RESEARCH ARTICLE OPEN ACCESS

Next generation architecture examination for Mass Notification System(MNS) collaborating with CCTV for Smart & Safe City

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ABSTRACT
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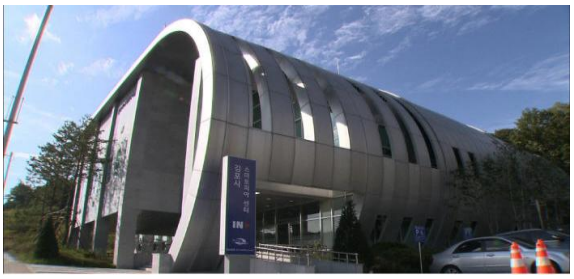
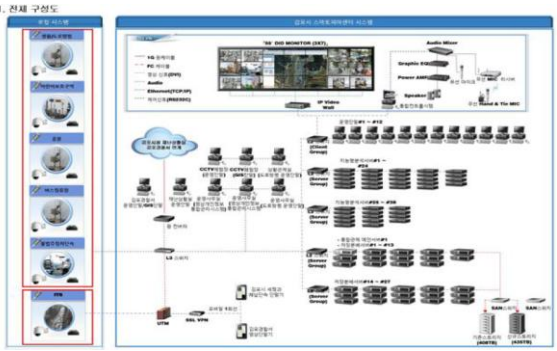
Keywords - About five key words in alphabetical order, separated by comma

I. INTRODUCTION

["Smartopia Gimpo" by City of Gimpo, Korea.[3]] is multi-year smart city project, awarded by Global City Informatization Forum(GCIF), www.globalcityinfo.org in 2013. The project Smart City programs aimed to deliver and integrate information of economy, culture, public resources, management service, citizen lives and cultural lives and one of hot activities was safety and emergency management using CCTV. Intelligent advances introduced in this project yield significant crime down and yield many improvements in the community such as parking ticketing and we wanted to purse of the next evolution after the successful deployment and opening the central centre in Nov. 2013 During the project, it didn't much involve the upgrade of MNS(Mass Notification System) but in this paper as the next evolution path, we are to discuss ideas of collaboration between these to to provide extra value in the era of IOT and Big Data world[1].


[Gimpo Smartopia Centre]


[Gimpo CCTV network A]

This work is financially supported by Korea Minister of Ministry of Land, Infrastructure and Transport(MOLIT) as 「U-City Manpower Development Program」
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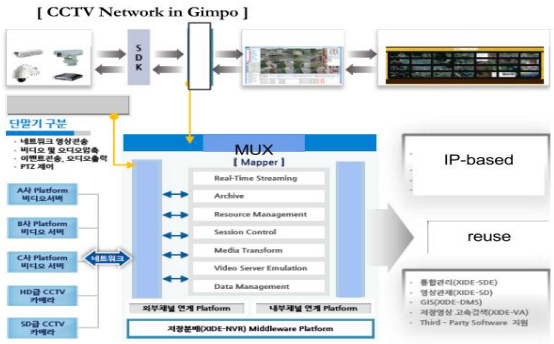


[CCTV network in Gimpo]

In the project, CCTV image processing advances were introduced and we now learned that by accommodating recent achievement in computer vision can help the emergency and disaster management. Machine learning as part of Big Data can detect or accurately guess more complexed situations which can't be alerted with the given operation cost through human labour. Medical community developed a collapse detection system for the old and effectively alert to call ambulance or assistance. To further develop the idea, let's explore more about the characteristics of disaster or emergency.

UNDERSTANDING DISASTER AND EMERGENCY SCENARIO

A disaster is a very general term that refers to many different types of catastrophe events. In general, a disaster occurs in an area where people live and their livelihood and health is influenced in ways that are not typically encountered. Disasters vary by extremity, types of consequences, size of the area affected, warning time, and many other factors. According to the US Federal Emergency Management Agency(FEMA)[2], the following are different types of disasters[4]:

[List] Chemical Emergencies, Dam Failure, Earthquake, Fire, Flood, Hazardous Material,

Heat, Hurricane, Landslide, Nuclear Power Plant Emergency, Terrorism, Thunderstorm, Tornado, Tsunami, Volcano, Wildfire, Winter Storm

Although the list mentioned covers many different disaster types, we would also add Power Failure, Building IT System Breakdown, as another important types of disaster. An example of this was the US & Canada power outage of August 2003.

Emergency and Disaster has three phases- emergency breakout, relief, recovery and MNS can be used not only for the break of the emergency event but can aid in other phases.

The emergency breakout phase is usually in the immediate wake of the disaster when MNS is mostly used. Not often but rare but involves many other subsequent activities such as rescue and life preservation.

Sub Activities in this phase

Sensing and Assessment: Type of Event & its degree, Victim and Critical Infrastructure
Emergency Rescue Activity Tracking

The relief phase follows the emergency break-out phase and is a time when temporary solutions are sought to assist the community

Sub Activities in this phase

Relief Activity Tracking
Resource Tracking

Finally, the recovery phase is when the primary objective is to bring the affected community back to their original, or even improved, quality of life level.

Sub Activities in this phase

Recovery Activity Tracking

While the three phases of disaster response generally occur sequentially, it is important to mention that the transition from one phase to another will typically be fluid and MNS should be considered to support this characteristics. It is possible for a disaster to revert backwards, for example, from the relief phase back into the emergency status.

From this, one can infer the CCTV as eye can monitor or assess various emergency situations and MNS(Mass Notification System) could be used to interact with the people in the area of interest. CCTV can also further utilized to understand the response from the people by monitoring their gesture or behaviour after communicating via MNS.

MNS(MASS NOTIFICATION SYSTEM) TODAY

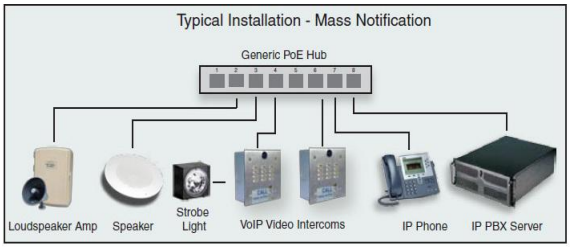
Thus, together with CCTV at IOT smart city[2], intelligent or savvy MNS can be great helping hands at various stages in disaster. Another major element in minimizing the risk of accidents is to set up an efficient communication system. A reliable flow of information between the visitors of an event, the organizers, security staff, police and ambulance is crucial for coordination. In fact, visitors often become aware of developing congestion too late because of the short-range visibility in crowded areas.

[Definition & History of MNS]

Mass notification and MNS provide real-time information and instructions to people in a building, area site, or installation using intelligible voice communications along with visible signals, text, and graphics. It may also include tactile or other communication methods.

Mass notification systems ("MNS")[5] are now becoming an integral part of both emergency and non-emergency communications for organizations of all sizes, within many industries. MNS not only dramatically improves safety and security with the potential of protecting and saving human life, but can be leveraged to increase revenues and cut costs by ensuring clear, concise communications during any emergency incident.

The purpose of mass notification is to protect life by indicating the existence of an emergency situation and instructing people of the necessary and appropriate action to take.



[MNS overview]

Mass notification was first defined in 1997 by the United States Department of Defense (DoD) in an investigative document termed the: "Khobar Towers Report". The report was developed in response to the deadly terrorist bombing of an American Military housing complex in Saudi Arabia in 1996. In summary, the report concluded that significant loss of life could have been reduced and even avoided entirely, had there been an effective means of alarm and "mass notification" in place at the housing facility.

As needs developed and following a consultation between DoD stakeholders and the National Fire Protection Agency (NFPA), a clear recognition of the convergence of traditional fire alarm systems with MNS/ECS became a requirement. NFPA establishes codes and standards that govern requirements for approved design[6], installation maintenance and management of life safety systems. The effect of MNS awareness on the life safety systems industry was highlighted when the 2007's NFPA 72's National Fire Alarm Code was re-named by NFPA in 2010 to the National Fire Alarm and Signaling Code.

The general consensus from federal emergency management professionals is that layering multiple forms of communication such as mobile phones, television and radio would provide the most reliable solutions in emergency situations. For example, in 2006; as part of the emergency broadcasting evolution, the Commercial Mobile Alert System, (CMAS) was developed as another modality to leverage, in the effort to deliver fast and efficient messages to the public via mobile phones.

Today mobile tablets, lap-tops, smart-phones and social media have become an industry reality. A comprehensive web-based multi-modal net-centric alerting solution would utilize social media, tablets and smart-phones as one layer of broadcast media dependent on the information technology portals available. We know that web-based notifications often will not provide the desired level of survivability especially during heavy weather conditions such as hurricanes and severe snow storms. Since this presents a serious problem, the layered approach requires that we leverage the higher reliability systems such as UL/ULC listed fire alarm/emergency communication systems.

The higher reliability layer consists of the use of the fire alarm/emergency communication systems. These systems provide live and pre-recorded intelligible voice messages via interior and exterior hardwired and supervised speakers and visual strobe signal appliances.

[What type of challenge is ahead?]

Hard and old-fashioned MNS does only one thing : siren. The next generation one in IOT smart city[2] would like to be utilized further and controlled in a sophisticated way. Perhaps inclusive of safety control, not the disaster level. For example, mass crowd congestion can increase the risk of collapse of them and we can use MNS to communicate controlling the flow. Injury or collapse of passenger or detection of unusual situation can be detected by the CCTV and MNS can be used to alert or call assistance nearby. In such situations, calm but clear loud speaker announcements informing visitors and well visible, variable message signs can let people know why they have to wait and what they should do. A robust communication system often constitutes the last means to gain control before a situation gets out of hand. It is also important that crowd managers have a reliable overview of the situation[7]. Existing technologies offer useful monitoring systems that allow for real-time measurements of density levels and predictions of future crowd movements (also see describing the use of smartphone applications for inferring crowd density). While such sophisticated monitoring systems are among the most efficient ways to keep track of the situation, most events are not yet using them. The minimum necessary requirement, however, is video monitoring covering the relevant zones of the event, from which the organizers can

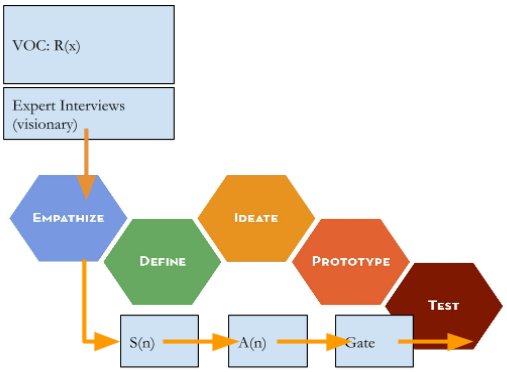
precisely evaluate the crowd movements and detect signs of upcoming congestion.

Methodology

To propose the next design, we made a quick assessment the depth of the challenges ahead in the previous chapter and here proposed such methodology following to maximize the chance of success in design completion.

We chose hybrid Method Engineering in marriage with Design thinking process as the underlying principle for the model. Originated in the Information Systems discipline, Method Engineering is concerned with the description, design, adaptation, and evaluation of methods, using engineering principles. Method engineering allows easier method adaption to project specific needs (so called method tailoring). Method fragments can also be combined to new methods (called method composition) . The formal description of a method allows the reproducibility of methods by other researchers and therefore the testability of the method's utility claims. Also, method engineering is able support the teaching of methods. For the formal description of methods, different elements are recommended like the purpose and scope, the process model, and the involved constructs of the methods. Typically a method has specific testable utility claims based on the purpose of the method. Sometimes these utility claims are based on kernel theories. The utility of the method should also be evaluated. As already mentioned, the purpose and scope of design thinking is the creation of innovative solutions for wicked problems. However, the question for which problems design thinking is especially beneficiary (the scope of the method) is still open. The utility claim is that design thinking can achieve its goal more successfully than other innovation techniques. For an evaluation of the method, an operationalization of these success criteria is needed, e.g. that design thinking may produce solutions that are more likely accepted by the relevant stakeholder(s).

Design Thinking[10] is a methodology used by designers to solve complex problems, and find desirable solutions for clients. Design Thinking draws upon logic, imagination, intuition, and systemic reasoning, to explore possibilities of what could be, and to create desired outcomes that benefit the end user (the customer). A design mindset is not problem-focused, it's solution focused, and action oriented. It involves both analysis and imagination.
The proposed method is illustrated below.



[proposed Hybrid Architecture Examination process]

Architecture Drawing

Upon the completion of the process, we propose such architecture and discuss the pros and cons in the following chapter.

- List of Disaster or Emergency Scenarios
- The proposed system can be used for such cases
- disaster notification - further improved operation
- Educational awareness notification - newly added
- mixing with recreational messages - newly added

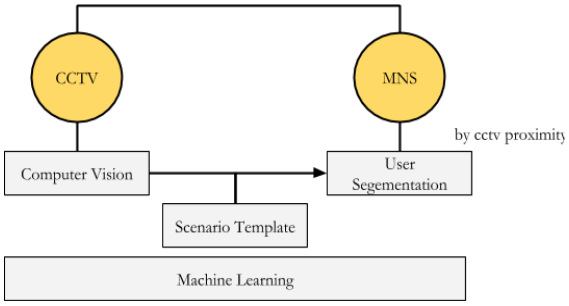
Especially, we examine the implication in design on such emergency scenarios as the first step of use of the MNS-CCTV combined system.

- Fire
- Collapse of passenger in the area
- smoke detection
- crowd overflowing

For example, as the second scenario, detecting falls of person- borrowing the technology from elderly people's assisted living where multiple camera was used[9]. The performance in terms of accuracy and more complex and sophisticated scenario support is very good. Multiple cameras allow for the monitoring of multiple rooms and the resolving of occlusions. Furthermore, the features for posture and motion velocity used in related work are highly dependent on the viewpoint of the camera, e.g. consider a fall along the optical axis of the camera versus a fall perpendicular to it. Therefore, in a real-life scenario robustness is highly increased when multiple cameras are used. This could be understood as situation awareness system that can interact with the local audience in some permitted cases.

System Diagram

This system starts by learning from the CCTV video inference. It combines the recent advances from computer vision at CCTV part - scenario detection- and localised/pin-pointing communication based upon user profile or location in IP communication, primarily smart-phone(mobile devices)



[Architecture Diagram]

The system works in such way following **[Sequence of operation]**

1. Computer vision part continuously try to detect given scenarios from the scenario template
2. Once the scenario is detected, it calls the action profile from the scenario template
3. The scenario is loaded to the system, accordingly the segment of users are chosen to deliver the message (are of people or types of people who need attention)
4. The notification is broadcasted and if possible, the response by people is collected by gesture or audio for further analysis - next scenario driving and future service optimization.

This above is generalized sequence and will be further specified in the later stage of design, especially the ending part-feedback learning can be further improved by networking other city or cross-sites data mash-up.

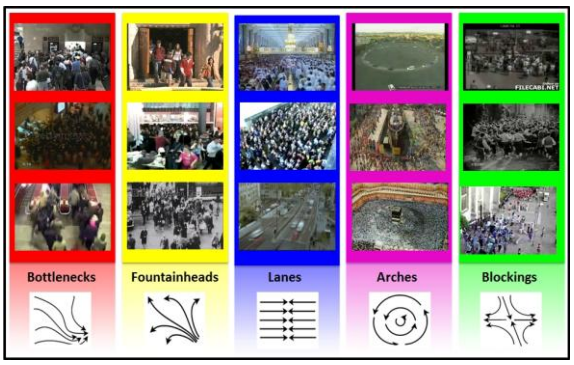
[How computer vision works]

Typical computer vision system detect motioning area - find regions in the video stream where there is motion. This is done through frame differencing based on image intensity values. The it starts tracking the region as object form this we can do such sub-assessments or running detection algorithm of choice[8].

- Collapse, Smoke or Fire

[CCTV person tracking]

The next step is gathering such objects tracking or calculate the characteristics of region in the screen to conclude group behaviour. In the picture below is the show work for the crowd detection[11]



[Group Behavior detection]

[How user segmentation works]

Segment group of users and deliver more optimized notice is very exciting in the world of MNS. Thanks to the IP-network and mobile phone surge, the central location can effectively plan and control the crowd using cloud-based as SAAS MNS. For example, in the example below, when some area are affected by contaminated water - which is emergency but different from building fire which request immediate evacuation -siren is best communication means. Back to the water problem, the central emergency and disaster management can broadcast the outbreak of such emergency post SMS, SNS message and broadcasting over media. They can develop different educational or guide by the proximity of the people in the city - closure one got higher alert and attention and more detailed guides[12].

[San Francisco Profiling]

Of course, this level of user segmentation and delivering customized message is further zoomed thanks to the level of graduality in the technology underneath. Facebook message or google email can be used following their location profile. SMS by the basestation is already included in this idea and we now can use the history of the user to infer further involvement from the event. One may be out of the region but many have family or close friend in the disaster region. In that case, rather than evacuation notice, he or she should got different message (e.g. situation update or latest development)

[benefits]

The proposed situation-aware emergency-notification solutions enable government or community to alert personnel quickly, effectively and securely via IP-connected personal devices such as computers, telephones and cell phones. Additionally, with an on-premise system, emergency mass-notification solutions readily can be integrated with legacy mass-notification devices such as Giant Voice, private branch exchange, fire alarms, physical security sensors and other traditional alerting systems.

Application back to the project

From the architecture drawn before, we tried to apply on the existing Gimpo infrastructure. It currently use CCTV for such six categories

Street Surveillance, Traffic Flow Monitoring, School zone Safety, Overall Community Policing, Parking Enforcements [See picture below]

Thanks to the massive number of installment and operation, we initially thought it can be easily developed. However, on top of different quality of CCTVs -multiple supplier and different specification by different usage requirement, the source and operation authority are different, we learned that it isn't that easy to in corporate all. The previous year project in Gimpo[3] was an effort to accommodate all in the central control unit thus gathering all video footage is now straight forwards at Gimpo, only leaving us to resolve different level of resolution or quality of image.

However, the networking of MNS is rather challenge. Unless the new regulation is introduced, large part of community or sub-regions are quite reluctant to make extra investment for replacement with new MNS. So we discussed this challenge (business-driven issue) and listed some ideas reusing the methodology.

- Needs to calculate the effective access coverage by the different type of emergency or disaster
- The cost of deployment to access between 80%-100%

Rather than limiting the scenario only to disaster - which impose 100% audience access with governmental regulation, we can adapt lower level of emergency which can permit not 1005 access using IP and mobile.

CONCLUSION

Massive notification systems have been widely and variously used as effective tools in disseminating disaster preparedness and response infor-

by the governmental organizations. This study examined the next generation functions and usages from the experience from the disaster and safety management system, especially CCTV, in Gimpo Smartopia, Korea. and used new hybrid methodology to rebuild requirements and design concepts in terms of their functions, service types, usages gated ratings. Based on the examination results, this paper suggested sketched the architecture and assessed implications and considerations for the public application development in the disaster and safety management. The overall conclusion of the project is that such system will improve the living in the smart city and

making people feel secure and the city infra resource will be further optimized adding values..

ACKNOWLEDGEMENT

Authors express their deepest gratitude towards Gimpo Smartopia team for their constant help and encouragement throughout the project work. It was great fortunate to have a guide who gave the freedom and ground to explore and at the same time helped and supported the design development with timely reviews and constructive comments, suggestions whenever required.

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