Highway Damage Information Communication System by GPS-aided Handset under Earthquake Disaster

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1. INTRODUCTION

It was empirically crucial learning for us from the Great-Hanshin Earthquake Disaster that to estimate and assess critical damage over the highly urbanized area for restoration measurements be not necessarily sufficient. Disaster information from severely stricken area and the programs using several pieces of its information for the first administrative task force are highly needed. Although Institute of civil Engineering of Tokyo Metro. Govt. have been developing the Disaster Assessment System against Strong Local Earthquakes beneath Tokyo Metropolis since 1992, the system hadn't any means of acquiring actual/crude disaster information. Nowadays collecting positioning data by handset GPS/mobile communication devices are becoming popular in Japan. This paper presents the concept of communication system for disaster information as well as field test results of two types distributed GPS-aided system. Besides the system's primary purpose of mitigating earthquake disaster on the basis of several types of scenario, countermeasures/aid operation derived from combining disaster estimation results and on-site highway disaster information will be fully enabled.

2. DISASTER ASSESSMENT SYSTEM

This GIS-based system is, in general, expected to contribute a series of four primary actions as follow: (1) to simulate several types of disaster with fundamental variables such as the distance to the earthquake fault, epicenter, focal depth and so on, (2) to assess and mitigate its damage condition during minimal time just after an earthquake occurred, (3) to verify a set of feasible alternative plans to alleviate a deteriorated standard of living with effective and speedy administrative early-stage activities, (4) to provide rational and reasonable information for maneuver to settle confusion in the aftermath of earthquake.

The proposed system achieves above requirements with its basic functions, the system also has the advantages in respect of evaluating functional disorder for highway transportation system. The function have been enabled especially by not only evaluated every choropleth damage such as buildings damage, victims, evacuees and so on but also estimated traffic demand related with malfunction service of utilities, vehicles/trucks volume on damaged highway network and the maximum highway network flow capacity employed by the traffic assignment theory. The assessment of the deteriorated transportation system will be applied to draw up transportation management plans, restoration measures and many earthquake-proof projects. **Fig-1** shows the System's outline.

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3. DISTRIBUTED SYSTEM CONCEPT REVIEW[1)]

(1) SnapTrack™

Most conventional commercial-based GPS-aided user positioning system performs four primary acquisition processes. These processes, however, are very time-to-first-fix consuming and power dissipating especially in case of weak signals GPS receiver has acquired. SnapTrack, now position/location subsidiary of QUALCOMM CDMA Technologies (QCT), has developed a distributed server-aided DSP (Digital Signal Processing)-based processing approach to improve this problem of locating wireless communication devices in 1995[2)]. The SnapTrack™ server-aided system architecture (also known as Wireless Assisted GPS) distributes the four primary functions between a GPS reference receiver, a location server and a wireless GPS-enabled device (handset) described in **Fig-2**[2)]. NTT DoCoMo, Inc., technically cooperating with NEC Communication, Inc., provides DLP (DoCoMo Location Platform) service employing SnapTrack™ technology for mainly public agencies/private enterprises to evolve business with

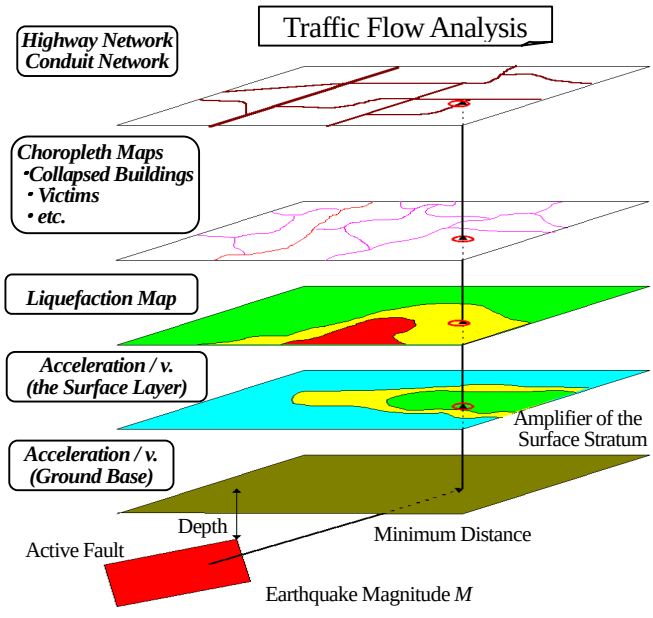

Fig-1 Idea of The Proposed Disaster Assessment System

positioning/tracking information of security, logistics, cab/bus transport, police activities, medical care services and so forth. DLP service drawn from the SnapTrack™ technology is deployed in DoPa (DoCoMo Packet) network.

(2) gpsOne™

In 2000, using proven A-GPS-based technologies, QCT has developed anew position location technology, combined A-GPS technologies with auxiliary positioning information derived from wireless network, to provide an optimized position location solution in Universal Mobile Telecommunications System (UMTS) network category (also Global System for Mobile Communications network (GSM) and General Packet Radio Services network (GPRS), known as 2/2.5G mobile telecommunication system). This combination of satellites and terrestrial-based technologies, referred to as "hybrid" positioning, provide accurate and higher-availability positing solution where new location management unit/equipment isn't required. KDDI, Inc. takes precedence over adopting the technologies for ordinary cellular phone users to provide position location information (also known as "eznavigation" service by "au").

4. GIS WITH GPS-AIDED SYSTEM CONCEPT

Some essential differences in basic concept of the wireless assisted-GPS communication system between by SnapTrack™ and by gpsOne™ are not important. External Application and its interface, shown in Fig-2, play key role to compensate the differences between the two technologies through communicating on-the-ground information of disaster.

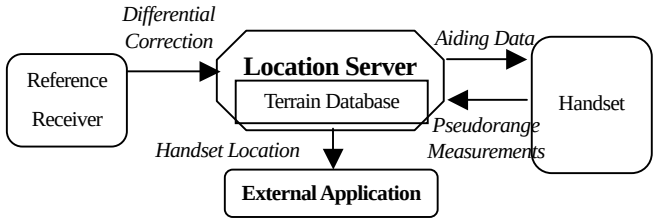

Fig-2 Concept of SnapTrack™

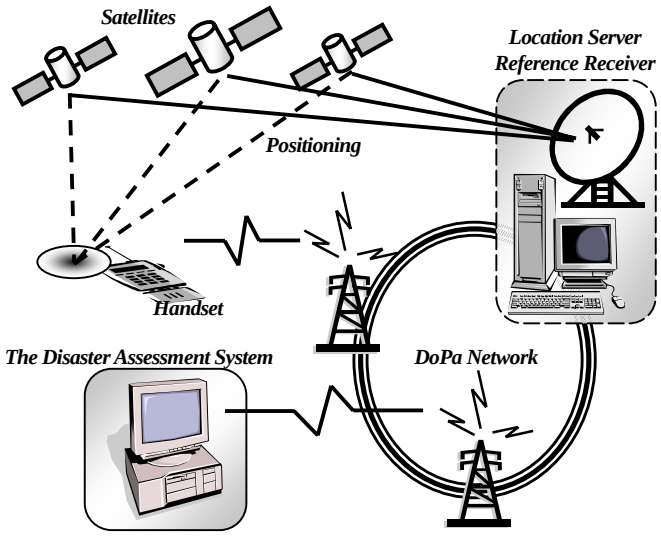

Fig-3 The Damage Information Communication System

Since the proposed Disaster Assessment System depends on latitude-longitude coordinate system in accordance with Japanese Geodetic Datum, to treat on-site disaster information through the system can be practical by means of complementally developing a subprogram both to log on to the location server in DoPa network (also in eznavigation service) and to download the damage status with its position information from a location server.

The subprogram consists of two parts: one is the process of mathematically transforming the acquired location information from WGS84 to Japanese Geodetic Datum, and the other is the process to let on-site disaster information recognize to the System accordance with the damage status. The status is extraneous integer number established on the basis of infrastructure types (especially highways and bridges) and the degree of damage. Since location acquisition process is automatically carried out simultaneous with handset operation, handset operation is only to dispatch the damage status to location server using the push-buttons upon itself. The Fig-3 shows the formation of the System applied by DLP service (SnapTrack™ technology).

5. FIELD TEST RESULTS AND EVALUATION

Field test of the damage information communication system employing DLP and eznavigation service has been respectively carried out as a part of the Metropolitan Disaster Fighting Drill on Sep. 1st, 2002, at Nerima ward in Tokyo. It was field experiment whether the proposed System can exactly accumulate pseudo damage status of highways with each location information and whether the handset can transmit accurate information.

As the result of rudimentary trials, the proposed System, arranged at an elementary school, has acquired reasonable pseudo damage information dispatched from a distance by trainees as the enrolling members of the homing drill. The positioning precision and comparative study of characteristics between the two technologies are simply summarized in **Table-1**. This communication system particularly has the indispensable feature of not being affected by the places/time/number of units the System operates at/on/with. Exactly the same on-the-ground information with its location is available without any difficulty.

Table-1 Characteristics of The Two Technologies

	DLP	eznavigation
Convenience (Accustomed, Portability)	△	◎
Reliability (Non-Congestion)	○	×
Deployment	○	○
Positioning Accuracy	approximately 10m	
Feasible Transmission Volume of Status	◎	△

References

1) QCT, Inc., Location Technologies for GSM, GPRS and UMTS Networks, 2003.

2) SnapTrack, Inc., An Introduction to SnapTrack™ Server-Aided GPS Technology, 1999. Both are from http://www.snaptrack.com/