

PARTICIPATORY WEB GIS FOR REAL TIME DEMINING MAPPING WITH GPS ENABLED REMOTELY CONTROLLED PLATFORMS

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ABSTRACT

Landmines stay as a main obstacle to economic and social development for many developing countries all over the world. When a war comes to an end, the areas where landmines have been laid have to be cleared for human relocation. therefore developing and testing new technologies for demining is a vital process which should be carried out by the landmine infested countries. This research was carried out to develop a software solution to store information about landmines and areas covered into a GIS database and to control a remote controlled robot. A Web GIS was developed to display the information of the detected landmines. In this research the Web GIS is a participatory approach to collect and analyze geographical information on human-environment interactions. Core module of the system will do the transmission of detected locations of landmines to mobiles and GPS enabled Personal Digital Assistants (PDAs) via Short Messaging System (SMS) to update the community who lives or travel on the landmine contaminated areas.

1.0 INTRODUCTION

Today various research groups and commercial companies have come with efficient and effective demining solutions by using the cutting edge technology. But most these projects are mainly focus on the areas of detection and removal of landmines. Existing demining projects have some limitations with the integration of GIS technology while they are very handy to detect and remove landmines. These systems have limited GIS functionality with real-time Web GIS mapping with the position of the robot position and the locations of detected landmines.

The main objective was to build a software solution and a GPS enabled mobile robotic platform to extract the landmine positions into a GIS database and to a participatory Web GIS. This paper only describes about the Web GIS component of the research. Web-based GIS solutions can be used for humanitarian demining projects as well the military applications. Humanitarian demining projects can update the positions of the detected landmines and the cleared areas of mine fields on Web GIS to update the community via internet. A research paper was presented about the same research on ACRS 2008, which was concentrated on the software solution which was developed to control the GPS enabled robot and to extract the positions of the detected landmines.

2.0 METHODOLOGY

A simple remotely controlled platform was developed to detect landmines and to store the positions into a GIS database. Then the same GIS database is accessed by the Web GIS which was developed to use as a participatory GIS to update the community with the landmine contaminated positions.

Mainly in this system three active users are engaged.

Robot Controller - Robot controller is the administrator of the system. He controls the robot by using the controlling software.

Web User - Web user is the user who login to the Web GIS and updates the mine accidents and demining accidents.

Mobile User - Mobile is the user who gets SMS that contain the location information of the detected landmines from the main system. The mobile user has to be registered with system to receive SMS.

2.1 Remotely Controlled Robot

Remotely controlled robot will be able to detect a landmine with its sensor and transmit the location to the system. Then system will update the landmine position in the GIS database. This robotic platform is remotely controlled and the position of the platform will be mapped in real-time.

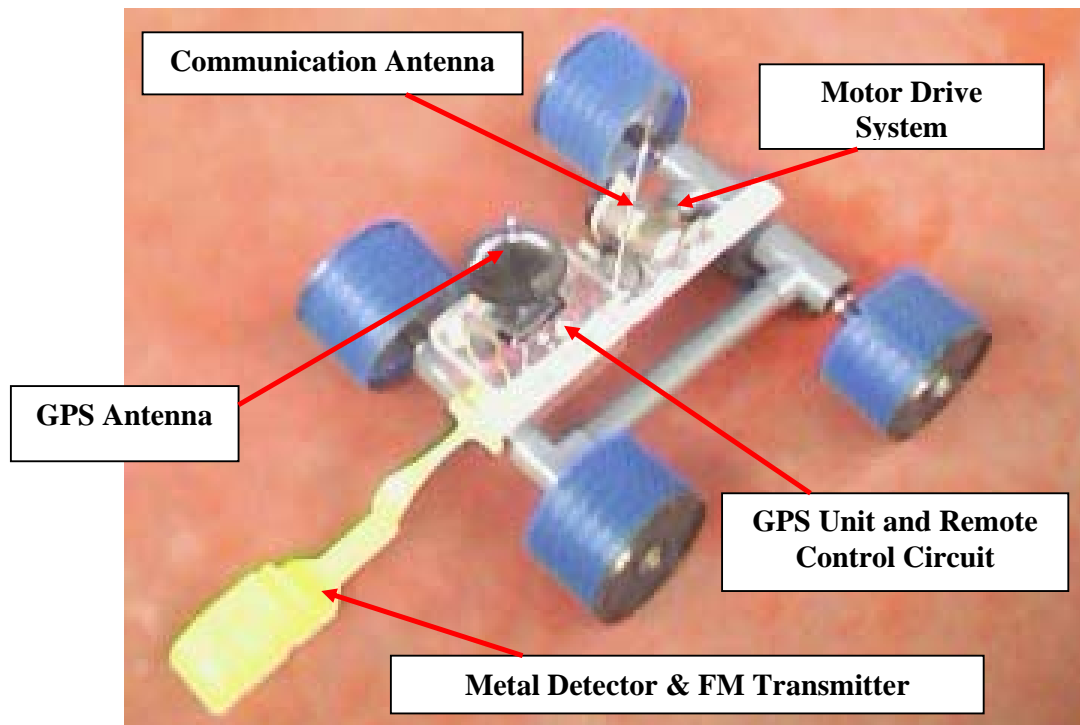


Figure. (1) The Remotely Controlled Robot Which Was Developed For The Research.

2.2 Web GIS Integration

Web GIS should be capable of getting input from the community also. Two layers are reserved for the community who uses the participatory Web GIS to update the mine accidents and demining accidents.

2.3 Storing A Landmine Position

When the metal detector of the robot detects a landmine then the metal detector sends a signal to the FM transmitter. Then the FM transmitter emits a radio signal. Then the FM radio circuit which is attached to the controlling PC/Laptop receives the signal and the controlling software identifies the current position of the robot as a landmine contaminated point. Then the system will add a point feature to the GIS layer which is reserved for landmines. This point feature has attributes such as identification number, latitude, longitude, altitude and the time of detection. The process of storing a position of a detected landmine is illustrated in Figure.(4). The database table structure of the landmine GIS layer is as follows.

Table 1 Database Table Structure of the Landmine GIS Layer

Field Name	Data Type	Description
POI_ID	Integer	Identification Number
POI_Latitu	Double	Latitude of the Position
POI_Longit	Double	Longitude of the Position
POI_Altitu	Double	Altitude of the Position
POI_Time	Date/Time	Time of Detection

2.4 A Participatory Web GIS & Data Transferring To Mobile Phones

This is to check and visualize the landmines detected by the robot. Robot is updating the positions of the database and the Web GIS is able to display the detected landmines. System can be used to locate demining accidents and the mine accidents. The System can SMS the positions of the detected landmines to a mobile phone via SMSs (See Figure. (2)).

The web user can update the Web GIS with information of mine accident and demining accidents of their environment. This information should have a proper validation otherwise the administrator can clear the updated information from community (See Figure. (3)). The community can participate actively to support demining projects by using the Web GIS. The system will send the landmine information to registered mobile users.

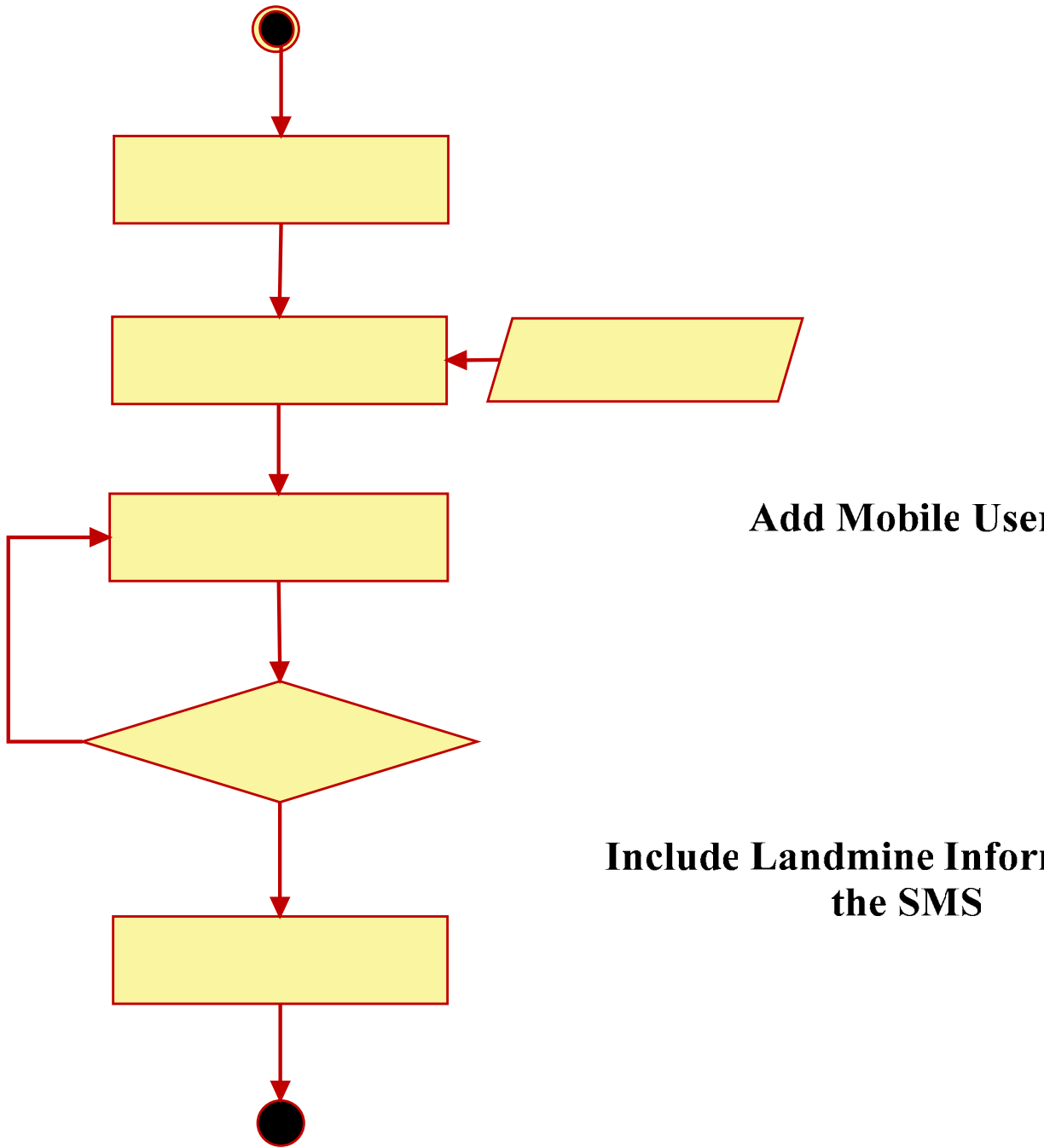


Figure. (2) The Activity Diagram for Sending Positions of Landmines to Mobile Users via SMS

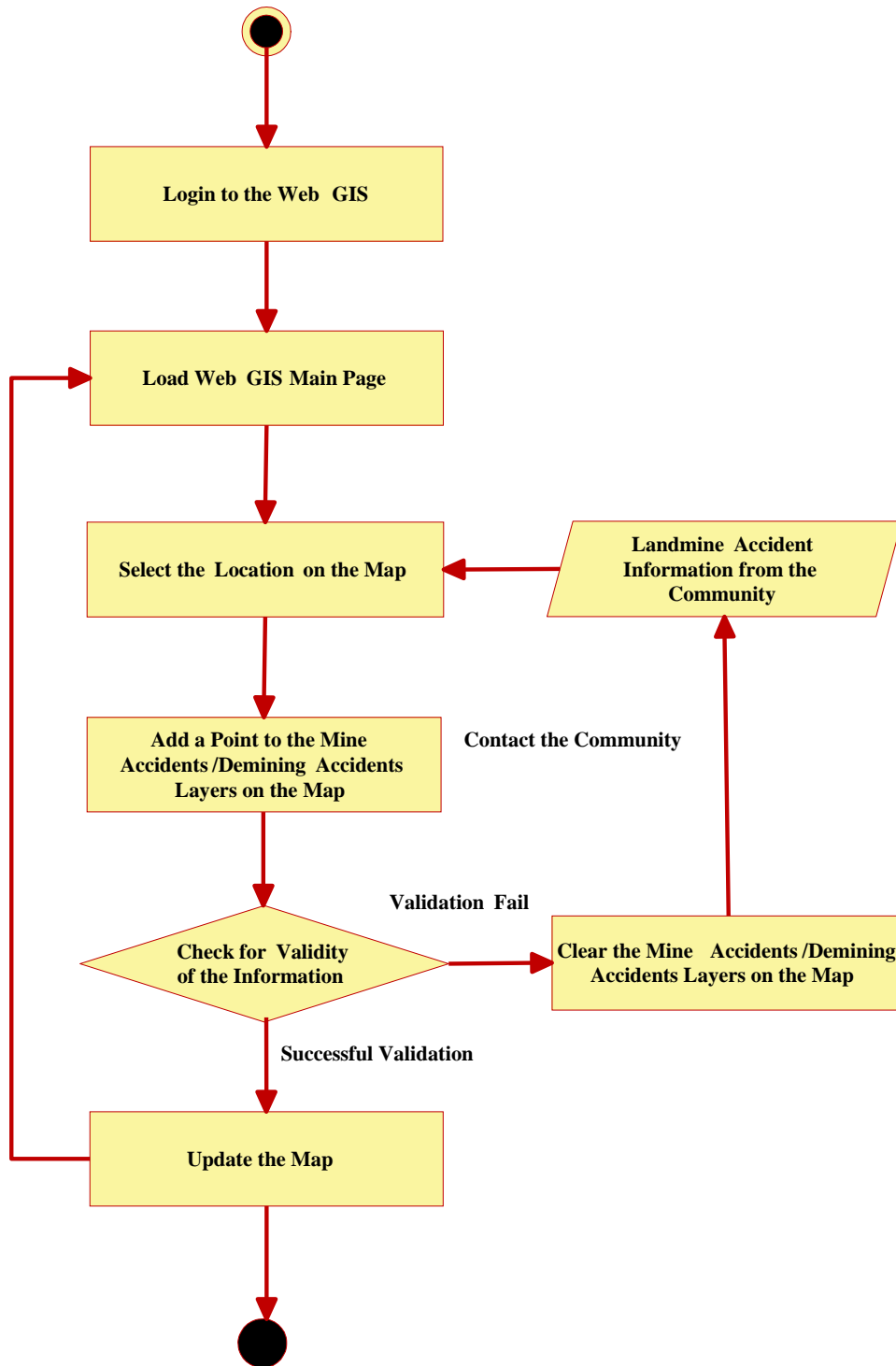


Figure. (3) The Activity Diagram for the Participatory GIS (PGIS) Approach

3.0 RESULTS & DISCUSSION

Web GIS is able to display the same GIS layers, which were used for the controlling software of the robot. Additional two layers were introduced Web GIS. Web GIS system is consists of three main web pages. The Login Page is the stating page of the Web GIS. First the web user has to log into the system by using the given username and the password. After logging to the system, the user will be redirected to the admin page After that the user can select one option out of two options. The user can continue to the Web GIS system or the user can logout from the system by clicking appropriate button control on the web page. When the user click on the button “Continue to Web GIS” then the user will be redirected to the Main page of the Web GIS system. The user can find four main parts of the page. Map area for displaying the GIS map, Map functions with a checklist, button controls and checklist for viewing the GIS layers .

3.1 Map Functions of the Web GIS System

Basic map functions are allowed in the Web GIS. Zoom In, zoom out, identifying a feature of a selected GIS layer and adding a point to the mine accidents layer or to the demining accidents layer. Map functions are placed on the web page by suing a checklist. If the user wants to do one of the functions in the checklist, then user has to check a selection and perform the map function.

- Zoom In - Zoom the extent of the map around the point of the muse click on the map.
- Zoom Out - Zoom out the extent of the map around the point of the mouse click on the map.
- Identify - Identifies the feature of the selected feature of a GIS layer.
- Add Point - Adding a point to the selected layer from the GIS layers for mining accidents and demining accidents.

3.2 Participatory GIS for updating Mine Accidents

The web user is able to update the GIS layers called “Acci” and “DmAc”. The layer called “Acci” is reserved for entering mine accidents. “DmAc” is reserved for entering demining accidents. This facility can be used to educate the community about the landmine contamination and the community can update the mine accidents in their environment. Demining accidents can be updated by communities or organizations, which are engaged in demining projects.

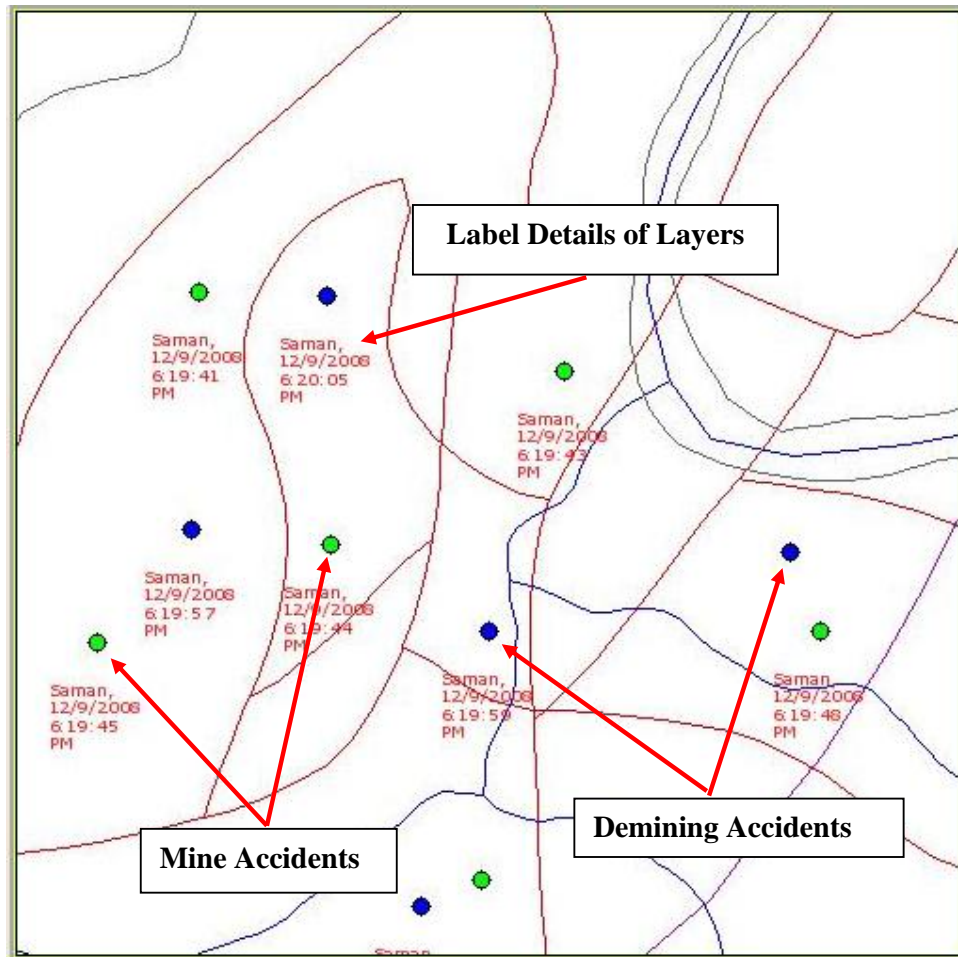


Figure (4) Updating the Mine Accidents Layer and the Demining Accidents Layer

If the administrator wants to clear the mine accidents layer or the demining layer as a modification, then user has select the appropriate point layer and click on the button called “Clear Active Point Layer”. Then the system will clear the selected point layer. This operation can be done only on point layers of mine accidents and demining accidents. Any other user except the administrator of the Web GIS system cannot clear the layers of mine accidents and demining accidents.

3.3 Updating the Community Via SMS

The system will send the detected positions of the landmines of the area via SMS's to the registered mobile users of the system. This part can be developed with GPS enabled mobile phones with ability of uploading the GIS maps with the detected landmine positions.

4.0 CONCLUSION

Integration of GIS and GPS technology for demining is helping to create a useful database which will contain the information of landmines and unexploded ordnances (UXOs).The GIS database can be populated with the following important information

- Hazardous sites with detected landmines or UXOs.
- Where mine accidents or demining accidents occurred.
- Suspected landmine contamination areas.
- Land already cleared.

Decision makers of the demining projects can decide the most important areas to be demined by analyzing the GIS data .Analysis of the GIS data will be based on the factors like most accidents are occurred ,where the most people are affected by the problem and the most number of landmines are detected. This will help to make a prioritization index for the unclear areas. The prioritization index will help to get the decision when and where to start the demining project.Integration of a GPS with the robot system will help to map the position of the robot on the GIS map. When the system detects a landmine or an UXO system will send a signal to store the position into the GIS database. The robot system can be easily navigated on the terrain by looking at the GIS layer which is reserved for the robot on the GIS map. This layer is updated in real-time by using the GPS data which transmitting from the robot in real-time. Real-time GPS data collection will increase the efficiency of demining mapping. This project could be viewed as a low cost simple system to detect landmines and locate them in a localized map. Users can access the locations of the detected landmines by using a desktop application / web based application. The robot used in this project is of very primitive type and as further developments the robot can be developed to a state, which it is capable of de-mining the detected landmines.

5.1 FURTHER DEVELOPMENTS FOR THE SYSTEM

- **Neural Networks to Analyze the Spatial Distribution**

If the system can use a neural network model to analyze the spatial distribution of landmines as well as other human-environment interactions such as mine accidents to build a prioritization index for mine clearance then the efficiency of the system will be increased.

- **Automated Navigation Capabilities**

In this project, the robot is navigated manually giving the commands by the user by using the control panel of the software which is used to control the robot. The robot can be developed with the capability to move from one place to another place by giving only the coordinates. Efficient navigational algorithms can be used to improve the mobility of the robot.

- **Using Efficient Coverage Algorithms**

Robotic platform coverage is the problem of moving the sensor to detect landmines over all the points in a given landmine contaminated area. Usage of an efficient coverage algorithm will optimize the coverage path and minimize the cost and time. Then the system is responsible for covering the whole area given for demining in a reasonable time.

- **Integration of Remote Sensing Technology**

Presently the system will up on the framework of existing GIS layers. If the System can use geo-referenced remotely sensed images like satellite images or air photos then the detected location of the landmine can be mapped more accurately. Then the position of the robot can be also mapped more accurately on the map. Then navigational functionalities of the robot can be done more accurately.

- **Standardized Map Symbols for Demining Mapping**

Map symbols are important in humanitarian demining projects because various map symbols are need for displaying the many categories of landmines, mine fields, mine accidents and demining accidents. Map symbols used in these projects are not standardized symbols, which are using for demining projects. Symbols, which are using to display landmines, land mine and demining accidents, can use standardized symbols. This will be useful when the database is using for humanitarian demining projects where many number of organization are working for a common goal. This will increase the quality and the standards of the project.

REFERENCES

Directions Magazine. [Electronic version]. *Landmines - GIS Helps Harvest the Dragon Seed.* . Accessed July 22, 2008. <http://www.directionsmag.com>.

Electronic Mine Information Network. [Electronic version]. *Kosovo Landmine Impact Survey.* Accessed May 10, 2008. <http://www.mineaction.org>.

ESRI ArcWatch July 2008. [Electronic version]. *Bomb-Sniffing Dogs, Mine Detection Equipment, and GIS.* Accessed July 30, 2008. <http://www.esri.com/news/arcwatch>.

Military Intelligence Professional Bulletin, [Electronic version]. *NGIC uses web-based visualization technology to inform soldiers of minefield locations in Afghanistan.* Accessed August 20, 2008. <http://findarticles.com/p/articles>.

NMEA0183. [Electronic version]. *Wikipedia free encyclopedia.* Accessed August 22, 2008. http://en.wikipedia.org/wiki/NMEA_0183.

Kruger, H., Ewald, H., Fechner, T., Bergeler, S., Advanced signal processing for reduction of false alarm rate of Metal detectors for humanitarian mine clearance, IEEE-IMTC 2006 – Instrumentation and Measurement Technology Conference Sorrento, 1452-1456.

De Silva, C.W. (2007). Book on Mechatronics, 2250-2280.

IRobot Coporation. [Electronic version]. *PackBot.* Accessed August 20, 2008. <http://www.irobot.com/sp.cfm?pageid=326>.

IRobot Coporation. [Electronic version]. *Warrior t.* Accessed August 20, 2008. <http://www.irobot.com/sp.cfm?pageid=150>.

Demining. [Electronic version]. *Wikipedia free encyclopedia.* Accessed July 20, 2008. <http://en.wikipedia.org/wiki/Demining>.

Landmine. [Electronic version]. *Wikipedia free encyclopedia.* Accessed July 22, 2008. http://en.wikipedia.org/wiki/Land_mine.