A SMS-BASED INTELLIGENT DISASTER ALERT SYSTEM

Abd. Samad Hasan Basari[1], Amni Mohamad Zain[2], Nuzulha Khilwani Ibrahim[3], Norzihani Yusof[4], Siti Azirah Asmai[5]

[1,2,3,4,5]Faculty of Information and Communication Technology,
Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya,
76100 Durian Tunggal, Melaka, Malaysia

Email: [1]abdsamad@utem.edu.my, [2]nuzulha@utem.edu.my,
[3]amnimohamedzain@yahoo.com, [4]norzihani@utem.edu.my,
[5]azirah@utem.edu.my

ABSTRACT

A SMS-Based Intelligent Disaster Alert System (IDAS) is an expert system in helping geologist to predict disaster incidences. The disaster includes flood, earthquake, hurricane, drought and tsunami. If disaster is predicted, an alert based on possible disaster area will be sent to the residents via mobile device i.e. Short Messaging System (SMS). The system is developed by utilizing Artificial Intelligence (AI) techniques of Rule-Based, Decision Tree Analysis and Guided Rules Reduction System. A Microsoft Visual Studio.Net and MySQL database are used as the software development environment while SMS technology is based on Global System for Mobile Communications (GSM) connected to IDAS. The case study was done at the area of Melaka Tengah, Melaka. A resident's information is stored in the database in order to send alert via SMS. Once disaster is predicted, SMS will be sent to their respective mobile phone.

KEYWORDS: *intelligent system, disaster, artificial intelligence.*

1.0 INTRODUCTION

Users expect the use of technology was a big help for them to ease the burden of their daily lives. The major drawback of the existing system is not very effective in conveying information and warnings to local residents when the occurrence of disaster. As we know, the current trend in information and communication technology (ICT) is changing very fast. Thus, the message will not be able to deliver in systematic way when warnings need to be sent to the residents. Furthermore, the system also faces time constraints in delivering information to local residents if the existing facility is not compatible. The last notes, but not least, the existing system has lack of forecasting facility to predict the coming disaster. Intelligent Disaster Alert System (IDAS) is developed to complement the existing system. The aim is to give early information about disaster occurrences at their places. IDAS is developed by utilizing rule-based expert system, decision tree analysis and guided rules reduction system as part of AI techniques.

2.0 OVERVIEW OF ALERT INFORMATION SYSTEM

This system is developed by referring two existing system namely, National Tsunami Early Warning System (NTEWS) and Global Disaster Alert and Coordination System (GDACS). A brief overview of the systems is discussed as follows.

2.1 National Tsunami Early Warning System

Following the occurrence of the tsunami that hit several Indian Ocean nations and Malaysia on 26 December 2004, the government of Malaysia has decided to set up a National Tsunami Early Warning System (NTEWS) available at *http://www.atsb.my/index.php/project/advanced-technology/ntews.html*. This system will ensure that an early warnings can be disseminated in the quickest and most effective manner to the people especially those residing at the coastal areas in the event of a tsunami posing a threat to the safety of the people and the country. It was implemented by the Ministry of Science, Technology and Innovations through the Malaysia Meteorological Department in 2005. Generally, this system comprises of three major components: Monitoring and Detection, Data Processing and Data Dissemination. Monitoring and detection of this particular system are Seismic, Deep Ocean Buoy, Tide Gauge and Coastal Camera Sensor and Network. ANTELOPE, a Seismic Processing System is used to compute the latitude, longitude, magnitude as well as the depth of an earthquake automatically. To ensure the accuracy of the result, a manual calculation is also carried out. The data dissemination components are using SMS, direct line (hotline), internet, telephone and fax. The earthquake and tsunami warnings are disseminated within 15 minutes of the occurrence. Radio Television Malaysia (RTM) and as well as other TV stations have also begun to live broadcasts on the earthquake information.

2.2 Global Disaster Alert and Coordination System

The Global Disaster Alert and Coordination System (GDACS) available at *http://www.gdacs.org/* provides near real-time alerts about natural disasters around the world and tools to facilitate response coordination, including media monitoring, map catalogues and Virtual On-Site Operations Coordination Centre. GDACS provides a platform allowing stakeholders in inter-national disaster response to exchange disaster-related information in a structured and predictable manner, particularly in the response phase of disasters. It is not aimed at informing the potentially endangered population. GDACS combines existing disaster information management systems, even if their accuracy is limited. Early information is expected to be uncertain and will be refined as better information becomes available. The features of GDACS are:

i. Near real time alerts or early warnings about sudden onset disasters, delivered by email, fax or SMS.
ii. Near real time automatic situation reports based on modeling and a prior information.
iii. On-line discussion forum for emergency responders (including Search and Rescue teams and humanitarian aid donors).
iv. Rapid situation reports based on field information.
v. Full integration with established news services.
vi. New mapping products based on post-disaster satellite imagery.

GDACS include disaster-prone countries which also establishes an awareness-building process among its stakeholders and promote capacity building in disaster-affected countries in order to facilitate their participation in the system. Since GDACS is an open concept to early warning and alert system, GDACS aims at establishing standards for quality and information exchange. This will allow users to compare similar systems. It will also allow seamless integration of the many existing disaster alert systems and relief information management systems. New and better systems will naturally replace early prototype systems. Even though NTEWS and GDACS are well developed and properly monitored by the respective authority, there are improvements need to be carried out. These includes the needs to store the most unsafe residential areas information especially their contacts, the needs to remind them about the current situations and the utilizations of AI to ease the information disseminations.

3.0 DESIGN OF INTELLIGENT DISASTER ALERT SYSTEM

In designing IDAS as an expert system, three AI techniques have been chosen. The techniques are rule-based, guided rule reduction system and decision tree analysis.

3.1 Rule-based

Rule-based is used to store and manipulate knowledge in a rules form to interpret information to be meaningful and understandable (Desa *et.al*., 2008). This technique is often used in AI application especially in expert system and research. In this system, rule based is the domain specific expert system that uses rules to make predictions (Yen and Wang, 1999). It might help geologist to predict whether disaster occurs and level of disaster in order to help resident to make early preparation. To predict disaster and level of disaster, those knowledge representation in the form of ruled-based symbols are essential for expert system (Szpyrka, 2008), (Holand *et.al*., 2006). A set of rules provided to the system based on the early sign of disasters.

3.2 Decision Tree Analysis

This technique is a decision support tool that uses a tree like graph of decision and possible consequences, including chances of outcomes (William, 1993). A decision tree consists of three types of nodes which are decision nodes (commonly represented by squares), chance nodes (represented by circles) and end nodes (represented by triangles). The purpose of using this technique is to predict level of disaster based on the rules. The information is provided based on experts describing a situation and their preferences of outcomes.

3.3 Guided Rules Reduction System

Since the system needs hundred of rules, some of the rules that give the same output will be deducted based on the guided rule-based reduction system (Kai and Lim, 2006), (Song and Smith, 2000). It means redundant output that comes from different rules will be eliminated. Thus, it can reduce the number of rules and improve the processing time.

Example is as follow:

Rule;

i. IF Rainfall is less than 1000mm AND Weather is Very Hot AND Level of Dust is High THEN Hazard
ii. IF Rainfall is less than 1000mm AND Weather is Hot AND Level of Dust is High THEN Hazard
iii. IF Rainfall is greater than 1000mm AND Rainfall less than 3000mm AND Weather is Very Hot AND Level of Dust is High THEN Hazard
iv. IF Rainfall is greater than 3001mm AND Weather is Hot AND Level of Dust is High THEN Hazard

Output: Hazard

As a result, rules number 2, 3 and 4 will be deducted and rule number 1 is selected. These three AI elements are the main engines to produce the type of notifications to the residents. In order to ensure the information gathered is adequate and relevant, a case study conducted to respective institutions and research papers are conducted. The information is essential to prepare the rules in representing the current situations and scenario.

3.4 Overall Structure of IDAS

Figure 1 shows the navigation flow of IDAS. The main part of this system is to predict disaster and classify what type of alert will be sent to the residents based on the given rules. In the first interface, user (administrator of the IDAS) must login into the system. This is to ensure only an authorized administrator can use IDAS and for security purpose. The second part is user have options of menu where they can choose to edit IDAS users, edit resident's information or choose the disaster menu either to predict or place the area of cases.

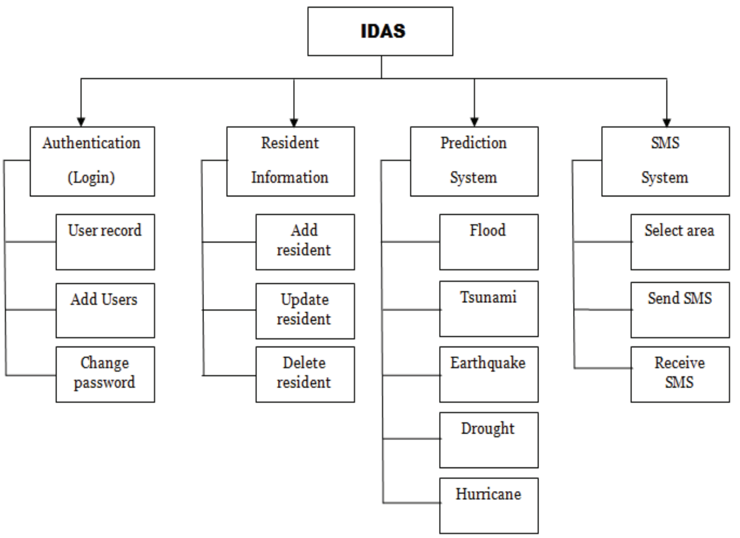

Figure 1 IDAS Navigation Diagram

Prediction and SMS system are included in the option menu. Using the prediction system, based on the given information, it will predict whether disasters will happen or not. If it happens, what type of alert need to be sent to the resident via SMS system. Finally, resident will receive an alert from the system in real-time basis via their mobile phone.

3.5 User Interface Design

Figure 2, Figure 3 and Figure 4 show some of the interface design of IDAS.

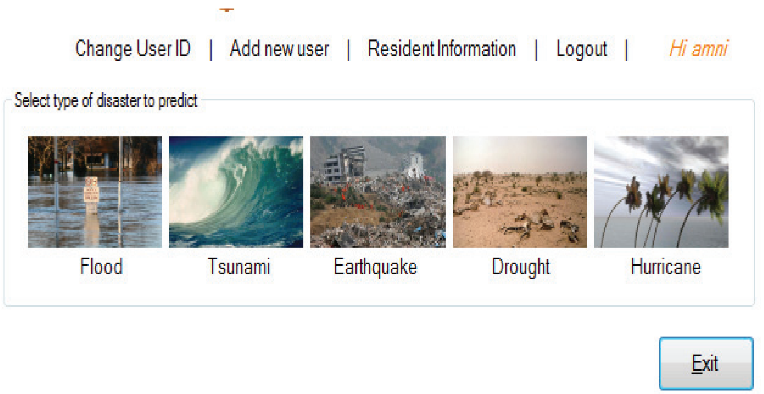

Figure 2 Main Menu Interface

In Figure 2, user as system administrator has to select one type of disaster to predict the disaster based on the rules given. They can also change user ID, add new user, view resident information which has an option to add, delete, update or search the information. In order to ensure the SMS is given to the right person system administrator needs to select area of resident before send the SMS. In Figure 3, the drop down menu facilities will allow user to select area before sending an SMS. Figure 4 shows list button that will display list of resident in selected area.

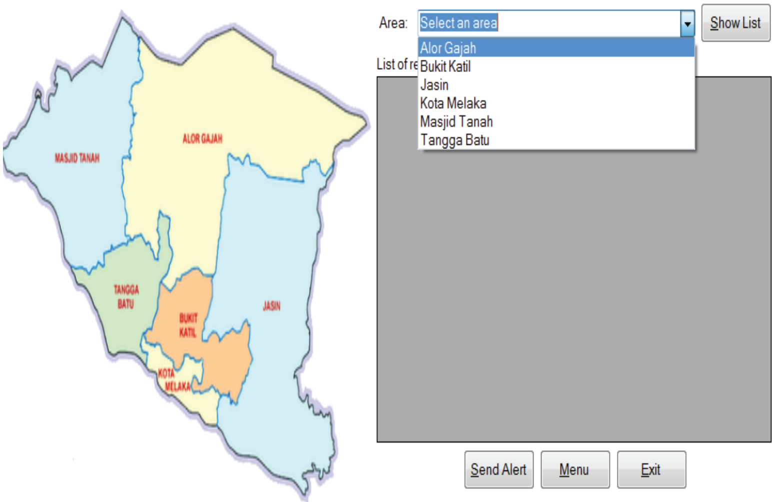

Figure 3 Resident Area Interface

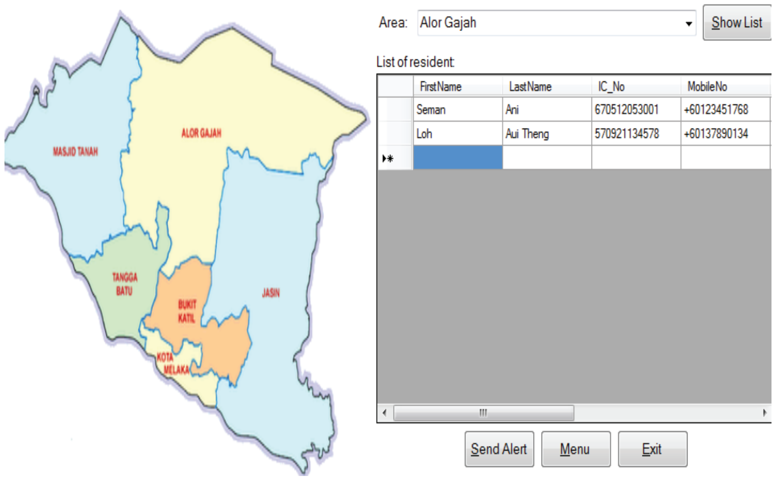

Figure 4 List of Resident in the Area of Alor Gajah Interface

4.0 SYSTEM DEVELOPMENT AND IMPLEMENTATION

The system is developed by using Microsoft Visual Studio.Net and MySQL database as software development environment. The SMS technology is applied based on Global System for Mobile Communications (GSM) connected to IDAS. In developing the flood forecasting procedures, Figure 5 shows an interface that will be used by the system administrator. This interface needs a user to input necessary information and select the rules. Then they have to forecast by clicking Forecast button. The result will appear similar to the output forecast in Table 1. By clicking the Alert button, SMS will be sent to the selected resident. The same concept applies to other Prediction System (Earthquake, Drought, Hurricane and Tsunami).

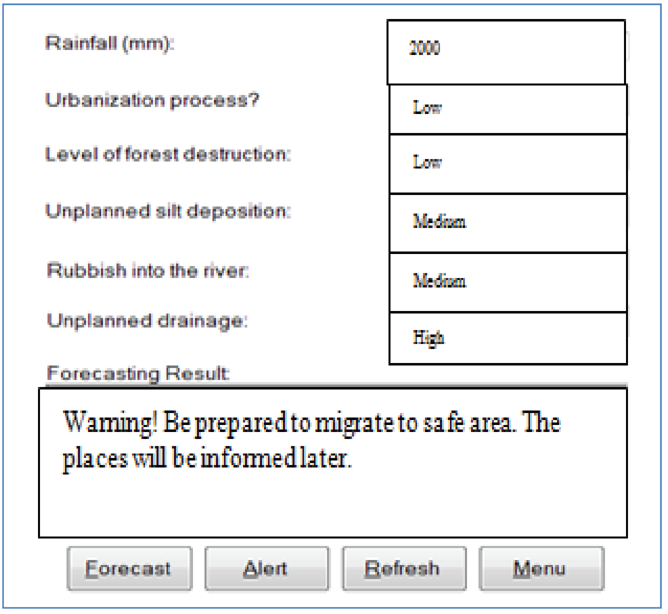

Figure 5 Flood Forecasting Interface

Example of output predicted for Hurricane alert is shown in Table 1.

Table 1 Sample Output Messages

Type of Messages	SMS Alert
Alert	Alert! Tropical depression was occurred. If the wind speed is increased in a continuous, tropical storms are predicted to occur.
Warning	Warning!! Tropical storm was occurred. You are suggested to take this actions: * Listen to radio and television broadcasts regular weather bulletins and other announcement * Take appropriate steps to avoid any damage and loss of life due to flood if that tropical storms hit continuosly * Beware of landslip incidents if driving in torrential rain in the highlands * If a tropical storm expected to hit your area, delivered all property that can be blown gale * Avoid going out to sea when tropical storm or hurricane approaches your area * Be prepared to evacuate if you live in coastal areas or near rivers
Hazard	Hazard!!! Hurricane was occurred. Please prepare yourself to move. You will receive instructions to move at any time due to the hurricanes hit

In order to view the SMS that has already sent to the resident, Figure 6 shows the interface. This interface shows recipient mobile numbers, message appears and time of receiving the messages. The main AI elements shall be the notifications according to the given rules. For examples if the notification is an alert the reminder should be every 2 days. In other scenario if the notification is a warning the reminder should be every day. Finally if the notification is a warning the reminder should be at least once for every 4 hours.

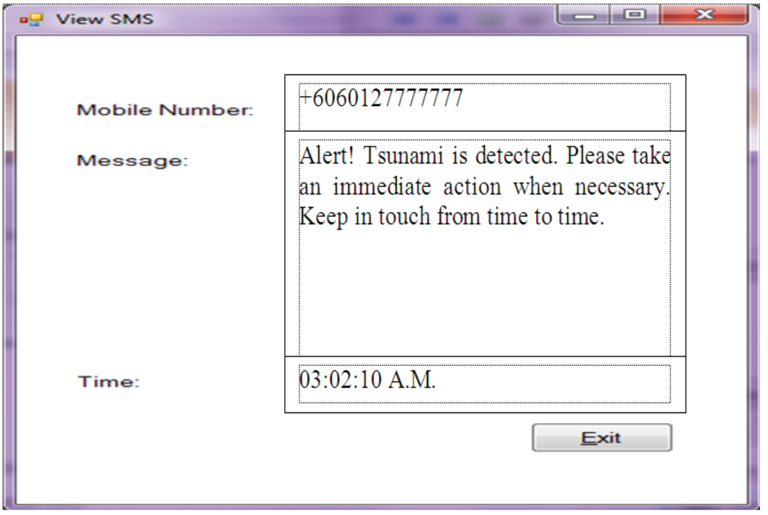

Figure 6 SMS Message View Interface

5.0 PRELIMINARY RESULT AND CONCLUSION

This research is aimed to develop a mobile and intelligent system, namely IDAS that has the ability to give immediate information to help resident do necessary action. To deal with the above-mentioned problem, the system is proposed. The case study demonstrates that methods discussed in this paper can improve the existing system and act as a complementary. To date, the system is in the implementation stages and basically the outcome is satisfactory. In future, IDAS will be tested and validated based on the given case study by using the real data gathered from the related agencies.

6.0 ACKNOWLEDGMENT

The authors would like to thank Faculty of Information and Communication Technology, UTeM for providing facilities and financial support.

7.0 REFERENCES

A. Holand, M. Fathi and S. Berlik, 2006, "Rule-Based Compilation of Graphical Structures" *IEEE International Conference on Systems, Man and Cybernetics*, Taipei, Taiwan.

E.M. William, 1993 "Decision Tree Analysis: Drawing some of the Uncertainty out of decision making," *Swine Health and Production*, Volume 1, Number 4, pp. 17- 23.

F. Song and S.M. Smith, 2000, "A simple weight based fuzzy logic controller rule base reduction method," *IEEE International Conference on Systems, Man, and Cybernetics,* Volume 5, pp.3794-3799.

J.Yen and L.Wang, 1999, "Simplifying fuzzy rule-based models using orthogonal transformation methods," *IEEE Transactions on Systems, Man and Cybernetics*, Part B, Volume 1, Number 29, pp.13-24.

M. Szpyrka, 2008, "Exclusion rule-based system," *International Multiconference on Computer Science and Information Technology*. Kielce, Poland, pp. 237–242.

M.I. Desa, A. S. H Basari and N.S. Herman, 2008, "A practical and user friendly interface of fuzzy logic rule based system for maintenance policy decision making," *Jurnal Teknologi Maklumat*, Volume 20, Number 4, pp. 124-138.

M.T. Kai and C.P. Lim, 2006, Fuzzy FMEA with a guided rules reduction system for prioritization of failures, *International Journal of Quality & Reliability Management*, Volume 23, Number 8, pp. 1047-1066.