Advancing Disaster Response Systems

Implementing Biometric Technologies as Demographic Identifiers

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***Abstract*— This study covers multiple findings from the origin of biometric technology, its application in the modern world, and new ideas that have made this technology practice very useful and popular. It also provides an assessment of how future developments of Natural Disaster Response Systems can benefit from utilizing parts of this technology during search and rescue situations to administer emergency medical care for disaster-stricken victims that may be unresponsive and without identification. Using biometric technologies such as fingerprint identification and iris recognition software on handheld devices will allow responders to scan fingerprints or the iris of unresponsive victims to gain emergency medical records that their healthcare professionals use to treat them.**

Keywords-biometric technology; natural disaster; response systems; fingerprint; iris; handheld; emergency medical care

I. INTRODUCTION

Agencies on the local, state, or federal level all face different challenges and continue to encounter issues when it comes to rescuing and administering emergency medical assistance to stricken victims. The first Emergency responders that arrive on the scene - firefighters, police, coast guards, paramedics, etc. - can only apply emergency care within their realm. Agencies that manage disaster situations however, have been taught the proper response procedures. In terms of technology, emergency responders have limited options for managing and/or delegating tasks. Despite these limitations, disaster situations occur more frequently than they have historically, spurning the need for advancements in how responders apply medical assistance and what resources are available to help them do this in the most efficient way. Potential drawbacks of this advancement are: security breaches, accuracy, consistency, cost, privacy and legal issues, adaptation to newer technologies (in an environment where new technologies emerge often) etc. Nonetheless, with a rapidly changing world and considering natural and man-made disasters of the past couple decades, these two factors alone provide sufficient cause to make more resources available to target such technologies that could save more lives in the wake of such events.

Currently, fingerprints and iris recognition are two biometric identifiers used within various industries as tools to enhance security. Although very few states attempt to implement biometric technology within their disaster response models, more widespread use can help deliver specialized emergency response to victims who may have special needs (e.g., may have preexisting conditions that responders don't know of, etc.). The use of these technologies to acquire emergency medical records of victims to aid in life-saving treatments may be the next step in improving disaster response, bridging care that would be received at hospitals or other medical facilities.

The significance of the problem began after Hurricane Katrina pounded the Gulf Coast and most of the 1 million people displaced by the storm were left with no medical records, making it difficult, if not impossible, for emergency responders working on scenes, medical centers and community hospitals to treat them [1]. The patient medical histories remained unknown and medical responders made vital treatment decisions with incomplete information.

In the case of the Haiti earthquake, the Haitians were under-served and under-represented by the lack of medical knowledge and health services. Patients didn't had medical records to make available for emergency medical responders but just a sticky note from the triage tent with a chief complaint, age, and sex on their chests [2]. If by any chance any of the patients were transferred to another medical station, a piece of paper with critical information listed would be taped to their chest.

Biometrics consists of methods for uniquely recognizing humans based upon one or more intrinsic physical or behavioral traits. In computer science, in particular, biometrics is used as a form of identity access management and access control. It is also used to identify individuals in groups that are under surveillance. Biometrics comprises of two parts; the physical and behavior aspects. Features measured include face, fingerprints, hand geometry, handwriting, iris, retinal, vein, and voice [3]. The fingerprint identification is one of the most well-known and publicized biometrics because of their uniqueness and consistency over time, fingers have been used for identification for over a century, more recently becoming automated. Iris recognition is the process of recognizing a person by analyzing the random pattern of the iris. The automated method of iris is relatively young, existing in patent only since 1994 [4]. The iris is a muscle within the eye that regulates the size of the pupil, controlling the amount of light that enters the eye.

This study will further cover the statement of the problem which describes includes key dependent and independent

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variables, the research question and a hypothetical account if such technologies were to be implemented, assumptions, limitations such issues hindering the use of biometric technologies to acquire victim information; and delimitations that should be taken into account for this concept to be eventually become reality.

II. STATEMENT OF THE PROBLEM

There is a need for these responders in the frontlines of natural and man-made disasters to have access to victims emergency medical records which in turn allows them to efficiently provide the best medical services to those with or without unique health situations. In the cases of Hurricane Katrina and the earthquake in Haiti, providing medical assistance to victims proved to be very tough without the presence of effective medical care information. Unresponsive victims either died from not been given proper medical treatments or experienced further complications from allergic reactions to improper treatments.

The utilization of fingerprint and iris recognition as demographic identifiers in a disaster response system will allow first responders and professional disaster workers to efficiently provide the best medical services to those with or without unique health situations. The key variables of the problem will help answer the question about the influences, the factors contributes to the presumed effect of saving more lives in disaster situations. These variables include:

Dependent

- Electronic medical records databases
- Developed software web application
- Handheld mobile devices equipped with fingerprint and iris scanner

Independent

- Disaster response command center
- Medical care centers
- Emergency mobile units

The process of advancing current response systems would start from the development of electronic medical records of inhabitants in each community regardless of whether there are known or unknown issues. This will help populate a National Biometric ID database and also provide to baseline to giving responders adequate knowledge in providing response care if needed. It can be updated at the request of a prospective client to their assigned physicians. For example, proper information about a client would help avoid a responder treating an unresponsive victim with antibiotics that they are allergic to.

An efficiently ran command center has to be able to translate received data into valuable information for responders in the field to properly utilize. With information been passed down, responders on-scene can quickly determine at the side of a responsive and unresponsive victim if they administer medical care right away or be transported to a nearby medical center. With appropriate mobile devices on hand that are equipped with federal regulated finger and iris recognition software that will be developed, a responder can receive real-time medical information about victims and how best they can be treated to avoid further health complications besides the shock from experiencing the event. Mobile units including ambulances, medical helicopters and even foot responders have to be properly dispatched with these mobile devices in order to shorten the response time in these disaster situations. The process in Figure 3 displays a conceptual framework of the prospective concept's flow of research and development.

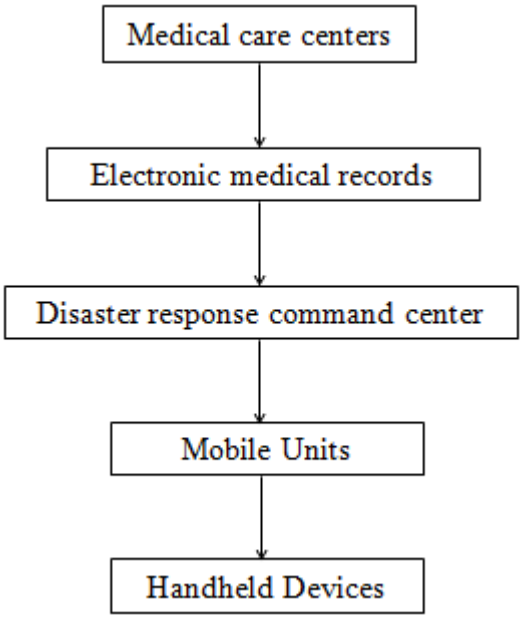

Figure 1. Conceptual framework.

An investigation will be conducted to help analyze and interpret data, sources and results by employing a hypothesis testing approach. Considering the type of research problem stated earlier, a well suggested experiment to employ will be based on both a lab and a field approach as described below:

Lab

- Done in an artificial or contrived environment.
- To control other factors that might contaminate the discovery of the cause-and-effect relationship.
- To manipulate the independent variable to establish the extent of its causal effect.

Field

- Done in the natural environment where activities take place regularly.
- It may not be possible to control all the contaminating factors.
- The use control groups.

A conducted lab experiment will allow for the recording and studying of real time request and response times during

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the use of these handheld devices. The experiment will also track the use of the fingerprint and iris recognition capabilities. This will allow for the creation of guidelines to follow when interacting with responsive and unresponsive clients. It will also allow me to measure the difference between traditional interaction between responders and clients before medical care is administered. Reducing that time and administering the right medical will make the biggest impact on whether the implementation of that technology will be successful. This process will validate the testing internally due to a controlled environment that will be simulated.

There will be dual types of useful data in this situation, some primary and secondary sources of data. The primary sources will be individual emergency responders and a focused group of emergency responders (two different townships); and the secondary source will be analyses gathered from the industry's emergency decision makers. In collecting data from individual emergency responders, an assessment can be made on how they personally feel it improves their performance in assisting patients in a lab or field environment with the presence of obstructive or non-obstructive measures. This data will also ascertain if there can be possible changes in the system processes from start to finish. With a focus group of respondents, interpretations and opinions can be collected on how effectiveness and efficiency evolves within a team in a controlled environment. It will display how quickly a respondent can end a task and assist in another to safeguard more lives. In terms of figuring out how a secondary source like analyses collected from the industry of emergency respondents will be utilized, it will go to show more than just in-field data like other influences involved in the business of saving lives. It will also show how saving time and costs in effectively managing man hours, legal and non-legal measures, community acceptance etc. can either encourage the project's implementation or not.

A structured set of survey questions will be utilized and observations will be closely monitored during experiments. The survey will be designed to fit the lab and field tests individually since there are specifically influences to both. Questions for the respondents will curtail to field operations and the other set of questions relating to the industry's analyses will be referred to agency managers. Both sets of questions will be arranged properly and accompanied by clear instructions, guidance and good alignment to minimize biases so as to acquire the best assessment from both parties. Observation will only occur during the lab and field testing to collect data on how reducing the time and administering the right medical can make the biggest impact on whether using biometric technologies such as fingerprints or iris recognition to access medical data from secure data servers.

Based on the data collection methods which involves the selection of emergency responders (Paramedic personnel), conclusions should be drawn based on how many samples are collected. Samples collected will be examined closely because the results will almost mirror how real-time performances will occur. To keep the sample simple and random, there should be participation from fifty different paramedic agencies who can allow the involvement of two personnel each. This will allow for close observation of partners working together to attend to a patient in a fast and efficient manner while utilizing the technology. Training sessions will take place initially to give the responders ample time to get familiar with the device. There will be no bias in the selection process because if the device is successfully lunched, every responder will be required to partake in training so as to keep procedures at an even standard.

After the data sampling information are recorded, they will need to be analyzed and interpreted properly to become useful to the project. The Analysis process will include the interpretation of the results from the experiments conducted. There are steps that will be followed before analysis which include:

- Editing data
- Handling blank responses
- Coding
- Categorizing
- Entering data

Once these steps have been followed carefully, getting a feel for the data collected from paramedics would follow. Also testing the goodness (stability and validity) and the hypothesis of the data would follow suit to ensure that mistakes are omitted and the process works.

Like all other technologies, they will have performance standards or metrics which must be evaluated first before implementing them in disaster recovery systems. Biometric News wrote that these performance standards, or metrics, are widely used by the biometric industry in order to gauge the effectiveness of the various biometric technologies. These standards are not particular to any specific biometric technology; they apply to all of the technologies [5]. These standards are:

- The False Acceptance Rate;
- The False Rejection Rate;
- The Equal Error Rate;
- The Failure to Enroll Rate;
- The Ability to Verify Rate.

This could pose to be very disastrous in scenes because everything going on is already hectic and such systems are meant to bring some sought of stability in the areas of emergency medical care. Equipping a handheld disaster response device a fingerprint scan and iris recognition can end up saving more lives of disaster struck victims and it should be able to rely on emergency medical information that can be accessed by the response team onsite.

There are various benefits and disadvantages of implementing biometric technologies as identifiers. The government would play the largest role in its use in order to monitor security for its citizens just like the United Kingdom that already uses a National Biometric ID. There are few reasons why it's been slow to be implemented in the U.S due to survey responses conducted concerning cost, risks of information misuse, privacy of personal data, and security [6]. Figures 2 & 3 below show the graphical illustrations from an earlier study.

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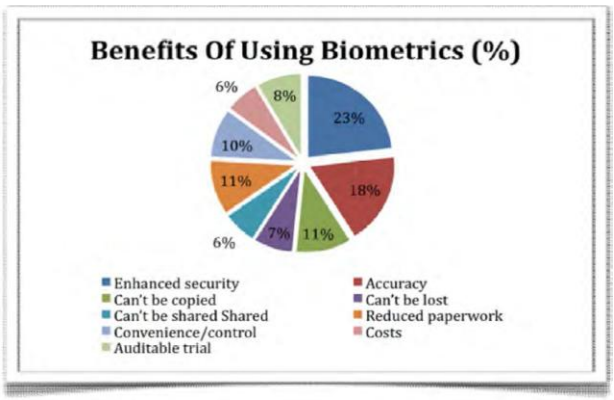

Figure 2. Benefits of using biometrics (%).

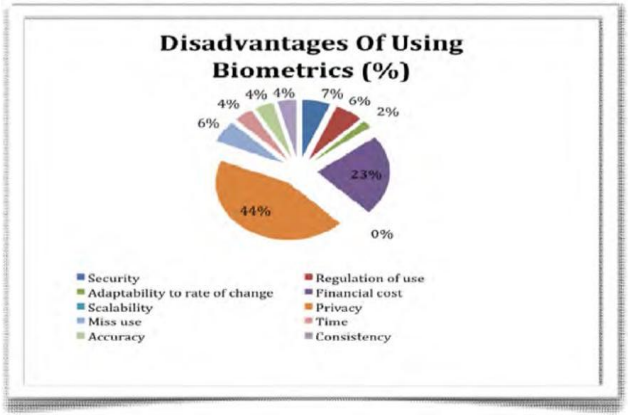

Figure 3. Disadvantages of using biometrics (%).

V. Chu, and G. Rajendran (2009), "Use of biometrics".

III. RESEARCH QUESTION/HYPOTHESIS

Research Question

Can the implementation of biometric technologies such as fingerprint and iris scan recognitions in disaster response systems be utilized as useful demographic identifiers in providing emergency medical responses to disaster stricken victims?

Hypothesis

Since natural or man-made disasters do not happen as often, it will be adequate to employ the help of paramedics who are healthcare professionals that work in emergency situations regularly to responsive and unresponsive patients. Paramedics provide advanced levels of care for medical emergencies and trauma. The majority of paramedics are based in the field in ambulances, emergency response vehicles, or in specialist mobile units such as cycle response. They provide out-of-hospital treatment and some diagnostic services, although some may undertake hospital-based roles, such as in the treatment of minor injuries. They have to perform at high expectations in every giving situation just as a disaster responder would, including following ethical and work related guidelines. With this approach, the paramedics will be able to utilize the proposed handheld devices that will run the web application software that handles fingerprint and iris recognition to retrieve medical information related to the clients.

This process validates the testing externally due to the fact that we will be aware of how and when it will be utilized. It will record real-time response of data request from the server to the handheld device and how effectively it assists the paramedic in applying medical care. A request will have to be made to the client to allow for the testing. A survey will be administered to clients that received treatments from the participating paramedics about how they felt about the medical assistance they got. It will studied to see if using the device saved ample time spent in trying to ask about medical information from the clients rather than spending it on actually treating them, not to mention the unresponsive ones.

IV. ASSUMPTIONS

Emergency medical records (EMRs) or Electronic health records (EHRs) can play big role in helping emergency responders during disasters because that would be direct access to important data that can cut down the increase in fatalities. Digitized records provide a timely, cost-effective way to share patient information. If physicians aren't using them in their private practices, they lose those benefits, as do the hospitals they work with [7]. If physicians can utilize this this system effectively, why can't emergency responders do the same? EMR systems can integrate evidence-based recommendations for preventive services (such as screening exams) with patient data (such as age, sex, and family history) to identify the ones that need specific services.

A group of researchers at Weill Cornell Medical College and the University of California, Davis, where they predict improvements in patient outcomes after a major earthquake through more effective use of information technology. They insist a control tower-style telemedicine hub to manage electronic traffic between first responders and remote medical experts could boost the likelihood that critically injured victims will get timely care and survive, according to the team's computer simulation model [8]. Currently the use of biometric technology is being used to track responders on scene by an emergency command center. With a smart mobile computer in the hands of responders, they can bring real-time mobile data to the point of activity. On site at an incident, such solutions can help rapidly screen, check in, and track first responders. Motorola developed mobile devices using mobility solutions that help improve the efficiency and effectiveness of first responders. However, with firefighters, police, rescue, EMS, and other first responders flooding the scene, keeping track of personnel, victims, and assets is no easy task. When every second counts, the paperwork burden and its associated productivity loss can translate into lost lives [9].

Furthermore, with manual systems, critical information often resides on clipboards at the scene and is inaccessible to offsite command centers, evacuation sites, hospitals and other agencies. Complete electronic record documents are made available when responders enter and exit an incident scene which will provide National Incident Management

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System compliance (NIMS) which mandates visibility into available resources to best prepare for, respond to and recover from an incident as well as efficient communications and information access during an incident.

The Emergency Operations Center (EOC) is the physical location where various organizations come together under the direction of Emergency Operations Management (EOM) during an emergency to coordinate response and recovery actions and resources. These centers may alternatively be called command centers, situation rooms, war rooms, crisis management centers, or other similar terms [10]. During an incident, there may be a need to confirm the identity and medical credentials of an individual clinical care provider when they request permission to enter the scene. At this step in the flow, the incident control personnel at the scene could request confirmation of the medical credentials in one or more possible ways, including:

- Via a request made to EOC systems. That center could either confirm the credentials from their own internal information sources (e.g. EMTs on staff for at center), or via a query to the Health Information Service Provider. In the latter instance, the response to the query could potentially include additional information that may be used to identify and authenticate the individual, as well as information which describes the role(s) which that individual is authorized to perform (as defined in steps I and III).
- Potentially via a field-deployable authentication device (e.g. identification card reader or biometric device) which could transmit information directly to a remote authentication service and receive authentication confirmation and authorization information in return.
- There may be additional mechanisms available for querying to confirm the credentials of a medical provider in the field. For example in the future, it may be possible to make this query directly from the field without the need for an intermediary (e.g. a query sent directly from the requestor to a registry service).

This is an on-going trend that wasn't seen as a possibility in the area of emergency response that has continued to gain popularity. Emergency response officials in Tallahassee, Florida, for example, must pass through a biometrics-enabled security system to access their Emergency Operations Center (EOC) as well as their daily office space [11]. There fingerprint scanners at the center where they go up to the doors and put their fingers on to be scanned. It has to be done to be able to access the building.

Federal Emergency Management Agency (FEMA) did a case study in 2008 on responder authentication which stated that advancements in biometric technology and the development of biometric tools for the public safety realm have begun to provide solutions to identity verification issues [12]. Such technologies, when integrated into emergency management plans and processes, can be a powerful tool for emergency response organizations in both meeting day-to-day operational needs and disaster response.

V. LIMITATIONS/DELIMITATIONS

There are several weaknesses that could revolve around implementing these types of technologies currently for disaster response which could possibly include security breach issues, accuracy, consistency, cost, privacy and legal issues, adaptation to newer technologies etc. Some of these limitations carry more effect than others but should all be considered as relevant challenges to this study. The major concerns for the general public's acceptance of the voluntary use of biometrics identification will be: privacy, necessity and identity protection. Many individuals will be concerned that information collected about them could be used against them such as medical records preventing them from the ability to get health or critical illness insurance. Major restrictions that will not be able to be addressed include policies by governing bodies on how medical records are assessed and the absence of a national biometric identification.

Just as the credit bureau keep track of how well we pay our bills and manage our credit, so does the Medical Information Bureau (MIB) on everyone that applies for health insurance and they are required to follow the same rules as the credit bureau because they are considered by the government to be a consumer reporting agency, its services must adhere to the US Fair Credit Reporting Act and the Fair and Accurate Credit Transactions Act. The purpose of MIB is to provide a vehicle for each of its members to contribute health and medical information obtained in connection with the underwriting of, and payment of claims made under, life and health insurance policies, and receives this same type of information contributed to MIB by other members [13]. MIB operates under certain but not all rules and regulations under the Health Insurance Portability and Accountability Act (HIPAA) of Privacy Rule as also stated in the article. This allows them to collect important medical data and share it to its members.

The Health Insurance Portability and Accountability Act (HIPAA) Privacy and Security Rules protects the privacy of individually identifiable health information; the HIPAA Security Rule, which sets national standards for the security of electronic protected health information; and the confidentiality provisions of the Patient Safety Rule, which protects identifiable information being used to analyze patient safety events and improve patient safety [14]. Although this agency would be considered one of the biggest hindrances to the concept of using biometric technologies during disaster response, it would make sense to have state legislatures approve the development of an emergency medical record database that would strictly assist emergency responders on the frontlines of disasters. Policymakers can sponsor universal electronic medical records (EMRs) and propose incentives for "meaningful use" of EMRs. They also state that even though emergency responders are particularly sensitive to the benefits and unintended consequences of EMR adoption, surveillance has been limited [15]. This just means that if further research can be approved by government officials who oversee emergency response

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agencies, the ability to display to the public that collecting these medical data can be advantageous.

Although this concept may seem out of reach in reaching reality, disaster response continues to lack focus from the U.S government and the past few disasters that occurred showed how much more response processes needs to be addresses and improvements to be made to save more lives.

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