the activity itself. The evaluation explored if OTs could remotely view and assess a patient's home with a family member or friend volunteering to be the citizen. This is a scenario that can be related to the Emergency Response domain due to (a) barrier between trained experts and citizens; (b) distance and limited interaction; (c) challenges of network connections in remote and random locations; (d) allows testing with casual users. Furthermore, the volunteer can be given tasks such as measuring furniture and spaces, show specific areas such as bathrooms or living spaces which are complex tasks and can result in confusion. As a result, the domain provided an excellent proxy for the evaluation.

Experiment Setting

The evaluation involved twelve OTs, at the Sheffield Northern General Hospital over a period of several hours in one day. Two volunteer citizens (C1, C2) were personnel of the University of Sheffield that had never seen the mobile app or the system before. Participants were initially briefed about the project in general, and the

[6] https://nodejs.org/en/

[7] http://www.nhs.uk/Conditions/occupational-therapy/Pages/introduction.aspx

system. Control room operators were shown how the system works and how to make calls, add notes, view video-stream and give instructions to the citizen 'on the ground'. Once briefed about the evaluation, all the OTs were grouped in one room (control room). One observer (OT1) was physically present with two 'citizens on the ground' (C1,C2), observing how instructions were followed in a room designed as a kitchen, bathroom and bedroom in a standard home (without intervening). C1 performed actions that were instructed, while the C2 held the mobile-camera. One participant (OT2) from the control room was then invited to use the system to contact the group (C1,C2,OT1) remotely and offer instructions to perform specific actions. Typical actions were:

"Show me the kitchen sink"

"Leave the kitchen and move along the corridor to show me the entrance door"

"Measure the height of the bed behind you"

"Measure the door width"

C1 performed the actions and OT2 took notes while this was done, also recording videos and taking screenshots. The task of measurement involved C1 to first position a known length (in this case, a standard A4 sheet of paper) next to the object in question (e.g. a bed, doorway or cupboard). Once the sheet of paper was placed in position, OT1 used the measurement tool in the CR session (Figure 3) to get an approximate measurement. The result was then later compared with actual measurements. Finally, all participants in the experiment were asked to join the group in the control room and a brief discussion was conducted to understand how the system performed overall from the perspective of the CR. In addition, a SWOT analysis [Leigh and Pershing, 2006] was conducted where empty marked sheets were laid out. Participants were provided with post-it notes to stick to the relevant sheets. A final discussion summarized the impressions of all attendees, from the four perspectives.

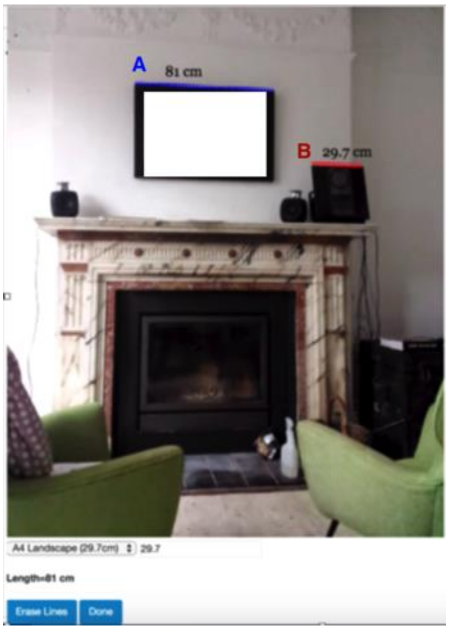

Figure 3. The interface to measure objects: a line is drawn on the known object (red line (B) known length 29.7); a second line (A) is drawn on the target object: the system displays the length (81 cm).

Results

We discuss the results from the perspective of the SWOT analysis (Figure 4) and participant discussions. Only the aspects that can be relevant to the Emergency Response domain are discussed, while healthcare and medical discussions are omitted as out of scope. Overall, the participants were happy with the technology and noted that such an approach can drastically reduce the need for a physical presence at remote locations as they felt that the remote visit effectively provided the information needed in most cases. The quality of the picture and audio was appreciated; participants noted that this could help save time and money instead of an expert requiring traveling and visiting locations. The citizens could follow the instructions precisely. One participant pointed out that recording the visit was helpful as it can help them re-visit areas several times if they had any doubts regarding a section of the patient home. The relation with the emergency service is here clear: the system can be used to assess the situation to decide if physical support is needed and in case what support. Another participant felt that a set of required steps (e.g. measurements) should be scripted in advance to support the CR personnel in choosing the right vocabulary and even to describe in advance to the citizen what was going to happen. This is expected to speed up the process and reduce possible misunderstandings during the process. All participants agreed that such an approach could help immensely toward providing a rough idea of a location/home before any visit is made, so any necessary preparations can be made. This was a highly positive outcome and promises significant opportunities for the domain. All users found the system easy to use and appropriate to the task.

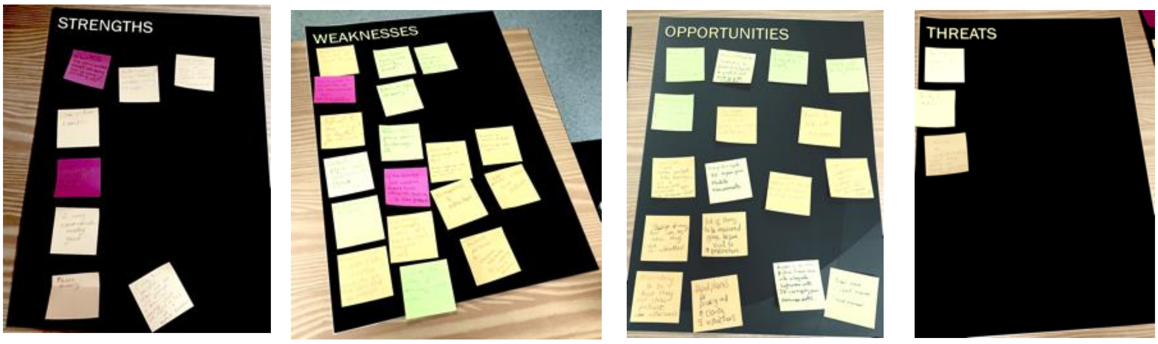

Figure 4. Results of the SWOT analysis for the Eyes on the Ground. Participants were provided with post-it notes and asked to stick on the appropriate sheet, based on their impressions of the system.

On the other hand, while an overall high quality of communication was experienced, the system had intermittent connection issues, owing to the unavailability of the connection at specific ‘dark-spots’ in the home due to interference with equipment and shielded zones such as near lift areas. Several issues were therefore discovered during such events as a result, which had not been identified in earlier tests. The participants noted this disruption and pointed the need for the solution to be more robust and able to cope with such incidents. A new version for the system was then developed able to robustly reconnect the communication automatically. In terms of threats, three main points were noted that require careful attention: security, confidentiality and trust. Although technical implementation is in place for a secured, confidential and trustworthy communication, the participants need to be alerted to risks and must be informed that necessary precautions have been taken.

Two main weaknesses were noted: (a) the measurement tool was not highly accurate (results varying between 70-90% accuracy when compared with actual measurements) – this indicates that the tool could be used for cases where accuracy is not essential; (b) a clear and unambiguous vocabulary must be studied to avoid misunderstandings – e.g. *“measure the door width”* was interpreted as measuring the door width while it was meant to measure the open access space. The issue regarding measuring objects was primarily owing to the object being 3D, while a 2D screen and sheet was used as references. Moreover, the angle of view often distorted the dimensions of objects (e.g. a standing user measuring a box on the ground vs on a raised table). An interesting point that is also relevant to the Emergency Response domain is that sometimes the volunteer may not be physically capable of acting on instructions, and this needs to be understood by the responder.

DISCUSSIONS AND CONCLUSIONS

In spite of the evaluations being conducted in a different domain, several findings were highly relevant to the application of the technology in the Emergency Response domain. For example, instructions from an expert may be misinterpreted by a citizen, eventually resulting in inaccurate information. Therefore, it is important for emergency responders to create scripted scenarios and an unambiguous vocabulary. In case measurements are required, estimates could be made which may not be highly accurate but sufficient for certain cases: e.g. estimating road access to provide access to an ambulance need not be highly accurate to a centimeter, but a rough approximation can suffice. It may also be helpful for citizens and authorities to collaboratively develop vocabularies that both actors can use with comfort, even under distressing conditions. Once a vocabulary has been developed, it needs to be communicated and publicized via different forms of media to raise awareness among citizens. This can be done by organizing periodic workshops, citizen engagement and recruitment drives, school workshops and so on. The possibility of introducing such workshops in school curriculum would be invaluable in bridging the gap between ordinary citizens and Emergency Response communities. It is also important for Emergency Responders to understand the limitations of citizens in terms of physical mobility or access to areas. Though this may be a standard practice for some organisations, it is an aspect that needs careful consideration. Some suggestions include an automated set of questions or messages that alert both sides of any risks or activities. Additionally, such messages could also be used to provide information to raise awareness of trust, security and confidentiality of the citizen in question. Audio-video communication is dependent on Internet connection and a reliable connection may not be always available at every spot of a house/location. Hence, such solutions must consider such scenarios and be robust to exceptional cases and provide alternative solutions in such cases.

The evaluation involving OTs was conducted several months back, and some of the issues raised have since been addressed (e.g. making the solution more robust). However, there is still a need to understand how a standardized approach can be employed to bridge the barrier between an expert and citizens. We will also focus on understanding how best to provide information to citizens related to their security and privacy and how their concerns can be addressed. Future work involves evaluating the system with Emergency Responders. A planned evaluation within the WeSenseIt project is expected to start in the next few weeks, where Eyes on the Ground will be integrated with other applications. We also plan to extend the system to explore how location based services can be incorporated. Future work also involves releasing the system for a several days/weeks longitudinal study to understand the effects of learnability on usability of the system.

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