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Developing Android-Based Personal Emergency Notification System with Global Positioning System as an Alternative Handling for Public Safety

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ABSTRACT

To handle many public emergency problems, Indonesian government did many things. One of them was launching emergency call center 110 for handling crime, and others. However, sometimes people couldn't able to send information about their emergency conditions and access to existing aid services easily and quickly. If this process was delayed, not only caused material damage, but also caused physical injuries and even lost of life.

One of the suggested alternative solutions is a personal emergency notification system. This application was composed of several technologies, such as accelerometer, Global Positioning System (GPS) to track the user's position and the Short Message Service (SMS) as a medium for sending basic information. This Android-based application could detect emergency conditions such as traffic accidents and unconscious fall, then sent an emergency message. This application also could track and periodically sends the user's position, so the position of the user could be tracked, even if the user continued to move.

With the above system, then public could send emergency messages easily to family, friends, or the relevant authorities. So that this application would help the evacuation in knowing the position and threats suffered by the sender. In the end, this application was expected to contribute practically to the society, as a fast communication facility when a traffic accident or unconscious fall occured. And this application was also expected to contribute to relevant agencies to support emergency relief services that already existed.

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1. INTRODUCTION

The public can't escape from a variety of safety threats, both internal and external. Those threats don't only cause material damage, but also death. According to a survey in 2008 by the WHO, there were 10 major causes of death in the world community. Among them heart disease, stroke, lung cancer, until a traffic accident [1]. Related to these problems, a variety of actions have been done in Indonesia. One of them was the launch of the emergency center channel 110 by phone number [2]. Emergency phone use was indeed one of good solution. By phone, relatives or institution in charge can get more information about the victim, either state or location. However, if the victim had an accident while was driving a vehicle, or suddenly fainted due to illness or certain things, obviously the victim will find it difficult to send emergency news by phone or SMS. When this process is delayed, the victim won't be helped, and the longer it would worsen the condition of the victim.

Along with expanding technology, many proposed solutions begin to appear. One of these suggested solutions is personal emergency notification system. Previous studies have used a heart rate measuring device as a trigger of emergency message sender. When user's heart rate beyond normal circumstances, the device would send a signal to application and trigger delivery of emergency information [3]. Related with faint detection system, previous studies have formulated unconscious fall conditions generally, various used algorithms, as well as a variety of detectors. Among others, the detection of the fall condition when output from accelerometer sensor passed certain limits [4], having used Dynamic Time Warping with accelerometer data [5], until having used *Multilayer Perceptron* with acceleration and orientation data [6]. However, these systems mostly focused on the detection function and delivery of emergency information. Furthermore, existing systems didn't use the tracking function, which its function didn't only know last location of the user, but also could ensure the system was still being run or not. Therefore, this proposed application will added the tracking function which could store and transmit user's position in a certain interval, and the detection function of traffic accidents. The tracking function will also support the detection of traffic accidents. This proposed Android-based application will use many technologies, such as accelerometer, Global Positioning System (GPS), and Short Message Service (SMS). GPS technology is applied to the system so that the receiver could track last position of emergency message sender [3]. SMS technology as a medium for sending information also is used because it was simple, cheap, and easy. This application will equipped with accelerometer that can detect when the user fainted.

With this system, people can send emergency messages easily to family, friends, or authorities. So that this application will help the evacuation in knowing the position and threats suffered by the sender. In the end, this application is expected to contribute practically to the society, as a fast communication facility when a traffic accident or unconscious fall occured. And this application is also expected to contribute to relevant agencies to support emergency relief services that already existed.

2. RESEARCH METHOD

This application was designed by having used ICONIX process. It began with functional and non-functional requirements analysis, then defined *Graphical User Interface (GUI) storyboard, domain model, use case, robustness diagram, sequence diagram,* dan *class diagram.*

2.1. Functional requirements analysis

After a review of various literatures and suggestions from lectures, these are application requirements that have been defined:

- Running traffic accident detection system
- Running faint detection system
- Running notification system via SMS
- Running tracking system
- Management of application options (user info, contact number, processing time, alarm)

2.2. Non-functional requirements analysis

Related to non-functional requirements of the application include the following:

- The speed of information retrieval location
- The accuracy of location info
- The accuracy of fall detection

2.3. Domain model

Domain model of the application is shown in the following figure.

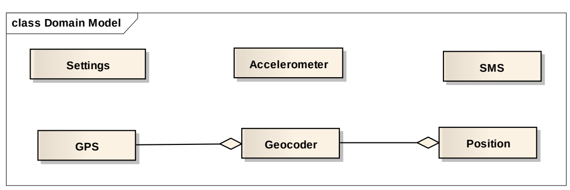

Figure 1. Domain model

2.4. Graphical User Interface (GUI)

Having defined functional requirements, then designed interface as a communication tool between user and system. This is a design example of application's start page.

Figure 2. Application Start Page

On this page, users can run process of faint detection or accident detection. When a process is activated, another button to activate the process of detection is disabled until active detection process is stopped.

2.5. Use case

Use case diagram is diagram that shows the behavior of the system related to the interaction between actors and the system to achieve the goal. Here is a use case diagram of this application.

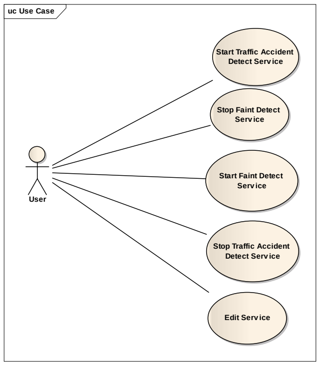

Figure 3. Use case diagram

Here is an example of use case description in the application.

Table 1. Use case description of start traffic accident detect service

Use Case: Start Traffic Accident Detect Service
Basic Path: User on the main page. System checks whether GPS service is enabled on the device. If so, user presses **Start Traffic Accident Detection** button. Then, system runs the **Accident Detection Service**. Then system looks for a GPS system provider, then takes the location info. After that, system checks whether any location data stored there. If there is, then the system checks difference in distance between the latest location from GPS with the last saved location is less than 25 m. If yes, then system stops **Accident Detection Service**, and then displays **Traffic Accident Detect** page, and sounds alarm. The system checks whether the user presses the YES button during the specified time span. If not, system turns off the alarm, sends emergency messages, and displays Traffic Accident Alert page. **Alternate:** • GPS service isn't activated on the device: The system will display GPS settings page. • No last saved location data found: System stores the last position directly. • Difference in the latest location to the final location of more than 25 m: the system displays a notification, stores location coordinates and sends a message last location info. • If the user presses YES button: system turns off the alarm, runs the service, and returns to the start page. • The system can't get the address of the location: the system sends the location info in the form of latitude and longitude coordinates only.

2.6. Robustness Diagram

Robustness diagram is a description of the use case, which is aimed to detailing the process of each use case. Here is one of robustness diagrams on this application.

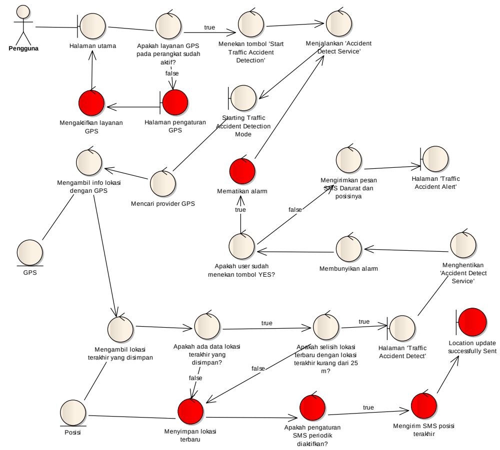

Figure 4. Robustness diagram of start traffic accident detect service

2.7. Sequence Diagram

Sequence diagram will explain the process that occurs in the system. Here is one of sequence diagrams on this application.

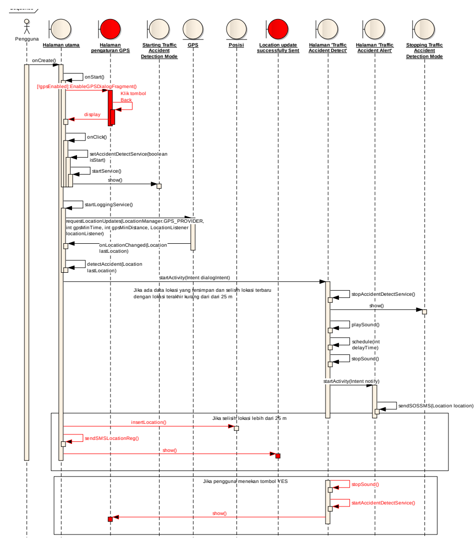

Figure 5. Sequence diagram of start traffic accident detect service

2.8. Class Diagram

Class diagram was a form of translation of domain models and sequence diagrams which implemented in the form of program code. Here is the class diagram of this application.

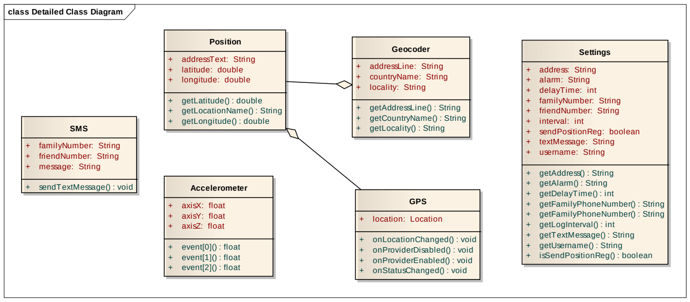

Figure 6. Class diagram

3. RESULTS AND ANALYSIS

When requirement analysis was completed, then writing the program code can be performed. Here are some examples of program code that have been implemented.

```java
// Based on isAccidentDetectService(), this application will starting
Accident Detect Service if the service isn't running
// and this application will stopping Accident Detect Service if the
service was running already

private void setAccidentDetectService(Boolean isStart){
   Intent bindIntent = new Intent(this,AccidentDetectService.class);
   if(!isStart){
     startService(bindIntent);
     Toast.makeText(this, "Starting Traffic Accident Detection Mode",
Toast.LENGTH_LONG).show();
   }
   else{
     stopService(bindIntent);
     Toast.makeText(this, "Stopping Traffic Accident Detection Mode",
Toast.LENGTH_LONG).show();
   }
```

Figure 7 Example of source codes

In this test, it is required supporting components as a means of implementation and testing. Here are components which used for testing applications.

Table 2. Specification of the hardware used in the system implementation and testing

Hardware	Specifications
Smartphone	Name: Samsung Galaxy Mini Plus
	Processor: Broadcom BCM21553 832 MHz
	Memory: 384 MB RAM
	Operating System: Android OS V.2.3.6 (Gingerbread)
	Provider: XL
	Sensors: Accelerometer, proximity, compass
	Messaging: SMS(threaded view), MMS, Email, Push Email, IM

The following are the result views of application when ran accident detection service.

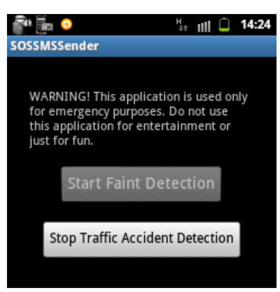

Figure 8. Example of application view

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Figure 9. Example of location message

Then testing to measure the speed of location info retrieval, either using GPS or through the network. Here are the results of tests.

Table 3. The speed test results of location info retrieval

5 Minutes to-	Mode Traffic Accident Detection (GPS)	Mode Faint Detection (Network)
0	20 seconds	5 seconds
1	17 seconds	3 seconds
2	19 seconds	4 seconds
3	22 seconds	4 seconds
4	18 seconds	3 seconds

Further trials conducted to measure the accuracy of the location information, either using GPS or through the network.

Table 4. The accuracy of location info

Data ke-	Mode Traffic Accident Detection (GPS)	Mode Faint Detection (Network)
1	25.0 m	1497.0 m
2	20.0 m	1384.0 m
3	15.0 m	1439.0 m
4	25.0 m	1487.0 m
5	20.0 m	1346.0 m

*Smaller the value, greater its degree of accuracy

Next conducted trials to determine how accurate the faint detection rate that failed and successful. Testing was done by asking 5 different people to use this application and try to fall. Here are the test results.

Table 5 Test result of faint detection

Order-	Number of Falls	Number of Detected Falls	Number of Undetected Falls
1	10	8	2
2	10	9	1
3	10	8	2
4	10	10	0
5	10	9	1

4. CONCLUSION

From results which obtained in the implementation and testing above, it can be concluded that:

- Mobile-based emergency notification application was built with Android operating system. This application used GPS, SMS, and accelerometer feature. This application could detect traffic accidents, detect faint state, track user's location and could send emergency SMS.

- From test results obtained, the use of GPS is more precise to used for the detection of traffic accidents because it requires high accuracy and its use outside of the building. While the use of network / A-GPS is applied to the detection of faint because it requires a fast response time and can be used in a building.
- The application isn't yet ready to be applied directly to the public, considering the need for further development related to both the accident and faint detection process.

While the suggestion of the authors is as follows:

- To allow users to monitor the location of the user, should have to improve the tracking system with the added GoogleMaps feature that can monitor location in real-time.
- In order for the detection of faint to be more accurate, there needs to apply data mining technique so that the result is much more dynamic and accurate.

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