A Mobile Application for Incident Detection and Tracking System

Adel Khelifi
Software Engineering Dept.
ALHOSN University
Abu Dhabi, UAE

Mohammed Ghazal
Elect. and Comp. Eng. Dept.
Abu Dhabi University
Abu Dhabi, UAE

Hussain Al Bloushi
Software Engineering Dept.
ALHOSN University
Abu Dhabi, UAE

Manar Abu Talib
College of Information Tech.
Zayed University
Abu Dhabi, UAE

***Abstract*— Detecting and tracking an incident is a complex task that requires high communication between involved parties and powerful broadcasting methods. The process of detecting and tracking an incident has been suffering from the lack of identifying the location of incident, type of incident, severity level, number of injuries if there are any. This Incident Detection and Tracking System (IDTS) eases the process of detecting and tracking incidents. It runs on two platforms: web server and mobile phone which eliminates lost or incorrect Incident reporting, increases accuracy of information, and improve user satisfaction. Governmental institutions can run IDTS on their servers to collect data on each incident occurrence. The incident data regarding fires, earthquake damages, accidents, floods, and water leaks come from users' mobile phone. These data can help government in detecting and tracking the location of the incident on the map and also get detailed information about incidents such as the severity level, and number of injuries.**

***Keywords*— Mobile Application, Incident Detection, Tracking System**

I. INTRODUCTION

Incidents and natural disasters can be defined as dangerous situations that can occur without any prior notice to human beings, or places. An incident or a natural disaster can be caused by floods, water leaks, earthquakes, volcanoes, fires, or car accidents. These incidents have significant effect on human life and their business. In this paper, we classify the incidents in five categories:

Accidents: Car accidents can happen when a vehicle hits another vehicle or another object that causes damages to the parties. After the accident, the person involved in the accident usually calls the police and tells them about status of the accident and the location. One of the problems that the person faces is specifying the location of the accident to the police. The reasons of this problem might be the person is not familiar with area names, or he is in a remote area such as desert.

Fires: Destructive damages and disastrous personal injury can be caused by fire accidents. Billions of dollars are being lost because of property damage which is caused by fire. If the fire is quickly reported with its exact location we can save lives and properties from damage.

Earthquakes, like other natural disaster, can happen any time without prior notice. As a result of earthquake, the ground starts shaking and cracking which leads to catastrophic damages to buildings, roads, bridges, general properties, and loss of life.

Floods: A water flood is an overflow of water in particular area. The normal cause of water flood is heavy rains that exceed the capacity of the water level. Water flood can damage buildings, cars, sewerages system, roadways, crops and food supplies.

Water leaks: It is very important to find out the water leak; because it helps you in reducing your water bill. Water leak can be found anywhere in your house, neighbor's house, or even one in the street's pipelines.

This paper discusses the development of IDTS. This system is supposed to ease the process of detecting and tracking incidents. There are two parties involved in using the IDTS: the first user who has the application running on his Android based mobile phone. And the second user is usually governmental institutions such as police, firefighters, or municipality who are using website to track the incidents. The incident data regarding fires, earthquake damages, accidents, floods, and water leaks will come from users' mobile phone. These data can help government in detecting and tracking the location of the incident on the map and also get detailed information about incidents such as the severity level, and number of injuries.

This paper is organized as follows. Section two presents a literature review about computer applications that detect and track incidents. The third section covers the methodology of the application and technologies used in the project. Functional and non-functional requirements of IDTS are gathered in section four. Section five discusses the system's design and includes set of diagrams such as ER diagram, class diagram, and sequence diagram. Section six talks about the implementation phase of the system and the last section highlights the conclusion and future enhancements.

II. LITTERATURE REVIEW

There are very few mobile applications or systems that detect and track incidents. The first application is a website that shows only fire incidents occur in USA. The website includes incident name, type of incident, unit name, state name, status, acres, and updated time. For more details please check: (http://www.inciweb.org/). The second application is mobile application that has website, running on the server, to detect the location of fire incident only. The application

records incident details in a database on an Android Phone or Android Tab and have the reports posted to the office via email, for more information please check: Please check:

(http://www.androidzoom.com/android_applications/tools/fire-incident-reporting-system_upph.html). On the other hand, our IDTS has five types of incidents to be reported such as fire, earthquake damage, accident, water leak, and water flood. The significance of IDTS is that the report of the incident includes much information such as location coordinates, pictures, mobile user information, and severity level of the incident. After choosing the idea for this paper, a thorough research using the web has been conducted to test the novelty of this idea. The results revealed that there was no system that encompasses five types of incidents, although some systems were found to have only one type of incident tracking and reporting. In order to test the significance of the idea and to collect demands and envisions of such a system:

- Questionnaires have been distributed.
- Responses have been gathered and analyzed.
- Requirements have been elicited from responses and demands.
- The stakeholders of the system have been identified, and the environment for deploying the system has been chosen.

III. METHODOLOGY OF THE APPLICATION'S DEVELOPMENT

"A software development methodology is a framework that is used to structure, plan, and control the process of developing a software product which includes the pre-definition of specific deliverables and artifacts that are created and completed by a project team to develop or maintain an application" [17]. The software development lifecycle is part of the software development methodology. "The Software Development Lifecycle (SDLC) is a process that involves the building of a software product. It describes the life of the product from its conception to its implementation, delivery, use, and maintenance" [14].

A. Software process models

The model chosen for the process of creating IDTS is the Iterative and Incremental Model. The iterative and incremental model delivers a full system at the beginning and then changes the functionality of each subsystem with each new release. The first version of IDTS is delivered during the first iteration. The first iteration of IDTS development was initiated with the Requirements and Analysis phase, then the Design phase and finally the Implementation phase along with a simple Testing of the system. Then, a new version is delivered in the next iteration based on the comments and recommendations of the evaluation phase. Further iterations are created until all the users' requirements are met. The main deliverable of IDTS project is version one that implements all the core functionality of the system. The reason for choosing this model for developing the system is that it has the following advantages over other software process models:

- It provides more flexibility to the process
- It lessens the cost of system development.
- It eases the process of testing the system that is developed using such kind of a model.
- Each iteration in this model is considered as a milestone that can be easily managed.

B. Deployment Environment and Technologies Used

The web part of the IDTS is developed using "C#" language which is part of the "ASP.Net" web application framework provided by Microsoft, a technology made available by the "Internet Information Server" (IIS). The integrated development environment (IDE) for the website is used "Microsoft Visual Studio 2008", and the database "Microsoft SQL Server Management studio 2005". The mobile part of the IDTS is developed using "Java" language which is used in developing application for "Android" based mobile. The integrated development environment (IDE) for the mobile application is "Eclipse". The main technologies and tools used in the project are:

- OpenProj provides enhanced tools to help in tracking and controlling project work, schedules, and finances. This software was chosen to lead the process of developing IDTS [13].
- Eclipse is a language software development environment including an integrated development environment (IDE) and an extensible plug-in system. Eclipse includes open-standard technologies to provide a development environment for J2EE WEB, XML (Extensible Markup Language), UML and databases. This software was used to build the mobile application of IDTS [4].
- Dia is free and open source for diagramming that has a modular design with many shape packages available for different needs: network diagrams, flowchart, and more. It was used to create ERD, use case, and sequence diagrams [3].
- "Microsoft SQL Server Management Studio 2005 is a relational model database server produced by Microsoft [12]. It is used to create computer databases for the Microsoft Windows family of server operating systems. Microsoft SQL Server provides an environment used to generate databases that can be accessed from workstations, the Internet, or other media" [8]. SQL Server Management Studio 2005 was used to generate the database for IDTS, where all the data related to the application and its users is stored and updated.
- "Internet Information Server is a group of Internet servers (including a Web or Hypertext Transfer Protocol server and a File Transfer Protocol server) with additional capabilities for Microsoft's Windows NT and Windows 2000 Server operating systems" [2].

IV. IDTS SOFTWARE REQUIREMENTS SPECIFICATION

"A requirements engineering process is a structured set of activities which are followed to derive, validate and maintain a systems requirements document" [9]. This process is best described by the software engineer and father of the IBM System/360 computer family Fred Brooks when he said "The hardest part of building a software system is deciding what to

build. No part of the work so cripples the resulting system if done wrong. No other part is more difficult to rectify later."

This Software Requirements Specification (SRS) specifies the requirements and functions of IDTS. It aims to fully explain the system features, performance and constraints. It will also explain the way the system will respond to users' needs regarding incident detecting, how it will react under different circumstances and the way it will manage content. The SRS is intended for both stake holders and developers of the system.

A. IDTS Functional Requirements

"Functional requirements specify the functions of the system, how it records, computes, transforms, and transmits data" [11]. They are intended to describe the inputs, outputs and behavior of a system. Use cases have quickly become a widespread practice for capturing functional requirements. "A use case diagram is derived from use-case study scenarios. It is an overview of use cases, actors, and their communication relationships to demonstrate how the system reacts to requests from external users. It is used to capture system requirements" [16]. The use case diagram in figure 1 below shows the IDTS functions and their actors.

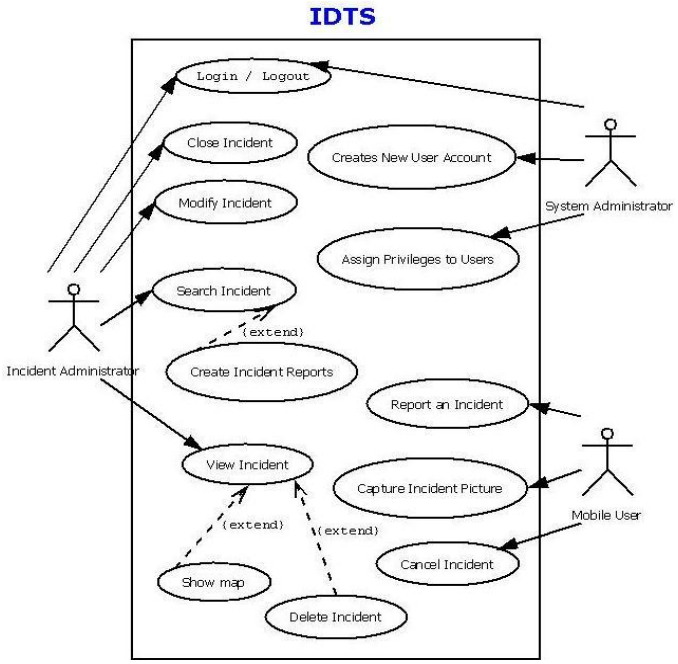

Figure 1. Use Case Diagram

B. IDTS Non-Functional Requirements

Every system is built from many parts. Each part plays a vital role in running the system gently. One of these parts is called non-functional requirements. "Non-functional requirements are requirements which are not specifically concerned with the functionality of the system. They place restrictions on the product being developed and the development process, and they specify external constraints that the product must meet" [9].

1) Implementation Attributes (not observable at runtime)

Portability: "Portability specifies the ease with which the software can be installed on all necessary platforms and the platforms on which it is expected to run" [19]. IDTS is supported by hardware and software environments similar to those where it was developed. It is also supported by a variety of Internet browsers such as Internet Explorer (IE), Mozilla Fire Fox and Safari (IE recommended).

Flexibility: "The ease with which a system or component can be modified for use in applications or environments other than those for which it was specifically designed" [7]. IDTS will be capable of accepting and applying new features without the need of rebuilding its whole architecture, or having major changes in its components.

2) Runtime Attributes (observable at runtime)

Security: "A system's ability to cope with malicious attacks from outside or inside the system" [16]. IDTS is expected to provide security and ensure protection against data corruption, and attacks from unauthorized users.

Usability: Is concerned with providing an easy-to-use system. Usability includes learnability and attractiveness. IDTS is intended to users from different educational backgrounds, so the system's functions should be easy to learn for all types of users.

Reliability: "Is the probability of success or the probability that the system will perform its intended function under specified design limits" [15]. Reliability includes availability and failure rate. IDTS is expected to provide maximum availability and minimum failure rate. In order to achieve that, the system, which is running in the server side, should be available for service when requested by mobile users, and should have a reasonable failure rate, which should not have critical consequences on the system. The failure rate is estimated as follow: Our system has 1 failure over 168 hours which is 0.0059.

V. DESIGN OF THE SYSTEM

"Software design is a process of problem solving and planning for a software solution. After the purpose and specifications of software are determined, software developers will design or employ designers to develop a plan for a solution. It includes low-level component and algorithm implementation issues as well as the architectural view" [18]. The design of the system includes several diagrams such as database schema, sequence diagram, and class diagram.

A. IDTS Database Schema

"A database schema is the structure of a database described in a formal language supported by the Database Management System (DBMS). It refers to the organization of data to create a blueprint of how a database will be constructed or divided into database tables" [1]. Figure 2 below gives an overview of IDTS database.

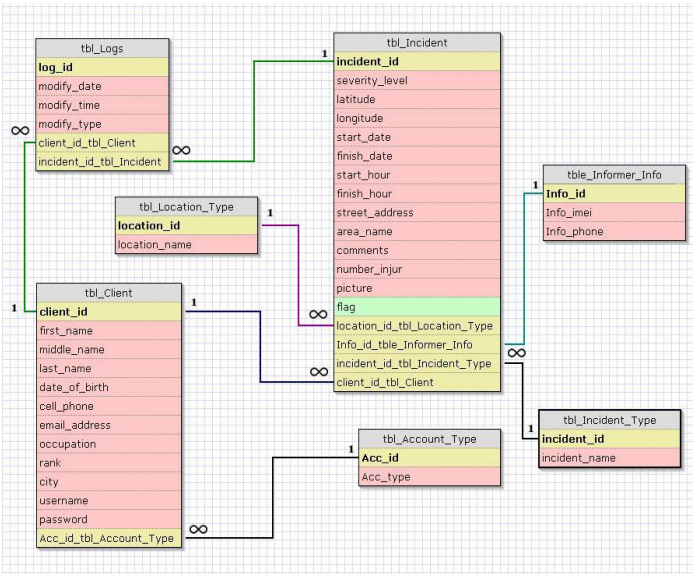

Figure 2. IDTS Database Schema

B. *IDTS Class Diagram*

"A class Diagram represents an overview of classes for modeling and design. It shows how classes are statically related, but not how classes dynamically interact with each other" [16]. The figure 3 below demonstrates IDTS class diagram.

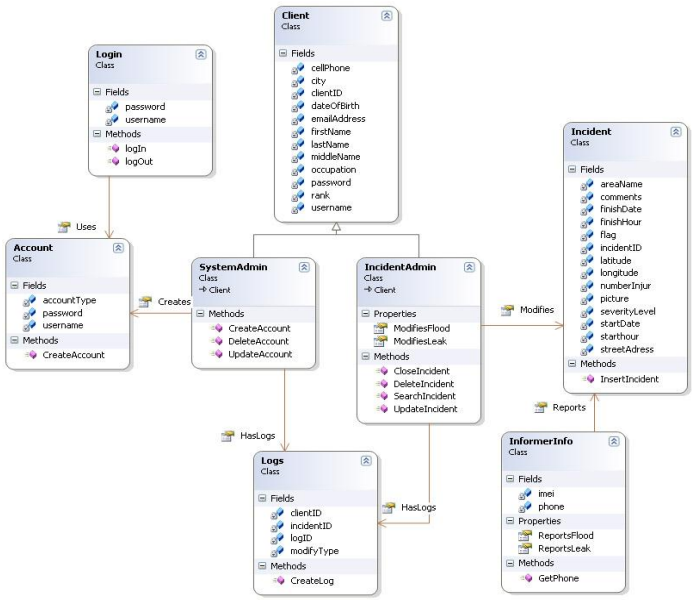

Figure 3. IDTS Class Diagram

C. *Sequence Diagram*

"A sequence diagram is a time-oriented interaction diagram showing the chronological sequence of messages between objects. Each sequence diagram corresponds to one use case" [16]. The following sequence diagram - figure 4- illustrates the "Create New User Account". Here the System Admin enters to admin page where he selects create account to create new user account.

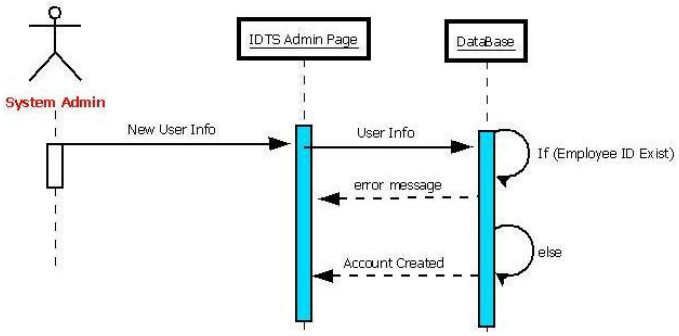

Figure 4. Create New User Account Sequence Diagram

D. *IDTS User Interface Screen Shot*

The figure 5 below is the main interface of IDTS on the mobile phone.

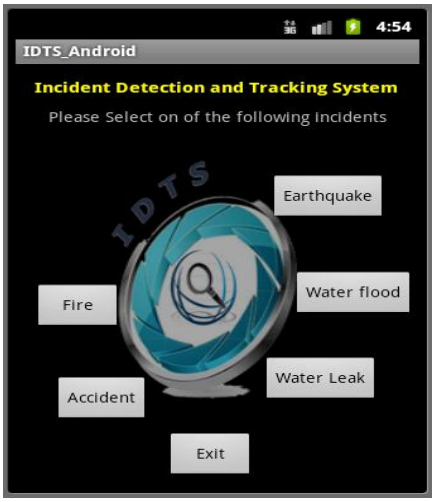

Figure 5. Mobile Main Menu Screen Shot

VI. THE SYSTEM'S IMPLEMENTATION

The implementation phase is an important part of the SDLC. Generally, in this phase the system design is converted to code, that generates a complete system, based on the requirements addressed and defined at the beginning of the SDLC by the stakeholders. The main deliverable of this phase is a developed working environment, which is the final product or software. In this phase the basic technical architecture to be used in creating IDTS, which is the client-server architecture, is defined. The database, which is the repository of all the system's data, is created. The code which represents the logic of the system is developed. The main deliverable of this phase is the first version of IDTS, which implements core functionalities of the system. Later versions include enhancements to the current functionalities as well as addition of advanced features.

A. *IDTS Client-Server Architecture*

"An architectural style or pattern abstracts the common properties of a family of similar designs. It contains a set of rules, constraints, and patterns of how to structure a system into a set of elements and connectors, even if it might not be the most elegant, the fastest, or the most economical, the

chosen architecture must be "optimal" and not necessarily focus on one particular aspect of the system constraints" [16].

The choice of a software architectural style has marvelous effects on all aspects of software design and implementation. An architectural style selection that is inaccurate might have a negative influence on the system's development time, the application's response time, and the system's future flexibility and maintenance [5].

For these reasons the following aspects have been taken into consideration before choosing the proper architectural style for IDTS:

- Requirements of the system.
- Priority of each requirement.
- Constraints of the system including project budget and release date.
- Complexity of the application.
- Level of integration and interfacing required.
- Number of users.

The architectural pattern used in developing IDTS is the Client-Server architecture, which is the most common distributed system architecture. In this architecture the system is composed of two major subsystems: client and server.

The mechanism of action for this architecture is as follows:

- The first process, the client, issues a request to the second process, the server.
- The server process receives the request, carries it out, and sends a reply to the client [16].

The main advantages for this approach include [16]:

- The separation of responsibilities such as user interface presentation and business logic processing.
- Reusability of server components.

The figure 6 below emphasis the IDTS client-server architecture.

Figure 6. IDTS Client-Server Architecture

B. *Android and ASP.Net Technology*

The mobile side of IDTS is developed with Android Technology. Android is a software stack for mobile devices that includes an operating system, middleware and key applications. The Android SDK provides the tools and APIs necessary to begin developing applications on the Android platform using the Java programming language.

ASP.NET stands for Active Server Pages .NET. It is an integral part of .NET programming framework developed by Microsoft. ASP.NET is used to create web pages and web technologies. ASP.NET is purely a server-side technology. It is built on a common language runtime that can be used on any Windows server to host powerful ASP.NET web sites and technologies [10]. IDTS, which runs on the IIS, is developed using the C# language, one of the languages of ASP.NET.

C. *Google Map API*

In this paper, Google Map API was used to locate the location of the incident on the Google maps and used to retrieve area names or street names by reverse geo-coding.

Google offers user with mapping services application and technology for free. One of these mapping services is Google Maps website which provides the user with street maps, a route planner for traveling by car, foot, or public transport. The images that Google Maps uses are not updated in real time; they have been taken several months or years ago [6].

CONCLUSIONS AND FUTURE ENHANCEMENTS

Natural disasters affect everyone. The unpredictable incidents such as fire, accident, earthquake, water flood and water leak may collapse homes, cause great loss of life, property, livestock and wildlife and cause widespread devastation.

Through this paper we proposed the development a mobile application for an Incident Detection and Tracking System. IDTS gives users, who witnessed any incident or trapped alive under debris, the possibility to notify the concerned governmental institution about the occurrence of an incident in very short time and through simple clicks on their mobile phones.

Using IDTS can help in reducing loss of life by developing solutions or discover strategies for eliminating the incidents, and successfully track all incidents.

IDTS overcomes incident's impacts by providing government with statistics that help engineers, and government organizations to be more conscious and prepared, to face the difficulties of disastrous incidents.

Future Enhancements

Given the importance of application's purpose, IDTS may contain many functions; the following ideas can be recommended as future enhancements to it:

- Creating a group of discussion about ITDS on information technology social network, such as facebook, can make people more aware about the existence of such system.

- Enable voice recognition function can allow IDTS users to report an incident.
- More natural and unnatural disasters can be added to the system.
- Email system will be integrated into IDTS for sending notifications to users.

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