Development of Rural Emergency Medical System (REMS) with Geospatial Technology in Malaysia

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Abstract. Emergency medical services are dedicated services in providing out-of-hospital transport to definitive care or patients with illnesses and injuries. In this service the response time and the preparedness of medical services is of prime importance. The application of space and geospatial technology such as satellite navigation system and Geographical Information System (GIS) was proven to improve the emergency operation in many developed countries. In collaboration with a medical service NGO, the National Space Agency (ANGKASA) has developed a prototype Rural Emergency Medical System (REMS), focusing on providing medical services to rural areas and incorporating satellite based tracking module integrated with GIS and patience database to improve the response time of the paramedic team during emergency. With the aim to benefit the grassroots community by exploiting space technology, the project was able to prove the system concept which will be addressed in this paper.

1. Introduction

Emergency medical services are dedicated services responding to sudden and unexpected events, and providing out-of-hospital critical medical care to illnesses and injuries patients with the aims of effectively treating the conditions, or arranging for timely removal of the patient to the hospital. In Malaysia, the problem with which medical emergency services are always confronted is late arrival or response time of the service to the patient’s site. The main cause was the unfamiliarity of the road network and the expansive ranges especially in rural areas. Other shortcoming includes the lack of utilization of mobility facility, and the difficulty in searching the patient database since most of records are still not in digital form and computerized [1]. An efficient Emergency Medical System (EMS) is essential in order to improve the service quality during emergency occurrence. An ideal EMS should be capable to provide real-time information and tracking of patient as well as paramedic team (ambulance), and a comprehensive database system to trace the records in a faster way.

The application of space and geospatial technology such as satellite navigation system and Geographical Information System (GIS) have been used and proved in enhancing the emergency medical service operation in many countries. Those technologies have showed the significant improving on the communication and time consume during the emergency. Several studies and researches have been conducted worldwide to improve the existing emergency medical system. Gulden et al. [2] have pointed out that the use of desktop GIS software can assist in emergency

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medical services by decreasing the transport time on ambulance to efficiently find a hospital for a patient while Alsallouma et al. [3] proposed an emergency vehicle location model to plan optimal ambulance location distribution. Meanwhile, Project E-vita [4] has been developed as a commercial product in the market of Healthcare management systems and electronic patient records. This system architecture is shaped to simplify the recording of all patient encounter history data in one easy to use browser based patient record.

In collaboration with a Malaysian medical service NGO, the National Space Agency (ANGKASA) has developed a prototype Rural Emergency Medical System (REMS), by incorporating satellite based tracking module and GIS technology. This paper presents the overall system set-up comprising the patient component, control centre and paramedic despatch component.

2. Development Overview
The development comprises two main activities: Analysis/Design and Prototype Development. During the Analysis and Design stage, discussions and engagement with the Malaysian medical service NGO have been conducted for the purpose of understanding the actual needs and requirements to the existing practices in emergency service. Input from the discussion has assisted in improving the conceptual design of REMS.

The Rapid Application Development (RAD) is used as software development technique in this project. The technique focuses on building applications in a very short amount of time. It creates iterative customizations while at the same time involving users directly, until users agree with the prototype development. The life cycle of application development becomes faster with better quality output compared to the traditional method [5].

The next component of the development is to consider the communication protocol between the information send from the geo-locator and the recipient of the information. In REMS this is translated as sending the information between the patient and the Emergency Despatch Centre (EDC). At the control centre (EDC) the system utilizes the Google Map API capability to interface the base map with Relational Database Management System (RDBMS) which manages the patient records. Table 1 shows the summary of the development approach for the prototype REMS.

| No. | Activity                  | Approach                           | Deliverable                                      |
|-----|---------------------------|------------------------------------|-------------------------------------------------|
| 1.  | Analysis and Design       | i. REMS capability review          | GPS personal device, Conceptual design, Overall architecture |
|     |                           | ii. Engagement with Medical Services NGO |                                                  |
| 2.  | Prototype Development     | i. RAD methodology                 | REMS prototype                                   |
|     |                           | ii. Communication protocol between the device and the receiver. |                                           |
|     |                           | iii. Google Map API capability as an interface and base map |                                           |
|     |                           | iv. Visual Studio technology to develop the engine. |                                           |
|     |                           | v. RDBMS for data management       |                                           |
3. Hardware and Software Specification

The geo-locator used in the prototype system (figure 1) consists of two different types of Global Positioning System (GPS) personal device equipped with latest GPS chips and capable to achieve five meter accuracy. The model called WT100 and TK333 supports GSM and GPRS communication and has two way talking function with SOS button. Besides this, the device has the ability of anti-jamming where it could filter useless and irrelevant character around the control commands and data packets.

![Figure 1. Geo-locator personal device Model: WT100 and TK333.](image)

The system web control panel was developed using Notepad++ and PHP as the programming language utilizing the Google Map API capability. PHP is an open source server-side scripting language designed for web development to produce dynamic Web pages. To receive the information signal and location from the geo-locator, back-end engine is developed by utilizing the Visual Studio.Net. Table 2 shows the summary of software utilized.

| No. | Item | Specifications |
|-----|------|----------------|
| 1   | PHP  | To develop the web panel for tracking and tracing applications. Act as an engine for control center web panel to track and trace the patient. | License: Free software (Open source) Operating system: Cross-platform Language: PHP |
| 2   | Visual Studio.net | Platform for engine development. To Extract Signal sent by GPS device, convert and push the signal into database. | Operating system: Windows Language: C# |

4. System Architecture

Figure 2 illustrates the prototype system architecture of REMS that consist of the following components: geo-locator personal device to provide location information of registered patient in real time mode; Emergency Despatch Centre with database server to receive, store, process and analysis data; and the Paramedic team. The first component, the Report Sub-system, performs the task of sending the signal with ID patient time and location from the geo-locator personal device to the Emergency Despatch Centre. The geo-locator will receive reply from the Centre with info on estimated arrival time of paramedic team to the patient site.
The second component is able to receive; trace and assign the despatching team. The system will perform the following tasks:

a. Receive signal from patient and identify the exact location via map viewer.

b. Trace the patient records from database server.

c. Provide instruction to the paramedic team based on the medical history record, location of the patient and the fastest route to the site.

d. Track the movement of field ambulance from the centre to patient site.

e. Receive and send a report to/from field ambulance from time to time.

The final component, Tracking Sub-system, is installed in paramedic team to identify the patient record through mobile platforms and estimate the time arrival to the patient site as well as to the nearest hospital. In this prototype MySQL is used as the database management system due to its robustness and flexibility to handle various emergencies and does not crash when error occurs. The web tracking application is set to refresh over certain time interval to select latest signal send in to the MySQL database.

5. Conclusion
The study of the existing emergency medical service in Malaysia showed the absence of utilizing mobility facility and geospatial technology. These technologies can bring significant impact to the quality of medical service to the public. A prototype Rural Emergency Medical System (REMS) which incorporate satellite based tracking module, Geographical Information System and patience database has been designed and developed with the aims to improve the emergency medical service in the country.

References
[1] Hameed S A, Zahirul A, Nuh N C, Salim N H B 2010 Integrated medical emergency model: An interactive web-based database. International Conference on Computer and Communication Engineering (ICCCCE), 2010 ISBN: 978-1-4244-6233-9

[2] Gulden B, Muncuoğlu E and Baykal N 2004. A GIS system for ambulatory transportation. In B. Tilg, (Ed.), Biomedical Engineering (pp. 417-817). Innsbruck, Austria: Acta Press.

[3] Alsallouma O I and Rand G K 2006. Extensions to emergency vehicle location models. Computers & Operations Research, 33(9), 2725–2743.

[4] E-vita, http://www.projectevita.com/products/what_is_pe.aspx

[5] Rapid Application Development http://www.casemaker.com

[6] GPS personnel device Model: T100 and TK333, http://topten800.en.made-in-china.com

[7] SMS & GPRS Communication Protocol for model T100 and TK 333. 2013. Hybrid Connection Sdn. Bhd. Malaysia