The Role of Location for Family Reunification during Disasters

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ABSTRACT

After large-scale disasters, displaced or injured people can lose contact with their family and friends. In an effort to mitigate the effects of these events, the US National Library of Medicine has developed People Locator, a Web-based system that allows family members to search for missing persons. The purpose of this paper is to describe the role of location in family reunification systems, in particular in People Locator, and the data input technologies that support it.

Categories and Subject Descriptors

J.3 [Life and Medical Sciences]: health, medical information systems; H.3.5 [Information Storage and Retrieval]: Online Information Services – Web-based services

General Terms

Design, Management

Keywords

Geographic information systems, family reunification, disaster management, geotagging

1. INTRODUCTION

A frequent consequence of widespread disasters is that people cannot find family or friends who go missing. Missing people often turn up in refugee camps or in hospitals where information on them may be taken and stored in a database that can subsequently be searched by survivors trying to locate their loved ones. For this purpose, the Lister Hill Center, an R&D division of the National Library of Medicine, has developed ***People Locator (PL)***. PL is a Web site to which photos and metadata (name, age) for missing (or found) people can be posted by hospital staff, relief workers, or family members, and which can be searched by professional counselors or the public to reunify families [31].

First deployed during the January 2010 Haiti Earthquake, and since then for several disasters including the Japan Tsunami and the New Zealand quake, People Locator has collected a substantial number of records (photos and metadata for missing people), some sent directly to this site, and many others imported from other similar systems, notably Google's Person Finder system.

Within our overall "Lost Person Finder" (LPF) project, we have designed five ways to enter data on missing or found people into the PL database: three of them used anywhere, one specifically for a hospital environment, and another to import data from other similar repositories. The three general ways are: (1) a (structured) Web form; (2) unstructured data entered by users in the subject line of an email message; (3) structured data entered by users into a smartphone running ReUnite, an iPhone app. The other ways to gather data into PL are: (4) by hospital staff using TriagePic, a Windows form-based application, (5) by importing data already collected in another repository that is interoperable with PL, e.g., Google's Person Finder.

We organized the paper as follows: Section 2 discusses the different techniques for entering data into PL. Section 3 lists the different types of location data processed in PL. Section 4 then shows how PL makes use of these location data. Finally, Section 5 projects future directions.

2. DATA SOURCES

2.1 Web Form

At the PL Web site, for a particular disaster, a registered user can report someone missing. Later, others may add comments or updates, e.g., that the missing person was found. The reporting form allows uploading a photo and has structured fields (such as name, age range, gender, eye color, skin color, height, weight) and free text. The latter encompasses description and last-seen location. A revision is underway that will provide latitude/longitude as a structured field as well.

2.2 Email

PL can receive minimal lost/found reports from the field through email. The Web site offers tips on structuring the subject-line to help PL parse out names, locations, and health status. Work on a more full-bodied system is described in Section 3.

2.3 ReUnite

For reporting by the public or aid workers in the field, an alternative to email is to offer form-based apps on smart phones or tablets. This side-steps the difficulties of parsing email. Our first effort in this regard, in response to the 2010 earthquake in Haiti, was to deploy "Found in Haiti", an iPhone/iPod Touch app. This evolved, with substantial revisions, to ReUnite, available now through the iTunes store for iOS 5 or later, and shortly in native

People Locator, ReUnite, TriagePic, and the Lost Person Finder design are trademarks of the U.S. Department of Health & Human Services.

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iPad form. Versions for Android devices are under development. Section 3 shows an example of reporting.

2.4 TriagePic

TriagePic is a software application designed to quickly enter minimal information about each mass-casualty arrival at a triage station, typically at the periphery of a hospital. Staff-entered patient information would ordinarily consist of a photo and categorizations by gender, pediatric versus adult, and initial triage status.

TriagePic currently runs on Windows XP/Vista/7 laptops and tablets, using either webcams or paired Bluetooth cameras. Versions for iPad and Android tablets are under development, and other platforms (Win 8, iPhone, Android phone) are of interest.

2.5 Other Registries

Person Finder Interchange Format (PFIF) allows exchange of information about missing and found persons among Web-based registries set up for a particular disaster. The information is provided by the general public, and is publicly searchable [24].

After hurricane Katrina hit landfall along US Gulf Coast in 2006, many Web sites for missing-person reports were rapidly put together. To promote a more unified and sharable use of this data, Ka-Ping Yee created PFIF, with its repository initially hosted by Salesforce, Inc. A more internationalized 1.2 version, reimplemented and hosted by Google as “Person Finder” (PF), was deployed for 2010 earthquakes: initially Haiti in January [34], then Chile and Christchurch, New Zealand. Version 1.3 was fielded in 2011, towards the end of reporting about the earthquake and tsunami that hit Japan’s Tohoku-Oki region [33]. Import of PF data into PL using PFIF has been successful during such events, and more broadly PL/PF data interchange has been demonstrated during test exercises (e.g., [11]).

The latest PFIF, version 1.4, was released in May, 2012. PFIF is a de facto standard, with efforts underway to embed it as a component of the emerging “Tracking Emergency Clients” (TEC) protocol. TEC [5][28] is designed to track displaced persons, refugees, and those who are accompanying patients being transferred. It is intended to be a new member of the Emergency Data Exchange Language (EDXL) [2] family of XML-based messaging protocols that share a common message routing schema. TEC has been recently submitted to the international standardization body OASIS [19].

3. TYPES OF LOCATION DATA

3.1 Explicit Geocodes

3.1.1 Mobile Device Location

Direct capture of latitude and longitude information is the ideal. Often a mobile device can directly provide its current location through GPS or by cell-tower triangulation or location lookup of known WiFi access points. The device user can arrange for this information to be included in a report, such as one created by our ReUnite app about a person who was found injured (Figure 1).

3.1.2 Hospital or Disaster Event

To report about a person through the PL Web site, log in is required. Self-registration requirements are a unique name and sufficient password. A user profile allows a few additional optional but private elements, such as email address. The profile currently has no geolocation information (such as home street address or its latitude and longitude), though it could be expanded. Note that to search records or report about hospital-based disaster events, logging in with hospital-privilege credentials is required.

As another example, when a PL administrator defines a new hospital (or other organizational facility) to the system, its street address and geolocation are included (Figure 2). As with ReUnite, the map pin location, typically set at first by either geocoding or “detect my address”, may be subsequently moved manually.

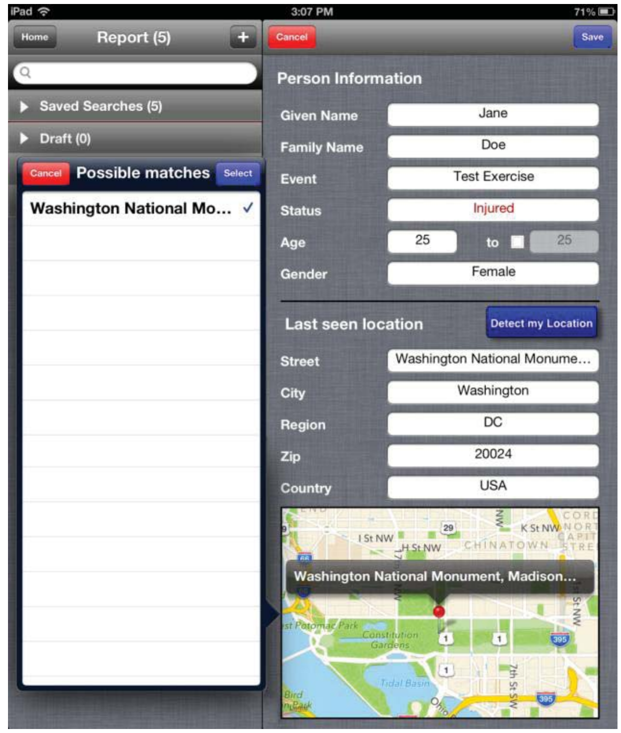

Figure 1. Reporting a person found injured using the ReUnite app on the iPad. Assume that when the reporter wants to report the “last seen location” (i.e., where found), the reporter is no longer at that location. Instead, he/she types “Washington Monument” in the Street field; this finds a single match, which when selected fills in the other fields, revises the Street field, and locates the pin on the map. The pin location may be directly manipulated further if desired.

Among other uses, when mass-casualty patients arrive at a hospital and are reported by TriagePic, the hospital geolocation appears on the “Last Known Location” map, seen within the patient’s full record on PL (Figure 3). The definition of a disaster event similarly includes a locational point marker (not shown). Future extension of this to area coverage may be considered.

3.2 Structured Address Data

3.2.1 PFIF Fields

We consider here the availability of geolocation information from a PFIF report. PFIF is a semi-structured protocol, in that much of the important content is conveyed in free-text fields.

A PFIF report about a missing or found person has two main components, a required “Person” record, with relatively unchanging information about the person reported upon, and a succession of “Note” records, with transient information. Information about the original Person reporter and any subsequent Note authors is insufficient for geolocation purposes. The main structured data about the reported person's home location is shown in Table 1.

Table 1. Fields in the PFIF Person record of possible interest to geolocation. Not shown: a catchall free-text `Person.other field`, renamed as `Person.description` in PFIF 1.4.

PFIF.Person fields	Comments
home_street	Without house number, often multiline. Conventions for format can be culture/country specific.
home_neighborhood	Somewhat free-text. Typically represents an entity smaller than a town (e.g., a subdivision, or area within a city), but larger entities (e.g., county) might also be specified here.
home_city	
home_state	2-letter abbreviation
home_country	2-letter ISO 3166-1 country code
home_postal_code	Such as zip code

Of greater interest is **`PFIF.Note.Last_known_location`**, a free-text string. There is no separate, structured geolocation field. However, as of PFIF 1.4, there is a convention to place comma-separate latitude and longitude in decimal degrees in this field (intermingled with other free text). Since Notes are time stamped, they can be ordered to give a time line to reports (e.g., of location sightings).

3.3 Free Text

3.3.1 PFIF Comments and Email

For PFIF, besides **`Note.Last_known_location`** just discussed, additional free-text in the **`Person.description`** or **`Note.text`** fields may include locational clues. Broadly, information about a person's location is often conveyed in free text fields like these, or within email or social media streams.

PL has the ability to receive lost/found reports through email, and applies rudimentary subject-line parsing to extract names, locations, and health status. Research, described next, has begun to develop a better system, less dependent on user formatting and able to use the email body as well. In the absence of an appropriate email corpus, the copious PFIF commentary is helpful as a text surrogate.

3.3.2 Improving the Extraction of Location and Other Data from Free Text

Extraction of geolocations from free text (as well as person names and health status) employs Natural Language Processing (NLP) and Named Entity Recognition (NER) techniques [16][1]. The standard steps are:

a) apply a set of rules based on common "address" writing conventions in English; and

b) look up gazette listings of the most common locations around the world.

However, this strategy fails to identify remote geospatial names such as cities or towns, when they do not meet the above criteria.

Our extraction task, which uses GATE [7] for NLP processing, overcomes this deficiency by adding the capability to connect to the Google Maps API Web Services [10] to recognize a much larger set of locations around the world, and retrieve coordinates of a location that was not identified in the initial NER steps.

Analogously, GATE "out of the box" cannot properly identify person names using its limited set of gazetteers and grammar rules. We plan to develop machine learning algorithms which combine NLP part-of-speech tagging and noun chunking, with name lookup from US and other censuses.

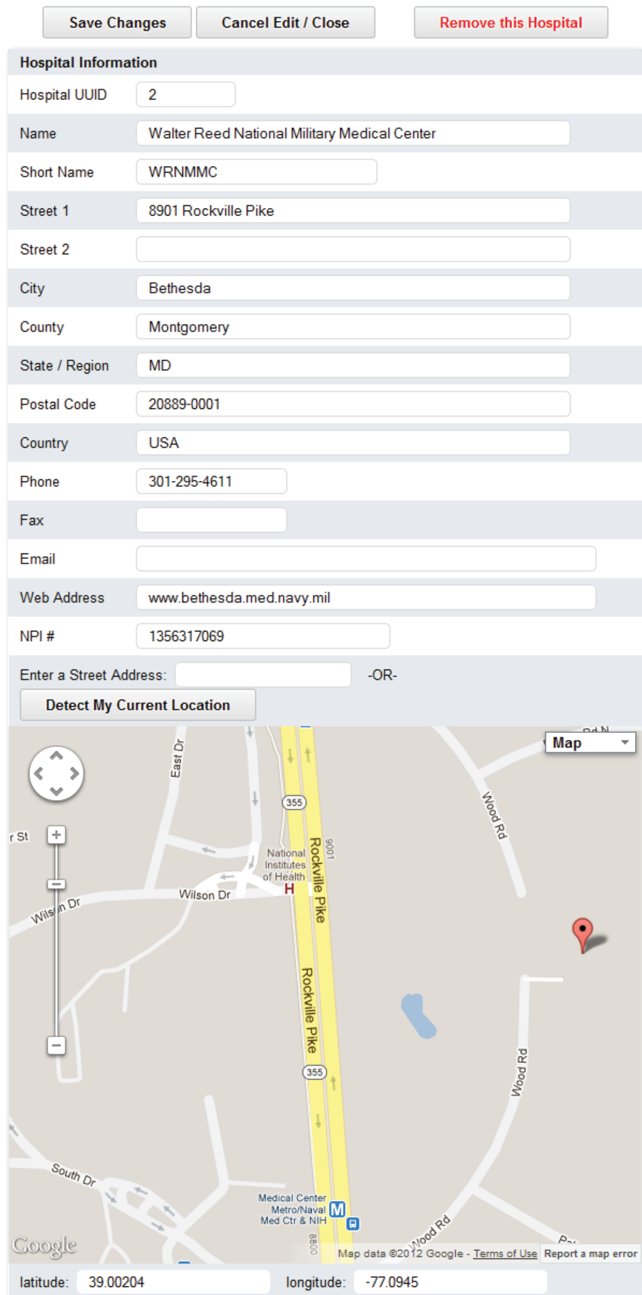

Figure 2. Part of the administrator's view of hospital-specific information. The "Detect My Current Location" button calls on the Google API, which in turn might use some combination of IP lookup, cellular lookup, and browser-provided GPS coordinates. HTML5-enabled browsers like Chrome are engineered for GPS support.

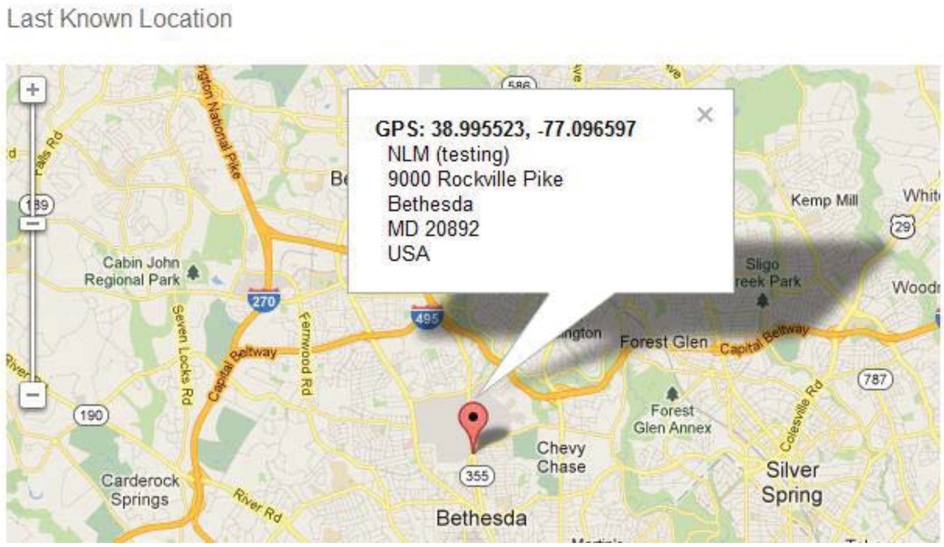

Figure 3. Hospital (or other organizational facilities) coordinates automatically assigned as the "last known location" for an arriving person; seen here on a Google Map in the PL web site.

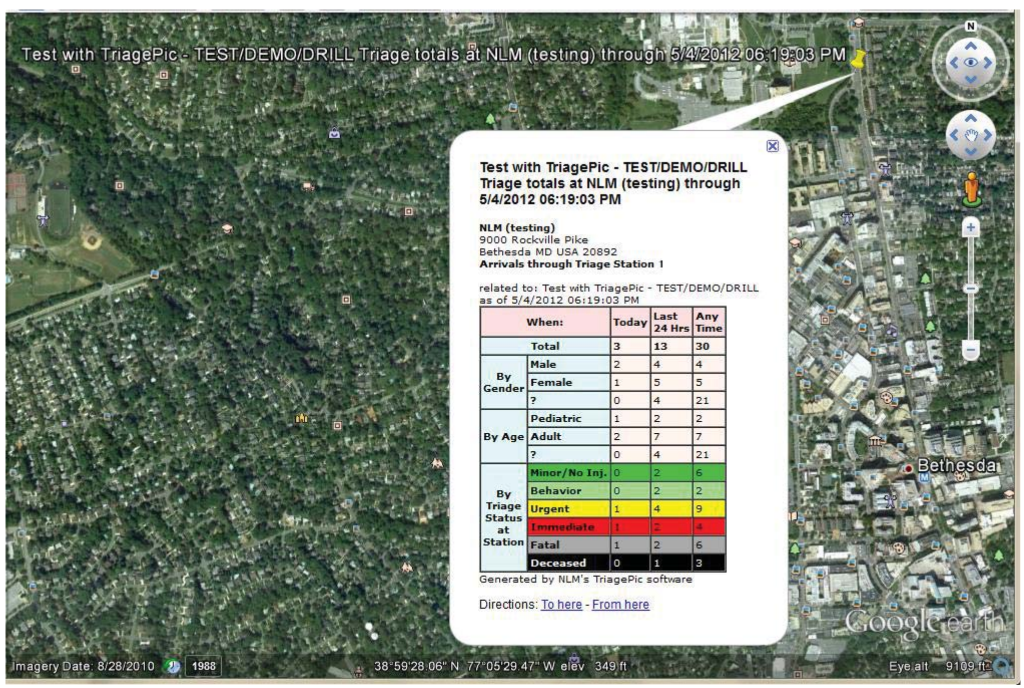

Figure 4: TriagePic overlay on Google Earth map.

This will also help in disambiguation of person names from place names [12][13]. Health status (e.g., alive, injured, missing) may be found by using look-up tables and regular expression matching. We also intend to incorporate the more useful Stanford Dependency parser [30] to connect a person name to its health status and location more easily. Finally, complete extraction would take advantage of email-part correlations and conversation flow across messages.

Apart from improving location recognition, the Google Web service mentioned can assign geocodes where none were specified in the text. However, if explicit geocodes are not given, it can still be very challenging to automatically infer geolocation from sparse data, whether structured or not. For example, in an actual report from the 2012 Philippines flood, the last known location was reported simply as "Race track". Clearly geocoding on this alone will fail. Additional constraints must be applied, based on other provided (or data-mined) structured or natural-language information about the reporter, reported person, and disaster event location. A spatio-textual search engine, such as the one presented in [29][14], helps resolve these ambiguous cases. Spatio-textual search engines can also help distinguish between the name of a person and the name of a place [12][13]. Since such inferences can be faulty, it is desirable to create an automated correspondence workflow with the email sender, allowing validation before finalization in the PL database.

4. USE OF LOCATION DATA

4.1 Hospital-based Reporting

4.1.1 Portraying Triage Arrivals

Point locations of resources like hospitals can serve as anchors for map-based situational awareness. For instance, TriagePic retrieves and retains contact information about its sponsoring hospital, including latitude and longitude, from PL. If a TriagePic station is deployed in a disaster, as each arriving mass-casualty patient is reported through the station, its Outbox is updated. Besides individual records, a tally is calculated and displayed, giving overall total arrivals for this event during time intervals of interest and by attribute category. If requested by hospital staff, TriagePic can send out a stream of tabular summaries of this tally as hospital-geolocated KML files, which a recipient may overlay on a map such as Google Earth (Figure 4). The summary contains no patient-specific information, so can be more widely disseminated without privacy implications.

A number of future enhancements are possible. While the current geolocation used is the one statically assigned to the hospital, drawing on the specific location of a GPS-enabled station may be preferable. An alternative to generating tally reports at TriagePic would be generating them at PL; this would be a logical place for cross-station and cross-hospital tallies to be aggregated. Such capabilities could build on recent and on-going work on a module for PL that provides charting and tabular display of flows and statistics with related export functionality.

4.1.2 Transport between Hospitals

Accurately tracking patient locations and movement is of interest to medical service providers. It is one of the factors, in addition to their basic care responsibilities, for which they are evaluated annually for accreditation purposes.

As a case study, consider patient transfers between hospitals, specifically because a new one has opened and some existing patients must be transported to it. While helping hospitals transition their facilities is not a direct goal of the Lost Person Finder project, certain elements of LPF were found useful in documenting and tracking patients for such a move of Beach Grove Hospital in Indianapolis, Indiana, in March 2012. Beach Grove Hospital was closing down and moving approximately seven miles away to new facilities. The nonprofit MESH Coalition organization [15] - a regional public-private partnership supporting this operation - utilized ReUnite on their iPhones to record transfers by ambulance of 42 patients, those unable to be discharged before the move. Over 3 days, MESH staff used ReUnite to report these transfers to the PL Web site. They did this by repurposing ReUnite data fields: recording patient ID and assigned ambulance in the name and age fields respectively. They also marked the departing patients as "missing" and changed their status later to "found" when they arrived. On PL, each day, this per-patient information plus transit duration could be seen in real time, as well as on a summary piechart of in-transit versus arrived.

Since the hospital locations were known in each case, no address information was needed. But for other types of future deployments, ReUnite's structured address fields may be useful. Also, shortly, GPS coordinates will be reportable with ReUnite on iPhone (via an update) as well as ReUnite on iPad (new release). With this feature potentially much more accurate (originated by the end user rather than a server side process) GPS coordinates will be reported to the PL Web site and will be used to represent locations via pins on a Google map. Furthermore, in the use case of public health emergencies, patients are sometimes transported in a multi-hop manner due to resource constraints or other reasons. With reasonable software changes at PL, we envision showing highly-current location history via pins on a map as users update their locations, thus providing improved information to searchers and health service providers.

4.2 Community-based Reporting

4.2.1 Last-Seen Location

ReUnite's role in reporting a person was discussed previously. It can also search over public reports (Figure 5) previously submitted by other ReUnite users, through the PL web site, or imported from Google Person Finder. Work is underway to allow submitting additional comments and suggested status changes through ReUnite, probably when the original reporter and/or PL admin acts as moderator.

4.2.2 Map-Based Audience and Situational Awareness

For visitors to the Web site, anonymous searching of community-based events is possible. Information about such visitors (as opposed to about reporters/reported persons) is often limited to IP addresses, from which approximate locational information could be derived through lookup-services. If this information was to be shown on a map, the imprecision would lend itself more to heat-maps than to pins.

Whether through PL or the mobile apps, map-based visualization of missing/found data is limited to that of the initial report (perhaps as updated) about a given individual. In the future, situational awareness of community-based reporting would be enhanced by showing multiple individuals on the same map, and not just the initial reports, but also the location of commenters (who might be family members far from the disaster scene) and possibly the time-order of their comments. Geolocation data may be missing or imprecise, and there may be clumping in the case of group reporting by aid workers. These present challenges to visualization, and may benefit from zoom-specific aggregation techniques or heat-map approaches.

5. CONCLUSION AND FUTURE WORK

5.1 Future Work with TEP/TEC Standards

Members of the LPF project contribute to the efforts to develop and promote standards in the arena of in-transit patient tracking. We have participated in groups discussing PFIF and Humanitarian Exchange Language (HXL), as well as the steering committee defining "Tracking Emergency Clients", mentioned above. For "Tracking Emergency Patients" (TEP [4]), a companion effort restricted to medical patients and further along within the OASIS standardization process, we have built prototype clients that exercised reference implementations [17] for creating and using reports through FEMA's IPAWS web services. This might be helpful in future in-transit tracking visualization, as well as heads-up data transfer, e.g. from ambulances arriving at hospitals.

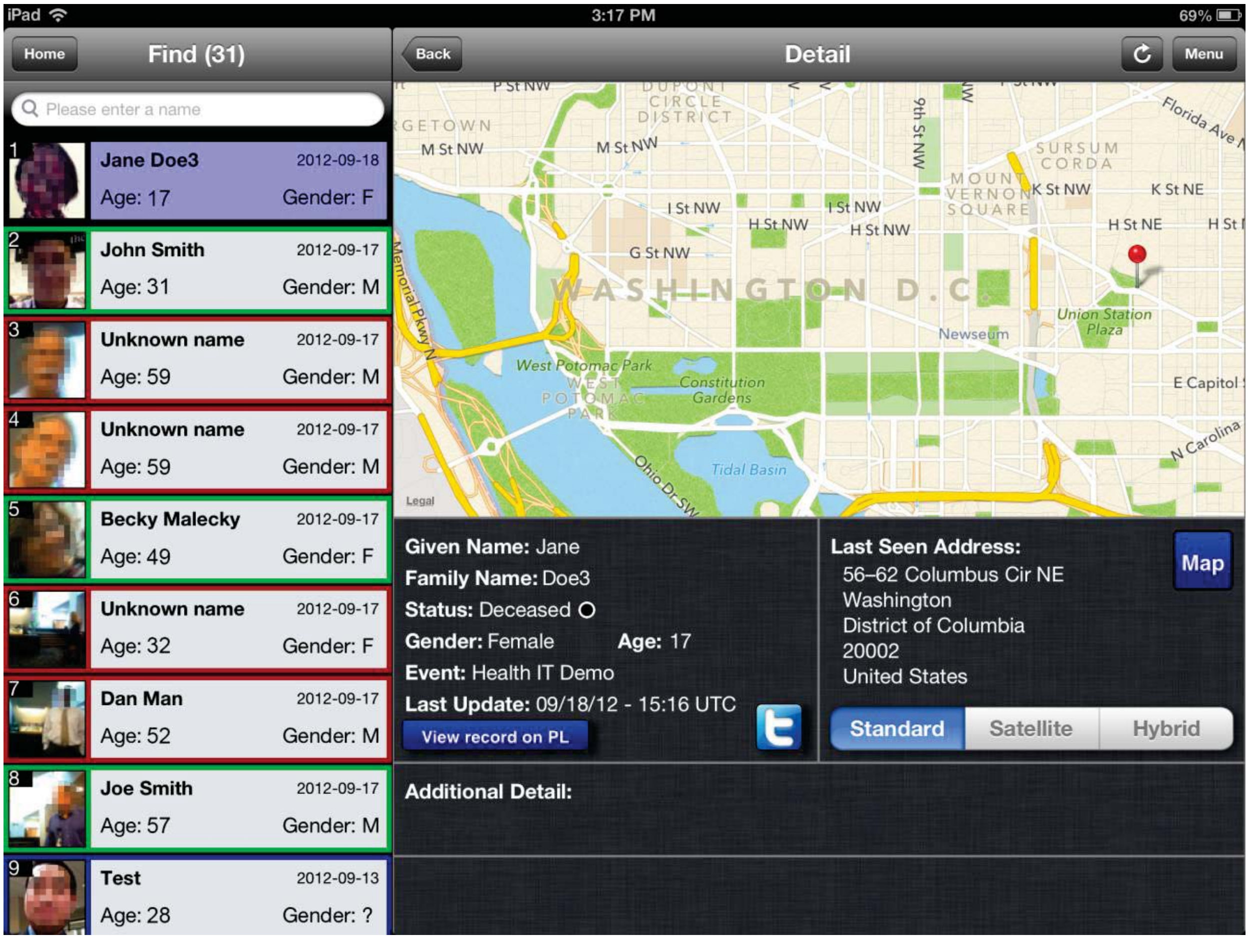

Figure 5. Using ReUnite/iPad to search for previously-reported missing and found people (here with artificial data and obscured faces; "Health IT Demo" is the "disaster"). If a last-seen geolocation is known, it can be shown on the map.

Briefly considering TEP, for location it includes a **`TEP.Location`**, which was originally modeled as a GeoOASISWhere object [8] to handle address and geocodes. However, a migration is underway, potentially adoptable by all EDXL family protocols, now that OASIS has

- defined EDXL "common types" [21]. Part of this is an "EDXL CIQ Profile" [20] to handle worldwide contact information. Constituent schemas define parties (i.e., persons or organizations) (xPIL), names (xNL), and addresses (xAL). The latter in particular allows both structured and unstructured street addresses and other geospatial designations.
- adopted the "Simple Features" profile of the Geography Markup Language [23], for locations defined by a point, a circle, a polygon, a line string, or a bounding box (envelope).

This will similarly affect the analogous, highly-structured parts of TEC (apart from embedded PFIF).

5.2 Future Work with Geospatial Resources

5.2.1 Background – Emerging Global Data Resources for Disaster Preparedness and Response

In many countries, there is sparse geographic information available on impoverished, crisis-stricken areas. Similarly, information about emergency relief actors in the field – national authorities, local organizations, international non-governmental organizations (NGOs) – often is insufficient and sequestered from the public. Past experience in Haiti, Japan, and other disasters recommends that this information be gathered, stored, and made easily disseminated *before* a crisis [22]. Then upon crisis, the information can be updated to reflect impacts.

As an example, the European Community Humanitarian Office recently funded a pilot project of 9 NGOs coordinated by France Volontaires [3]. Volunteers will be trained and deployed to four African host countries and local organizations for 6 months, where they will collect baseline humanitarian data, on geography and actors. Repositories will be built with collection and sharing tools like OpenStreetMap [25] and Sahana Eden [26][27], and locals trained in their use.

This touches on a core problem in humanitarian assistance and disaster response operations: fusion of data collected from maps, crowdsourced reports (like Ushahidi/QuickMaps [9][32]), authoritative reports, and sensors into a sense of shared situational awareness across organizations [6]. In the US context, this is explored in the annual Research and Experimentation for Local and International First Responders (RELIEF) experiments at Camp Roberts [18], exercising shared map/globe geospatial visualization systems such as GeoIQ and GeoCent (with Google Earth).

5.2.2 *Future Work with Global Data Resources*

As we have discussed, PL maintains information, including locations, about hospitals and related medical facilities. As international repositories and visualization systems emerge to aggregate data about such site-specific facilities, both fixed and temporary, interchange with PL is likely to become important. Similarly, exchange of information about disaster events, their locations, extents, time courses, impacts on medical facilities, can be foreseen. This will build on recent work to add more choices to PL export formats and streams, of both summary data and corresponding chart images. An example is provisioning PL so that it, like TriagPic, can create and distribute .kml files about peoples' arrivals.

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