A context driven information retrieval for online urban disaster management system

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ABSTRACT

Most of Disaster Managing Approaches depends firmly on information and communication management system. Due to the advances in Information and Communication Technology (ICT), a natural disaster, when occurs in an urban place, requires a high reliable quality of online heterogeneous urban information. In this context, decisions require the involvement of many decision makers and must be made in very short laps of time by using most of the available information. Since the information space has been opened the task of getting "online" the "more relevant information" has become real dilemma due to the huge structured and non structured available information whether on the Internet or on the Intranet.
In our project a Disaster Decision Support System is based on a groupware approach in which a collaborative information board has to share within the different decision makers. Such system incorporates, at least and in addition to the interactive decision board, an optimised Data Base Management System, a light Geographical Information System, an Electronic Document Management System and a very powerful server.
We consider that the information updating (as it is displayed or requested) on and within this decision board can enlighten a lot about the context. Consequently, we have been interested in Context Modelling available approaches. Most of these modelling approaches don't, exceptionally, fit to crises or disaster context. Therefore we built our own model based mainly on the approach of context ontology
We have also developed a context capturing approach capable to retrieve the "more appropriate" and "efficient" "contextual" information (or web-document) to urban disaster management system. Every time the context is captured it will be used to generate continuously an orderly sorted set of requests.

Keywords: Augmented Perception, Context Capturing, Decision Support System, Disaster Management.

INTRODUCTION

This last decade the Disaster Management has been considered as a real urban information management system issue. Most of Disaster Management Approaches depend firmly on Information and Communication Management System. Due to the advances in Information and Communication Technology (ICT), a natural Disaster, when occurs in an urban place, requires a high reliable quality of Online Heterogeneous Urban Information.
By Disaster, we mainly think about an unplanned danger or unexpected interruption of mission-critical processes. Disaster Management approach consist on a set of action and process (designated by the risk assessment system) to maintain a desired level of

risk. Modeling systems response or behavior to an interruption is essential to estimate the risk importance.

In every phase of the disaster life cycle, decision-making could be limited to the process of choosing among alternative courses of actions in a very short time with the available information. Disaster life cycle contains four main phases which are not necessarily chronological.

Preparedness

Preparedness is having plans or preparations already made for reacting effectively to save lives and ensure response-and-rescue operations. The main actors of this phase are local, national and multinational administrations

First Response

This phase begins as soon as an urban disaster is detected. Very often it covers the elementary rescues actions to be undertaken: mobilizing and positioning emergency equipment ; providing needed food, water, medical services ; bringing vital damaged services and systems back on line. Local responders are mostly government agencies, non governmental organisations and private organizations

Mitigation

It is the list of ongoing effort to reduce the impact that an urban disasters can have on habitants and belongings.

Recovery

The disaster recovery planning defines the processes, their infrastructure supports, tolerances to perturbations and the formulation of strategies for reducing the likelihood of interruption or its consequences. Recovery consists also on returning to a normal and safer situation.

In a disaster life cycle, quality of available information remains the key access of every decision making process. Regarding this point by considering the important impact of ICT (Information and Communication Technology), we have retained three statements:

- Enhancing quality of Urban Disaster Management (UDM) depends strictly on information management
- Capturing urban disaster context is essential to retrieve a reliable and pertinent information
- Getting relevant external information can augment the perception of the available set of information and consequently enhance the decision quality.

In this paper we are mainly interested in developing the role of ICT in the first stage of urban disaster management, i.e. first response. At this level, decisions require the involvement of many actors and must be made in a very short laps of time by using most of available information and communication means

SAFELINK: ICT APPROACH TO SUPPORT DISASTER MANAGEMENT DECISION MAKING

Urban Disaster Management life cycle embeds various outcomes: humanistic (saving life), economic (saving prosperity and keeping productivity), social (saving activities), cultural (saving civilisation and heritage) and the political outcome (designating and sharing endorsed responsibility).

In a such highly constrained context making the “appropriate” decision is a complex task. The political issue, of every decision, is very often determinant. This point might reduce the complexity of the decision making task. But it implies the incorporation, to

a given “context”, of all related regulation, decree, directive and legal information. Therefore, the UDM approach should be able to outline the decision “context” (Dey 2001). Due to ICT, the easy access to huge structured and non structured available information on the Internet, the Intranet or on whatever, the task of gathering “online”, the “more relevant information”, has also become real dilemma. The more the decision makers have access to information the more they are requiring a Personalized Retrieving Tools.
UDM is almost a fuzzy situation. It doesn’t belong to a Decision Support System nor to a an Integrated Information System. For this purpose we have developed SafeLink (Online Urban Disaster Management System) which is an interactive ICT environment supporting several data bases and electronic document management systems (see Figure 2). In ordre to reach and get just in time the appropriate information, SafeLink captures continuously every transactional data by observing all formalized interactions. To define a context, Safelink uses the set of observed interactions. SafeLink is an augmented UDM information broker.

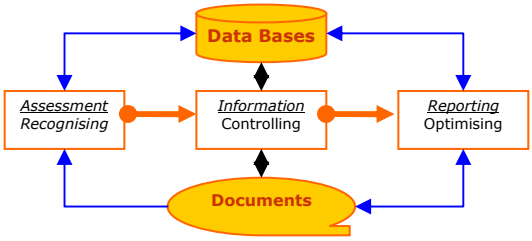

Figure 2: SafeLink Area.

In this context, SafeLink has to:
1. Assess the importance of the given urban disaster
2. Manage (control) information resources and communication protocols within the decision makers
3. Report on all exchanged and generated information
4. Capture incessantly the context of the UDM in order to retrieve the more appropriate information

Real and Artificial Experiences (scenario based simulations for example) remain the best resources to increase quality of UDM process and to ensure conformity of responsibility partaking. Consequently, SafeLink saves-up, in a data-warehouse, all inquiries and exchanged information.
In order to optimize the UDM, we believe that SafeLink has to perform the Context Capturing function. We believe that supplying the more appropriate information will certainly improve the assessing, managing and reporting functions. However, capturing the context is very useful to:
- Anticipate the very shortly needed information
- Provide an augmented perception of the problem to be solved.

CONTEXT CAPTURING

We have introduced the Augmented Perception Concept, and not the classical Augmented Reality one, into SafeLink system architecture. Many questions can be raised following this consideration: What is a Context? What is Augmented Perception? Why Augmented Perception? Why not Augmented Reality? And ones may ask what Reality is in this context? ...

Most of those questions could be explained by simple facts. In our approach, a context is a formal representation of a situation. Reality is reduced to just a complete representation of a situation. The problem of urban modelling and representation in IT is still a very complex issue for research and development. Therefore, it is nearly impossible to deal with Augmented Reality in an UDM context. SafeLink's, through its Human Computer Interface, doesn't pretend transmitting the reality of the disaster situation but just a perception of this reality, i.e. a factual representation based on a set of available information which is considered temporary as valid,.
Following this framework, we may consider the augmented perception concept as part of the Augmented Reality. However, in Augmented Perception, information is augmented only with regard to the examined situation, as it is perceived. Consequently the augmentation process is very subjective and strictly related to the set of communicated (or simply computed) information about a given situation in a given time. For example, information could be augmented by retrieving some regulations, norms, online cases studies or any relatedonline meteorogical or geostatics information. Also 2D or 3D plans as well any further graphical information can greatly enhance the reality augmentation quality.
We should remind that SafeLink's value added (see figure 3) is in obtaining a "good" (i.e. accepted in a given time and a given situation) global vision (a synthesis) of the disaster supported by possibly additional information (to be confirmed by the user) improving a perception schema necessary to select an anticipation schema on the progress of the disaster.

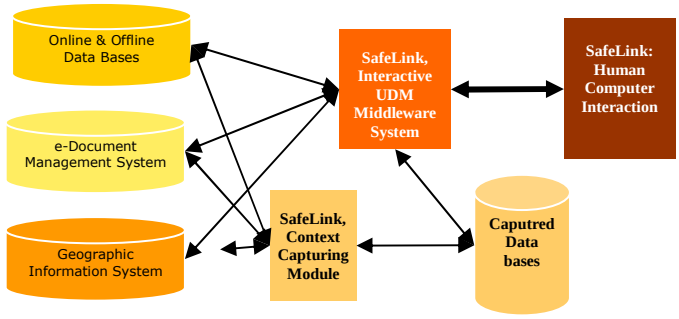

Figure 3: SafeLink simplified architecture

Moreover, SafeLink HCI module represents on itself a kind of information augmentation, as it embeds the two major tasks: information (data) selection and information (data) assessment.

The Urban Disaster Context
The Urban Disaster Context can be defined as the set of information surrounding an interest focus (Pasquier 2002, Dey 2001). The interest focus can be defined as the common centre of attention between the decision makers. It is related to enlighten entities identified on the decision support (information device), the HCI in our case. An interest focus is connected to the decision problematic.
Consequently, we consider the Urban Disaster Context as the whole organisation of the enlighten entities. It is much more than a selection of entities; it is multilayer organisation of Data. Relations between enlighten data have a great importance in the Context definition. A context is not limited to only one centre of interest.
As result of this analysis, we have to expand the definition of Context as given in (Pasquier 2002); to a more general one in which the context could integrate more than

one interest focus. This is very true in an UDM situation where a multiple kind of assistance or interventions have to be ensured at the same time.
In sum, we believe that a context has to be defined as a composition of different interest focus connected with entities. Some of those entities could be shared by different interest focus. Emerged dependencies between interest focus and interrelations between enlighten entities embody the core of the context definition.
Our concern is to optimise the decision process by supplying an augmented summary of the Urban Disaster. Capturing the UDM context ought to be both the necessary and satisfactory condition to ensure the quality of an augmented perception process.

CONTEXT MODELLING APPROACH

The capture of a context consists on:

- Extracting the interest focus (one or more)
- Selecting the set of enlighten entities
- Building a robust context representation

The process of capturing online the context of a fuzzy situation, like urban disaster, is a complex task (Henricksen and Indulska, 2003). A context, in this kind of situation, is naturally dynamic (Brezilion 2YYY). Its definition is completely time unite dependency. A context is dynamic then its capture should also be dynamic. However, in our approach, result of every capturing is partial as it is related only to a given time. Limits of the context capturing can be explained by a set of conceptual and technological constraints. It is obvious that most of information involved in urban disaster context should permanently be ready to cope with some modifications (Henricksen and Indulska, HHHH). Endowing the UDM system, like SafeLink, with some domain knowledge could be of a great help. In an urban disaster, modifications range is strictly related to the information nature, for example building location would not face the same level of modifications as safety equipments. However, a building could be expanded or it could be destroyed. Seeking and considering such kind of information, by using ICT and domain knowledge, will obviously augment the perception of the situation.
Beyond this limitation of capturing, one should notice that, most of exchanged informal information (verbal and gesture communications) is out of captors area. Either, it is possible to include properties like the temperature in the context model, but it is much more complex to make the system able to learn, in a disaster situation, about some human subjective judgements related to the temperature (too hot, not enough, very hot, etc.) as they are completely context oriented.
This notion of subjectivity is fundamental in context definition. For this reason it becomes more than necessary to endow every UDM system with a set of context information assessment factors.
Information supplied from captors could be reasonably evaluated following its resolution, accuracy or also through its update frequency. On the other hand, defining factors to assess subjective information, delivered by human being, is much more difficult, but it is always possible to take the expertise level into consideration: for example a fireman has better skill to assess the fire scale than a simple civil witness.

Context Model

Our context modelling is mainly based on classical ontological (entity-dependency) approach (Gu et al. 2004a) as illustrated in figure 4. We have retained the entity-declination and the dependency-declination suggested in (Gu et al. 2004b) and allowing defining a generic model having a wide expansion property and a large scope of future reutilisation. SafeLink context definition model has also integrated the information assessment approach (quality constraint) as introduced in (Gu et al. 2004a, 2004b).
Previously we have pointed out the importance temporal in urban disaster context extraction. For this reason, we have included a specific class the "Duration" able to associate various durations to different elements (entities and dependencies) composing the context model. In figure 4 we show some duration types used in SafeLink in order to augment the context perception.

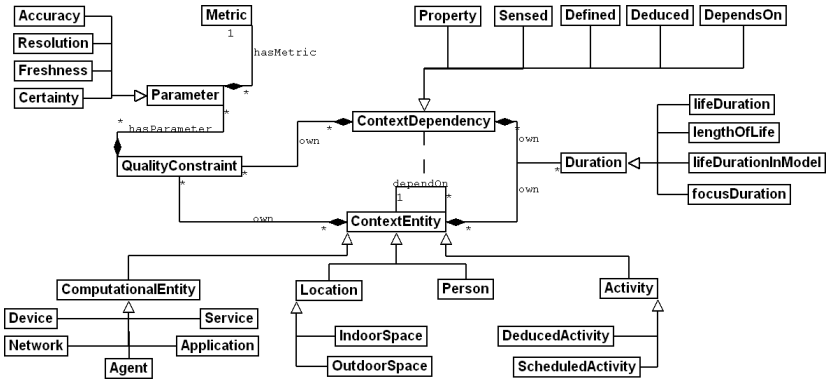

Figure 4: How to capture the context

- Life duration: since when a context entity has existed
- length of life: how long a context entity will exist
- Life duration in model: since when a context entity has been included in the context capture ?
- Interest focus duration: since when a context entity has been included in the context capture as an interest focus entity ?

In SafeLink the captured context will also be represented as a graph.

INFORMATION EXTRACTION

Which information has to be considered into the captured context?
We have defined the context as a composition of several interest focus connected through several entities. So it's very important to define how to perform the relevant data selection process in general and the interest focus extraction in particular.
We have also mentioned that the interest focus represents the central part of the context definition. Hence, we have considered in SafeLink the following statements:

1. The interest focus extracting depends strictly on the considered domain. Thus, certain entities will be considered, automatically and in default, as part of the interest focus. For example, if the system has to assist decision making during a flood disaster, emergency equipment as well as access to flooded area will be necessarily parts of the interest focus.
2. The Interest focus extraction can also be made by observing some identified data or indicator. The indicator variation is particularly important but variation's growth could be more important. For example, the UDM system should observe

that the level of a river is increasing, but it must capture immediately this information if the level is increasing quickly.

Interest focus Extraction

Context awareness as well as disaster management have been widely studied (Brezilion 2002; Hong 2002; Li et al. 2003) and have produced a great number of documentation (mainly notice guidelines, procedures, actions plans, disaster plans, communication plans, etc.) that can help preventing and managing an urban disaster. Those documentations are very useful to extract essential information (like safety threshold or risk awareness) related to a given phenomenon or a process (to be natural or industrial). This assertion has been considered as fundamental in SafeLink context capturing module. For example, the river flood level overtaken or the building oscillation variations seem to be relevant indicator in interest focus extracting.

Today lot of documentations are available on a standard and very often well structured format, i.e. they can be processed automatically or at least by a semi-supervised process (interactive clustering system) to extract relevant information.

Concerning the dynamic aspect of context capturing and in particular the problem of temporal data, we can introduce some simplified notions like: the “rush hour”, the “free hour”, the “Day-on”, the “day-off”, etc. For example, if a disaster taking place during a “rush hour” or a “free hour” will have serious impact on roadways access selection. It’s either concerning the criteria of choosing an evacuation plan of public administrative building during a day-on or a day off.

Beyond those predefined temporal notions, we should pay attention to the temporal characteristic of the context capturing process on itself. Elements belonging since a while to a captured context could be transformed into an interest focus. Either, some interest focus can disappear later on. For example, complexity of area evacuation can become so important in the disaster management that it becomes a new interest focus. Adding new interest focus as well as cancelling an old one, both of those operations require the definition of a robust and strict modifications protocol.

Contextual Information (enlighten entities) Extraction

Once the interest focuses have been extracted, the context capturing module start the process of selecting the contextual information to be connected to each interest focus. In fact, the selection process is extremely closed to the interest focus extracting approach.

First, the start point of the process will be the interest focuses themselves, i.e. the set of enlighten entities characterizing and composing them. Afterwards, a set of identified indicators will be used to launch the contextual information selection process. Let us consider the problem of the area evacuation as interest focus in the urban disaster management situation then it becomes indispensable to indicate a logical set of contextual information such like: the area location, the characteristics of the connected infrastructure, the number of injured people, etc.

At last, the context capturing module has to retrieve the most relevant predefined documentation (regarding the extracted interest focuses and the selected contextual information). Following our example (area evacuation) the context capturing module will set up links with relevant documentation like: risk prevention plans defined by the local administration, risk management likely cases studies, regulation guidelines, etc.

The set of extracted and selected information and documentation embodies on itself a first augmented perception of the urban disaster context.

Context Data Assessment (robust context representation)
SafeLink's context capturing module is not limited to the perception task and the information selection process. Extracted and selected data has to be restructured and classified. This step is vital in the information augmentation.
Clustering parameters would require an important data pre-treatment. Select enlighten entities, their dependencies and the set of the domain identified indicators could all be considered in the pre-treatment step. If regularity within the data representation has been detected, the descriptor extracting would be easily done and a supervised classification process could be fired up. Unless an unsupervised clustering process has to be considered.
Regarding the UDM situation, the problem of dealing with temporal data will re-emerge. In some cases the duration notions could help in seeking some regularity.
The selection process on itself associated to the context definition can enhance the contextual information classification process. Also, we can consider some additional observations then we can significantly enhance the classification (or clustering) process. For example, the transition conditions preceding the moving of simple context information into an interest focus (and inversely) is to be considered in contextual data classification process.
It is either, for the predefined used documentation during the context capturing, all information related to the document retrieval can be of great help to the classification process.
These last observations, confirm once more the importance of retracing the history of decision process in general and of UDM in particular. It is indispensable to ensure a high quality and secure saving module of the context capturing evolution and all related information.

RETRIEVING WEB-DOCUMENT THROUGH THE CONTEXT CAPTURING APPROACH

In SafeLink we have developed a program that is able to retrieve the more relevant online (electronic or web) document from the captured context (Budzik and Hammond 1999). The obtained results can confirm the augmentation of the context information and consequently an augmented perception of the UDM.
As every information retrieval process, the urban disaster augmented information retrieval quality depends on the following operations:

- Requests definition
- Obtained results classification

Request definition
The request definition process in SafeLink is directly in relation with the context modelling. Every request has to be defined by exploring the captured context graph. Thus, SafeLink generates automatically one request from every extracted interest focus.
A request is composed of the interest focus object descriptions (based on ontology). By exploring the interest focus graph, SafeLink improves and make more pertinent (precise) the request slot. It is important to underline that the graph exploration technique must be an integral part of the request generation process because it's probably not necessary to explore the whole paths of the graph.

In order to optimise the system performance, SafeLink requests definition module takes into account the importance of the negative aspect of the generated request (the discriminate part of the request slot). SafeLink does not consider only the positive part (the complete request slot), i.e. the retrieving process must provide at least all the desired documents. This is useful but it could generate lot of noises by retrieving non desired documents, especially in an UDM context. Therefore, SafeLink tries as much as the available information allows, to generate complete and discriminate request slots. For this it defines an adapted graph exploration strategy.
Also if the request definition has not connected to every new capturing context, it risks generating some unreliable requests which don't take the disaster evolution in consideration.
Noticeably, this statement will comfort retracing all UDM related information to improve continuously the system performances.

Obtained results classification

In a real time augmented perception processing like in the UDM context, SafeLink can not avoid classifying the retrieving process obtained results. It is not viable to display all obtained results in arbitrary way to the system users. SafeLink classifies (attributes priority to) every augmented information to be delivered to the final user.
Some elements presented in this paper yet could be useful for the classification process. But we don't present again all of it and we just precise some clues usable in classification activity.
It seems more fruitful if the classification criteria (the process of attributing priorities) can take in consideration the context evolution (Bauer and Leake 2001, 2XXX) and the variation between the request submission time and the results delivering time. The interest focus variation can also be useful in updating the classification criteria.
According to the request definition process, every request corresponds to a specific interest focus. Thus it is possible to make some crosschecking operations between the obtained results from the different requests.
Furthermore, the system can get some more information about classification criteria by comparing documents corresponding only to one interest focus with documents corresponding to different interest focus. In fact, we observe that this last kind of delivered document could contain general knowledge about the situation we are capturing.
Finally it's obligatory to take into consideration the user skill since the first step of the classification criteria definition. Also, the user behaviour (by consulting or not the delivered documents) can greatly improve the system performance.

CONCLUSIONS

This paper has been focused on context capturing within an Online Urban Disaster Management system. We have presented briefly our system SafeLink and its architecture. The capturing module has been developed to ensure an augmented perception of urban disaster information context.
For the while, the capturing module is connected to the internet and can be linked to any specific data bases. Obviously, this will require some simple filters development.
The Human Computer Interaction is the most important feature of UDM system. Giving more detailed about it will be given in a future full paper.
A prototype of SafeLink is already available. It has been completely developed with open sources. Tow version of SafeLink have been considered, the first one is

Geographic Information System based and the second is Communicative Landscape Objects based
In conclusion we wonder to pay your attention on the fact that this project has been submitted for a patent, so we have not been able to publish it before.

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