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Design for Citizen Safety in Crisis Management Stimulating Smartness in Applications to Enhance Digital Inclusivity

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Abstract: According to Statista global report 2020, worldwide smartphone adoption is over 3.5 billion users given the world population of 7.8 billion for the same period [1]. The world's most populous country China has about 851 million users which is 146% over the second highest populous country which is noteworthy and in well developed country like US it is about 260 million users who have adopted smart phones. This clearly shows the split in adoption of smart technologies among the people globally. We understand that still a sizeable population does not have access to smart devices yet. However, for better and safe living, we aim to develop a solution that is compatible with all types of devices and improve inclusivity among the various sect of people. This paper aims to create smartness in applications to touch the lives of people rather than merely relying upon smart devices usage.

Keywords: Citizen safety, Smart citizen, Smart technologies, Technology adoption, Wearable technologies.

I. Introduction

This era is the golden age of technology as it is rightly called due to plethora of digital technologies ruling the world today such as artificial intelligence, big data, cloud computing, analytics, blockchain, robotics, virtual reality, 5G and so on. The KPMG CIO survey 2020 finds that there is additional spending on emerging digital technologies despite recent COVID-19 crisis [2]. The main reasons cited are the technological challenges owing to cyber security threats, need for remote working and social distancing and further investments to overcome these challenges. The recent survey with CIOs also finds that almost 47% of the 4200 CIOs responded from 83 nations has opined that there is increase in embracing emerging digital technologies and digital transformation initiatives which are actually accelerated by the crisis. Given this scenario of remote working and social distancing needs, global quarterly smartphone sales by top vendors indicate either marginal increase or stagnant figures until Q32020. Despite the compelling need for smartphones, the market share has not reflected it as expected [3]. This can be slightly extrapolated to rethink that smart technologies adoption not only lies in making things smarter but also making utilities smarter. This paper aims to bring such smart features in to light which have potential to boost up the adoption of smart technologies by inscribing smart applications that touches upon lives of several millions across the world. In addition, the paper also argues that adoption not necessarily be in smartness of device but in smartness of utilities which people relate to in their daily lives.

This paper is organized as follows. Section I gives introduction and section II details on the literature review carried out. Section III gives the research goals followed by theoretical background in the section IV. Sections V to VII detail out on our proposed system, its functional flow and architecture. Subsequent sections explain the experiment, results and pilot implementation.

II. Literature Review

A. Smart Technologies Adoption Worldwide

Smartphone sales growth was increasing marginally year on year, however the growth rate had been slowed and was further impacted by COVID-19 crisis as per IDC analysts report [4]. Smart phones adoption is influenced by smart technologies and applications to end users. In the same period when the smartphone sales witnessed marginal growth, smart wearables sales witnessed a double-digit growth of 35.1% to 135 million units as of 2020 [5]. The users were able to relate the smartness around the devices in their daily lives which had an influence in the buying decision be it personal care wearables or smart homes or other utilities. According to Marikyan *et al.*, there exists an interrelationship between emotional, cognitive and behavioral factors following the evaluation of technology performance and confirming that negative disconfirmation may result in satisfaction [6]. In the similar manner, perceived ease of use, perceived usefulness, consumer perceived innovativeness and compatibility influence the smart technology adoption amongst users [7]. According to world economic forum report 2020, the recent crisis of COVID-19 has accelerated the need for adopting smart technologies in the context of industry 4.0, education, healthcare and other service sectors [8]. Besides this, the new technologies in the digital, biological and physical world need to remain human-centered and serve society as a whole, providing everyone with fair access to such smart technologies [8].

B. Smart Technologies a Necessity in Disaster and Relief Management

According to world economic forum disaster risk report 2021, the risks that top in the next decade include infectious diseases, cyber security, natural disasters, man made mass destructions, inaction of climate change and so on [9]. In just last year (2019), nearly 24.9 million people have been displaced due to disasters and other reasons cited above [10]. Moreover statistics on global displacement still shows an alarming number across the globe from almost 145 countries several millions of people getting displaced and are homeless [10]. Emergency situation handling and disaster planning needs a coordinated, collaborative process of preparing to match urgent needs with available resources on hand. In addition if the magnitude of the emergency exceeds or overwhelms local capabilities, then it is necessary to invoke higher levels of response and in near real time. Emerging digital technologies can be used to address the needs of near real time monitoring, planning, coordination and information dissemination to the right stakeholders [11].

C. Challenges and Opportunities

According to analysts, growing urban population is one of the biggest challenges and providing safety for each citizen is a key measure be it a natural disaster such as tsunami, flood, forest fire, earthquake, snow avalanche etc. or man-made disaster or emergency situations in routine lives like help sought by pregnant women or child helpline or senior citizen reaching out for help. The statistics indicate that the global urban population would be close to 1.56 billion by 2040 [12]. On one hand while we talk about smart cities, smart citizens, smart technologies like artificial intelligence (AI), 5G, Internet of things (IoT), cloud and so on, and on the other hand it is important that these technologies are made the best use for real time planning and disaster preparedness. To rescue people caught in disaster and improve response rate and provide relief measures for them at the earliest possible time, we need a simple yet efficient and powerful solution that hides the technological layers from the end users but covers the maximum number of lives that could be saved.

D. Gaps Identified from Literature

In our survey literature related to disaster management, disaster rescue management and relief measures, we found that smart technologies play a vital role in the immediate post disaster activities in identifying trapped persons to provide rehabilitation. Hossain *et al.*, 2021, found that smart technologies-based devices and applications were more effective than the traditional helpline numbers-based systems [13]. Timely information dissemination and initial situation assessment post disaster occurrence are the most critical aspects in aftermath of disaster. Especially in the world's second highly populated country like India, almost 85% of the geographic regions are disaster prone in some form or the other. A study by Mondal found that there exists gap between disaster related research and community capacity building [14]. The community response is the first in case of emergency situation and community capacity building alone can accelerate the response aftermath. Another study by Otsuyama and Shaw 2021 also reiterates that there is still lot more to be done in community capacity building [15]. The Communities Advancing Resilience Toolkit (CART) recognizes four key interrelated domains that contribute to community resilience: connection and caring, resources, transformative potential, and disaster management [16]. If we could use emerging technologies and build such system, then the resultant would certainly leave transformational impressions. However more adoption could be made possible only if the end users' perception on such neo systems based on perceived usage, perceived usefulness, perceived innovativeness and so on are on the higher note. Our paper aims to bring in a simple yet more efficient rescue operation framework that improves the end user perceptions and the usability aspects towards the disaster resilience measures.

III. Research Goals

Our research goals are primarily towards building a simple yet more efficient disaster rescue support system which improves the end user perceptions on ease of usage, usefulness, innovativeness resulting in the willingness to adopt or actually adopt the new rescue support system.

The subgoals can be listed as follows:

- To design a system that enables near real time identification of living beings entrapped or stranded in any disaster or a crisis situation either at home or outside.
- The system thus designed to have minimal technological barriers. For instance, minimal or no dependency on geo location, network availability etc.
- The system thus designed also to be less complex so that more victims could reach for rescue support.
- Overall, the system adoption needs to be more towards the smartness of applications rather than using of

sophisticated devices that are not affordable to each and every citizen of this world.

IV. Theoretical Background

Our work is based on cognitive dissonance theory which states that individuals have tendency to seek consistency between beliefs and actions which in turn drives the behavior [17]. On account of inconsistency between belief and behavior, dissonance arises in individual's attitude and that influences further behavior [17] [18]. By means of addressing that inconsistency, individual's action can be changed towards positive response of adoption [18] [19]. The schematic representation of cognitive dissonance theory is shown in Fig. 1 below.

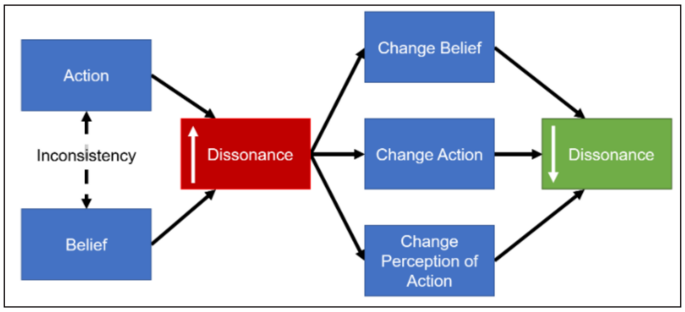

Fig. 1: Cognitive Dissonance Theory

V. Proposed System Design

Our proposed system is schematically shown as below in Fig. 2. In line with our research goals, our proposed system aims to provide quick response to emergency, rescue and disasters in near real time as a first rescue responder. It operates as a single window for several operations and transmits information without much delay to enable first rescue response and help in identifying people entrapped even in hidden areas. It also helps enhance the efficiency of relief supply chain activities.

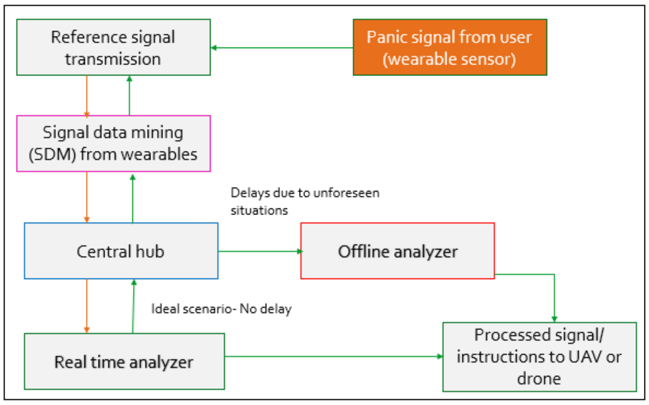

Fig. 2: Proposed System Overview

Our proposed system uses a simple user interface to send emergency rescue help signal to a centralized master data controller. Sensors from wearable systems can be analyzed in real-time on-site, or can be transmitted to a central hub to be analyzed off-line. In both cases, the purpose of the analysis is to extract from the measurement information about the state of the user, and identify anomalous behavior to alert rescue teams [22]. The state of the user referred here is if the person is in normal condition or is about to get any panic attack etc. based on the measurements. The master data controller also termed as base receives signals from sensors directly in real time or offline analyzer output routed through drones or unmanned aerial vehicles deployed for detecting stranded or entrapped living beings. The rescue operations begin thereafter either with manual intervention or automatic means. The subsequent sections would provide more details in to the functioning of the components of our proposed model.

VI. Our Research Work and Functional Design of Proposed System

In the last year of 2020, we had undertaken a pilot study on the need for simplified smart application in line with our goals to serve all and enhance safety related application for mobile users. We approached nearly 60 participants of different age groups from youth to senior citizens, gender, working style, travel style such as traveling in odd hours, geographic location either in remote rural or in urban areas and so on. In 2021, we expanded the study with more number of respondents and the numbers reached about 130. In addition, our study aims at bringing about development of solution using emerging technologies and simultaneously mask its complexity from end users so that we could promote more usage. Based on our interactions, we have designed a smart application with simplified rescue solution as shown in Fig. 3.

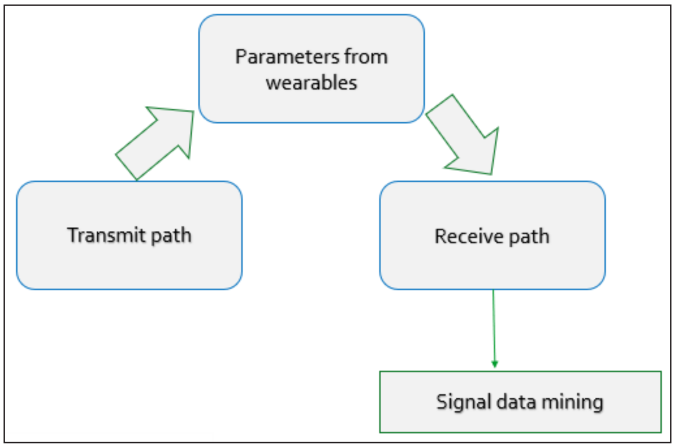

Fig. 3: Design for Citizen Safety Made Simple

Sensor parameter data from wearables can be either one dimensional or two dimensional as in case of images or videos. Analyzing sensor data from wearables and attributing it to state of the user (normal or panic) needs sophisticated statistical techniques. However, such complexity is masked from the actual users and is handled by our proposed system to improve digital inclusivity in the society. The first stage of the analysis consists in extracting meaningful features, and in removing confounding artifacts. This stage can be achieved using various time-frequency or multiscale methods [22] [24]. The second stage consists in reducing the dimensionality of the data by using well known machine learning algorithms like Principal Component Analysis (PCA) or Linear Discriminant Analysis (LDA) [22] [23]. When there is a crisis, the sensor state would turn abnormal or in short if the user is panicked by a situation, the sensor sends signals according to the user state [23] [25]. The panic signal is received by central hub, processed by using signal data mining technique and then appropriate information is sent to rescue teams.

The panic signal thus received would be synchronized once in every 30 minutes with our master data collector system (base) and the rescue teams would be intimated as shown in Fig. 5. The location would be traced using signal data mining system (SDM) which is detailed out in the next section. Further to these features, there is no limit on number of panic signals sent by user and users can send in any time on a particular day. To ensure safety and rescue the citizen is the ultimate motto.

VII. Master Data and Signal Data Mining System

In our proposed system shown in Fig. 2, we had mentioned about drone or UAV system. The detailed representation of signal data mining system (SDM) is given below in Fig. 4. The signal gets transmitted through signal mining even under the conditions of poor ambience conditions. Using the approach of master slave drone connectivity, the location and other details of people to be rescued are sent to slave drones and aggregated at the central hub (base).

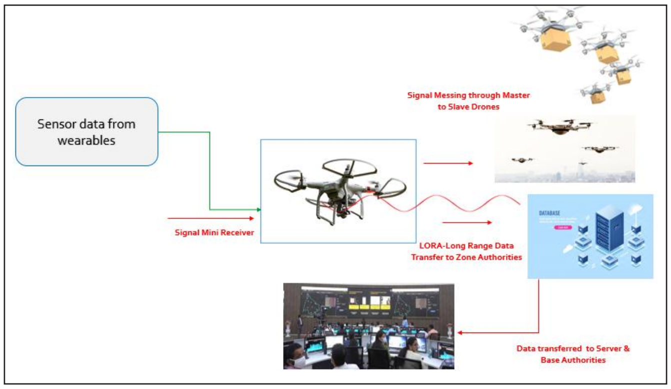

Fig. 4: Signal Data Mining System (SDM)

VIII. System Architecture

The overall system architecture is depicted in Fig. 5. In this system proposed, panic signal sent will be picked up accurately from 50 to 100 meters signal range using GPS (Geographic Positioning) tracker system embedded in the wearable and that information is sent further to central or base hub. Depending upon the situation and support needed, the rescue planning and operations are deployed. The users use minimal options of calling helpline or others during crisis and instead the wearable signals are sent automatically seeking help and the processing of information take place in near real time with the help of technologies and at the same time masking those complexities from end users.

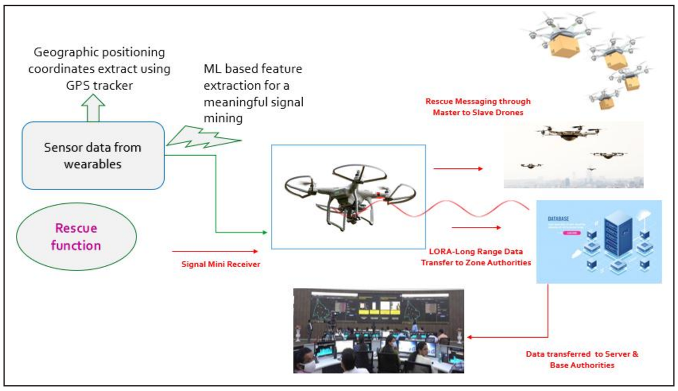

Fig. 5: System Architecture

IX. Benefits of Our Proposed System vs Incumbent

At present, the rescue operations are carried out either through manual aerial survey or based on the calls received to helpline numbers. In this case, using our proposed system, process is very much simplified and ensures digital inclusivity irrespective of age, gender, race or physical disability. Benefits of using our proposed system are multi fold and we have listed them below:

- Compatible with existing smart wearables and embedded GPS trackers.
- Less time and effort to seek help in the emergency situation.
- Technology complexity is masked from end users there by increasing perceived ease of use.
- The need for sharing geographic location manually is eliminated there by enhancing perceived usefulness (legacy smart wearables models especially).
- Automatic tracking and notification is an added benefit in the proposed model and this in turn enhances perceived usefulness.
- The system can be customized and extended to any type of disaster or emergency situation globally.
- Single-click relief feature aids in real near time deployment of resources during relief operations and this in turn enhances perceived innovativeness in the minds of the end users.

X. Research Experiments and Results

The survey questionnaire was prepared and validity, reliability tests were administered. Five-point Likert scale was used to measure the responses. Survey was launched using google sheets tool and we collected about 100 data points from citizens belonging to different age groups, gender, risk exposure to disasters and exposure to prevalent rescue techniques. The actual usage of one click rescue solution (Y) was positively influenced by perceived ease of use (X1), perceived usefulness (X2), perceived innovativeness using signal mining (X3) and willingness to switch to our one click rescue solution (X4) at 95% confidence level and 5% significance level as shown in the Table I below.

Table I: Regression Analysis and Findings

	Regression table		
Regressor Variable (Xs)	Coefficient	t-statistic	p-value
Perceived ease of use	0.35	1.25	0.02
Perceived usefulness	0.66	2.25	0.027
Perceived innovativeness	0.25	2.32	0.025
Willingness to adopt	0.47	0.25	0.001

XI. User Feedback First Look

"Very flexible product and surprisingly this initiative look compatible with multiple scenarios unlike most applications which are situation specific."

"A good initiative using modern technologies for social purpose."

XII. Conclusion and Future Directions

On an average about 60,000 precious lives are lost across the world due to disasters and this excludes missing people data which in turn is believed to contribute to additional 29% of deaths [20] [21]. The global deaths due to disasters vary anywhere between 0.1% to 0.4% of the world's population in the past decade indicating only an increasing trend despite multiple efforts by various governments [20]. Our solution aims at bridging the gap of common issues like network availability, support sought from remote areas or disaster-prone areas etc. with our innovative single click rescue aid using signal mining system. As a pilot launch, this has been implemented at a small level with select groups in Tamil Nadu state of India. However, the very same technology and application could be extended globally to serve the less developed and poor countries deprived of very sophisticated technologies thereby saving several precious lives.

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