A NEW SYSTEM FOR THE REPRESENTATION OF PLACES HIT BY DISASTERS

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ABSTRACT:

This paper analyses a new system for data collection and management after a disaster. In particular, the system enables to represent what exists in a place, and to visualize the preceding state, in a synoptic vision before and after the event; and also enables the consultation of synthetic information, the possibility of connections to internet sites for further in depth analysis and then the possibility of archiving and retrieving data through researching specific items. This is carried out in a simple and quick way, utilizing a portable device. The obtained product is consultable on site, or otherwise memorized and archived. Because of all these functions, it could be a useful instrument to document the situation of the places hit by disasters, and to organise the interventions. The system is currently subject to patent application.
The paper will be detailed in the following sections: user equipment, formation of the product and functions of the obtained product.

1. INTRODUCTION

A catastrophic event turns places upside down. The landscape changes, the referring elements are cancelled and together with them the capacity of recognising what was there and where, in relation to the morphology of the site and to the objects located on it. This impedes the intervention of the rescue of survivors and subsequently the intervention of reconstruction, because of the difficulty of orientating through the ruins and recuperating, place by place, the knowledge of the actual state before the event. This makes us hope for a system which, on site or subsequently, enables us to have a clear document of reference, with localised information, comparable before and after the event.
Later in this paper a system, which has these requirements, will be explained.
The system comprises various functions which can be utilised profitably to answer to the above mentioned needs. We will focus on these functions in the following sections.

2. USER EQUIPMENT

The system can conduct the operations totally internally to a user portable device or relying on a dedicated server. This last solution lightens up the device limited to the software and the memorised databases, and to the processing power. Besides, frees the user from the necessity of retrieving and archiving each time the data related to the different locations within which it operates (figure 1).
The system is composed of the following software and hardware parts:
- a portable device integrated with GNSS (Global Navigation Satellite System) means and inertial compass;
- a three-dimensional model associated to an alphanumeric database (eventually localised on an external server);
- a software for managing the three-dimensional model (eventually localised on an external server);
- a software for forming and a software for managing the final product;
- processor, operating memory and fixed and removable memory for archiving data;
- a possible connecting system via a mobile telephone network (GPRS/EDGE, UMTS/HSDPA*) in the case in which the device is connected to an external server to the user device;
- a possible internet connecting system (mobile internet or WI-FI connection), in the case in which, as above, the device is connected to an external server or in the case in which it's needed to consult online a web page.
- wireless connection (bluetooth and/or infrared) for possible connections to peripherals.

The devise is equipped with a display, preferably touch screen, and interface controls, speakers and microphone to guarantee to operate and receive the information in a vocal mode, leaving the operator more free to move his/her hands and to observe around whilst receiving the data.
It is planned the integration of the various parts within the portable device.

3. FORMATION OF THE PRODUCT

The final product is obtained in real time, and constituted by a view of the site after the event, complete with a view before the event, and supplied with the cognitive data prior to the event. The organisation of the data is such that it allows consultation on site, on the portable device, or at a later time, after having downloaded the product on a PC.
Because the Patent application is at the moment in the confidential phase, the method to realise the product will not be detailed in this paper.
What will be underlined, however, is the fundamental importance of the surveying data for the quality of the final product. In fact, formation requires the knowledge of internal and external parameters of the device. In particular, the

*GPRS (General Packet Radio Server); EDGE (Enhanced Data rates for GSM Evolution); UMTS (Universal Mobile Telecommunications System); HSDPA (High Speed Downlink Packet Access).

coordinates of point of view, and the azimuth, *pitch and roll angles,* are fundamental to line up the representation of the

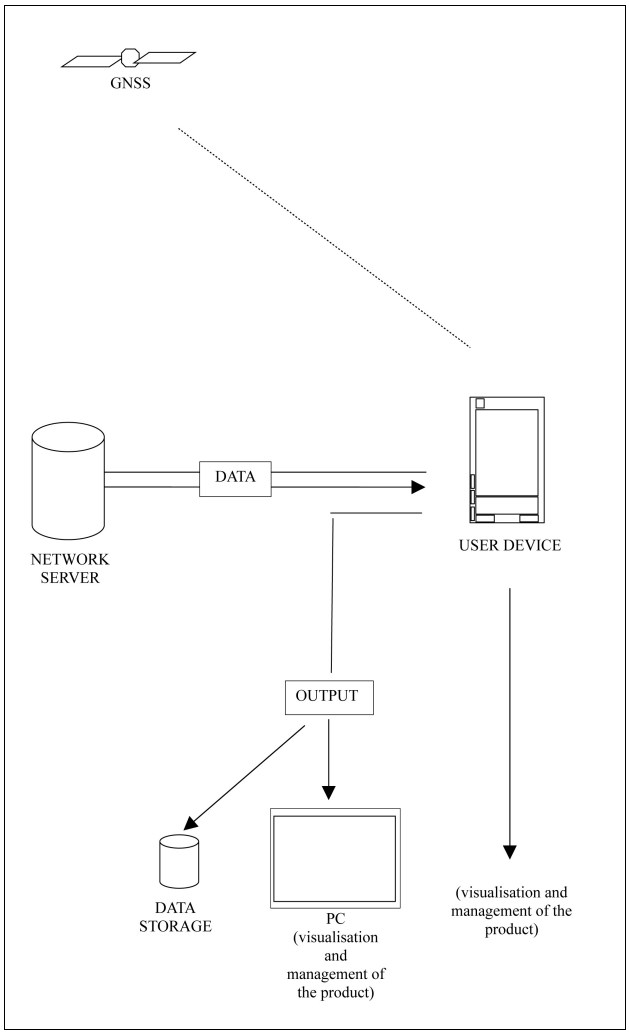


Figure 1. Example of the system connected to an external server

place and that of the three-dimensional model. Together with them, also the contents and the precision of the model are important. For this reason, it is advisable that all these data are detected with a precision appropriate with the nominal scale of the final product. In some particular cases, if necessary, it is possible to use an external GNNS means interfaced with the user device*.

Partly what has just been said might seem to refer to some applications of augmented reality. On the other hand, the system is at a distance from them, both for the way the product is realised and also the final product itself, which constitutes an archivable document and consultable in any moment on a computer, also even one without a specialized software. The system, besides, doesn't need in any of its phases a GIS (Geographical Information System) dedicated software.

* Particular attention will have to be dedicated to the correspondence between the coordinate reference system of the device and the coordinate reference system of the model.

3.1 3D Model

The 3D model is necessary to virtually reconstruct the places and the objects prior to the event (the date of its formation must therefore be prior to the disaster which needed to be documented). To efficiently realise this function, it must contain the detailed representation of the terrain and their located objects, describing the morphology of the land and the volumetry of the buildings, of elements such as bridges, tunnels, vegetation, water bodies, road infrastructure, urban furniture. The volumes can be reproduced with different levels of detail: with a simplified mode, that is through 3D blocks, or with a more complex one that is through 3D blocks with the reconstruction of the roofs, arcades, subways, etc. The surfaces can be represented with uniform colours or realistically, through photographic texture, which reproduce the material qualities of the objects, and the details not three-dimensionally reconstructed. During the rescues, the last two ways respond to different needs, in relation to the impact of the disastrous events on the objects. Generally, however, the virtual reconstruction in photorealistic mode is more effective for the system, because it helps to obtain a more complete picture of that which has been destroyed.

The availability of three-dimensional models, therefore, is at the base of the application of the proposed system. Regarding this matter, nowadays times seem to be favourable because an increasing interest has been focused around the formation of three-dimensional models, with production directed both to generical users, and to specialsists in the geomatics sectors. The tendency is to cover wider portions of territory both urban and extraurban, by using a three-dimensional database, according to specific standards established generally. These standards aim to reach consistency of contents, and the precision typical of the cartography, without forgetting the metric reliability in the name of the visual effect**.

The models are generally associated to an alphanumeric database, as now specified.

3.2 Tables

In the 3D model, the information are organised in the form of tables.

In view of the application of the system they are specifically formulated, with a degree of precision and entirety compatable with the cognitive needs to which the system wants to respond to. These cognative needs are of two types: an imediate need, for the rescuers; a need at a later time, for the rebuilding.

With reference to the first point, the tables will aim to provide, during the rescue operations, useful and synthetic data to know what to look for place by place. The recordered data, therefore, will comprehend, for each object, the road address, the category and the destination of use; if buildings, also the structural typology, the number of floors, etc. But not only this. They opportunly could comprise also contingent data, acquiried with a continuos monitoring operation and transmitted online to the model, which memorises them in the corresponding fields of the tables. I am referring to, for example, the number of people present in a building, to retrieve any eventual people left inside

** It should be remembered, on this point: a) for the representation of the territory, the GDEM of the earth, with steps of 30 m, derived from the ASTER sensor, still in experimentation and, for Italy, the DEM with steps of 20 m from the Geographic Military Institute, b) for the representation of cities, the 3D city model of the Blom Group, uploaded to the database of Tele Atlas, which focus on navigation, location based services and internet portals.

them at the moment of the event[***].
The above mentioned, however, have to be considered examples of possible types of data. Like in every database, in fact, the table is a container of which the number and categories of data depends on the chioces of the planning phase of the database itself. The table, therefore, doesn't constitute an innovation iteself. What is new in the system, is the possibility to realise, in a simple and quick way, a synoptic vision that can be filed and that allows to retrieve the information preceding the event and also to obtain a more detailed knowledge, through the connection to dedicated web pages. These enable indepth analysis, because the web pages contain for example plants, photographs, thematic maps, drawings, regulations, etc., and links to other sites of interest. These last functions are above all useful to satisfy the cognitive needs during the analysis and recostruction phase.
The tables are set up to be acquired by the system automatically, excluding other information introduced in the database with other aims, for example administrative, planning, touristic, etc.

4. FUNCTIONS OF THE PRODUCT

The product can be consulted through a management software, which enable these main functions: the visualisation of the places the way they were after the event (figure 2), the visualisation of the places the way they were prior to the event, (figure 3), and the synoptic view of the places prior and after the event (figure 4). In addition to, the software will enable the retrieving of data and the connection to the web pages (figure 5).
The interface will be organised to allow the consulation of users also not expert in the use of information systems. To deal with the main functions, in fact, it will not be necessary to disentangle oneself through a drop down menu, because the basic controls can be given with a touch screen, which is simply by touching the image, or through a vocal command. More sophisticated functions will instead be expressed through simplified icons, according to the software dedicated to a non specialist public.
To allow an efficient displaying in synoptic mode, one of the two visualizations can be with reduced opacity. The user can however intervene manually in the opacity during the consultation phase.
Some errors could affect the synpoptic representation. These will depend on the errors in determining the position and orientation of the device and on the errors in the coordinates and in the contents of the model, as mentioned above. However, if the places didn't undertake a high degree of destruction, it's possible to activate a controlling function to correct eventual shifting and disorientation. The procedure can be carried out automatically at the time of the formation of the final product.
In the event it is not possible to activate the functions, it is advisable that the positioning and orientation data are detected with a high precision, if necessary using an external instrument interfaced with the user device.
In addition to the representation, the information or the links to websites for indepth analysis can be attivated.
For example, in the case of a landslide, the perpsective view

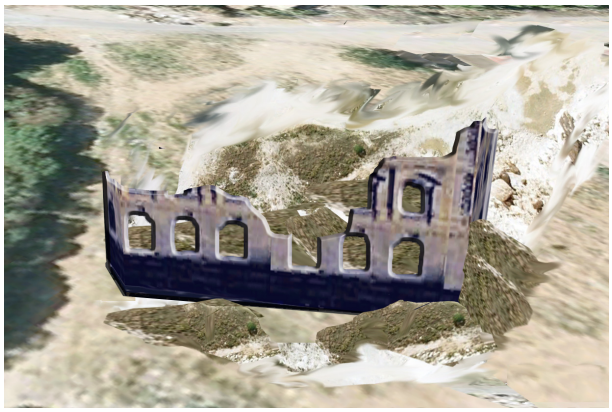


Figure 2. A simulation of the product: visualization of the place the way it was after the event

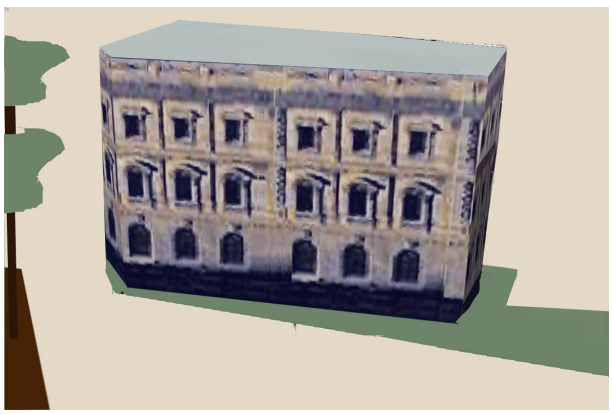
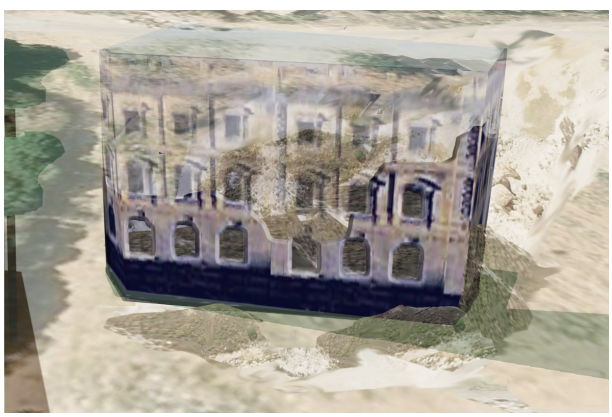


Figure 3. A simulation of the product: visualization of the place the way it was prior to the event



[*][**]With this aim, in case of buildings particualarly at risk, and above all when it's already been activated the alert warning, it is possible to preview the collocation of counting people system in each strategical points of the buildings, with transmission to the database of the monitored data. The signaling to the database of some eventual interruption of the functioning during the event, would lead the rescuers to consider the last recorded data as a beginning point. Then the last recorded data will be corrected on the basis of the declaration of the people who got out and abbandoned the buildings.

Figure 4. A simulation of the product: synoptic visualization of the place the way it was prior to and after the event

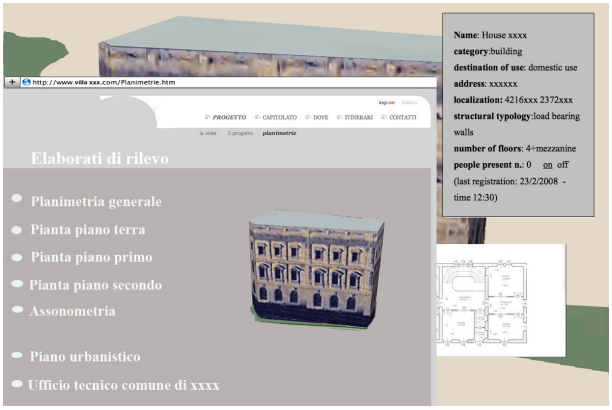


Figure 5. A simulation of the product: visualization of the table and web page

will be able to reproduce the morphology of the devastated land and of eventual building present before the event. In the tables there will be found the information on the geological characterstics and, regarding the buildings, the localisation through coordinates, the street address, the number of floors, of the apartments and of the inhabitants, while the links to the Web will enable to visualise eventual plans, the distribution of the services and so on.
In short, this product constitutes an archive potentially branched, of which its extendability is limited thanks to the routes carried out on the web.
All of this can be consulted together with an intervening rescue session; it can also be archived and then retrieved at a later time. The retrieving can be realised inserting in the search engine the name of an object or a street address, or one of the data contained in the database. Another possible research is through coordinates. Introducing the values and the ray of action, the system will retrieve all the products within the chosen area, visulaising the results of the reseach, if the user is requesting it, on a map.

CONCLUSION

The conducted research has enabled to concieve a system which can be very useful in the case of disasters to document the situation of the places, to retrieve data and, on the basis of this, to guide the rescue and intervention of reconstruction place by place, having always, together with the present state, the reference to the state prior to the disaster.
All this is realised through the use of a portable device, equipped with the necessary software and connectable via mobile network or internet. With a simple procedure, it is therefore possible to obtain, place by place, a detailed and reliable reference which allows the rescuers to know where to look and what to look for. The product, in fact, is realisable and consultable on site, in a situation whereby the lack of refering points, in the case of large areas hit by disaster, makes very difficult to find places and buildings also for the people who know very well the area.
The obtained product is archivable and therefore downloaded to a PC, maintaining its chracterstics. This allows, subsequently, in laboratory, to have a documentation, which, during the reconstruction phase, can be useful to have an immediate comparison with the original for each individual element destroyed or damaged.

FURTHER INFORMATION

The described system is currently subject to patent application. In this paper only some of the possible functions are discussed.

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REFERENCES

References from Journals:

Barzaghi, R., Betti, B., Pasoni, D., & Tornatore, V. 2008. Un esperimento per la determinazione di traiettoririe di veicoli ferroviari con il GPS in modalità NTRK. *Bollettino della SIFET*, 08(3), pp. 45-57.

Betti, B., Tornatore, V., & Bendea, H. 2008. Verifica delle potenzialità dell'utilizzo di ricevitori GPS a singola frequenza per il controllo: raccolta dati e primi risultati. *Bollettino della SIFET*, 08(3), pp. 59-72.

Cina, A., De Agostino, M., Manzino, A., & Porporato, C. 2008. Applicabilità e attendibilità di sensori GNSS e GNSS/IMU di basso costo per scopi cinematici. *Bollettino della SIFET*, 08(3), pp. 75-90.

References from Other Literature:

Corongiu, M., Galetto, R., Rossi, M., & Spalla, A. 2006. Cartografia numerica per i database topografici e il 3d city model dei centri storici. Proceedings of SIFET congress, 14-16 June, Castellaneta marina, Taranto.

Guo, Y., Du, Q., Luo, Y., Zhang, W., & Xu, L. 2008. Application of augmented reality GIS in architecture. In: *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences,* ISPRS Congress Beijing, vol. XXXVII, Part B5, Commission V, pp. 331-336.

References from Websites:

Döllner, J., H. Kolbe, T., Liecke, F., Sgouros, T., & Teichmann, K. 2006. The virtual 3D city model of Berlin - managing, integrating and communicating complex urban information. Paper presented at the 25th International Symposium on Urban Data Management UDMS in Aalborg, Denmark, 15-17 May. http://www.citygml.org/1535/ (accessed on September 2009).

Guearnieri, A., Pontin, M., & Vettore, A. 2003. L'evoluzione dei sistemi mobili multisensore. Paper presented at 7 ASITA conference, Verona 28-31 October .

http://88.41.139.89/cartografia/eventi/7confNazAsita/cd/Pdf/FIN180.pdf (accessed on August 2009).

Ellum C. M., & El-Sheimy, N. 2001. Portable Mobile mapping. Paper presented at International conference 'New Technology for a New Century', FIG Working Week 2001, Seul, Korea 6-11 May. http://www.fig.net/pub/proceedings/korea/abstracts/session14/ellum-elsheimy-abs.htm (accessed on August 2009).

(about Blom models) http://www.blomasa.com/blom-information-services/imagery-models/blom-3d-textured-city-map.html (accessed on September 2009).

AA.VV, 2009. BLOM has completed first forty high quality 3D models of cities throughout Europe. http://www.blom.no/en/news/news-archive/2009-05-27 (accessed on September 2009).

(About GDEM) http://asterweb.jpl.nasa.gov/gdem.asp (accessed on September 2009).