# MOTORCYCLE ACCIDENT DETECTION APPLICATION FOR ANDROID SMARTPHONES

A Thesis Presented to the Faculty of the
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of the Requirements for the Degree
BACHELOR OF SCIENCE IN COMPUTER SCIENCE

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Carl Patrick Agbisit

Rafael Bacus

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## ABSTRACT

Recent statistics have shown an increase in motorcycle-related accidents all throughout the Philippines, some of which lead to dead-on-arrival cases. The increased use of smartphones among the population have also been noted by statisticians. These smartphones contain sophisticated hardware, such as accelerometers and gyroscopes, which help deliver dynamic and powerful applications. These integrated hardware can be programmed to detect certain fall conditions, such as during a motorcycle accident. The accelerometer inside a smartphone can be used to detect external forces applied on the smartphone during a fall, and the gyroscope can be used to obtain the orientation of the user of the smartphone. In the event a positive fall is detected, pre-programmed contact numbers will be notified that an accident has occurred; both a message and the location of the user will be given to these contact numbers. The aim of this study is to provide an application that will notify friends and family of motorcyclists that an accident has happened. The expected result will be that immediate contacts of the user are aware of a life-threatening situation, and can take appropriate action following the events of an accident.

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# CHAPTER 1 INTRODUCTION

## 1.1 Rationale of the Study

In the second quarter of 2012, a total of 4210 vehicular crash-related injury cases were reported in the Philippines (ONEISS, 2012). Fifty-one percent of those cases were caused by motorcycle accidents (ONEISS, 2012). Ten of the sixteen, roughly sixty-three percent, dead-on-arrival cases were motorcycle riders. In the first quarter of 2013, the percentage of motorcycle accidents to total vehicular accidents increased to fifty-nine percent, despite the fact that there were less vehicular crash-related injury cases reported (ONEISS, 2013). The percentage of dead-on-arrival motorcycle riders increased to sixty-seven percent (ONEISS, 2013). These findings emphasize the rising number of vehicular accidents relating to motorcycles.

The age group for fifty-four percent of total people involved in accidents were ages 20 until 44 (ONEISS, 2013). Meanwhile, as reported by the statistic group Nielsen, young adults between the ages of 25 and 34 have the highest smartphone penetration at eighty-one percent (Nielsen, 2013). The age group that uses smartphones most frequently – 25 to 34 years old – as well as the age group of people involved in vehicular accidents – 20 to 44 – are roughly the same.

Smartphones have increasingly become more sophisticated and powerful with the inclusion of sensors such as accelerometers, gyroscopes, cameras, and microphones (Robin et al., 2010). Additionally, the leading mobile operating system, as of 2013, with fifty-three percent of smartphone users, is the Android operating system (Nielsen, 2013).

The researchers utilized these sensors as well as the open-source Android operating system to develop an application that will detect the occurrence of a vehicular accident, specifically motorcycle accidents. The application detects external forces on the smartphone using the accelerometer, determines the orientation of the smartphone using the gyroscope, and, if an accident is detected, sends a message to specified contact numbers. The general objective of the research is to be able to notify immediate contacts of the person involved in the accident.

## 1.2 Statement of the Problem

### 1.2.1 General Objective

The study aimed to design an application on smartphones using the Android operating system as a post-vehicular accident detection system.

### 1.2.2 Specific Objectives

1. Determine the different scenarios of motorcycle accidents
2. Implement existing algorithms to detect changes in forces applied to the smartphone and its orientation
3. Develop motorcycle accident detection application
4. Test and Evaluate application

## 1.3 Significance of the Study

Motor vehicle accidents will always be present in every day commute. Although steps may be taken to reduce the overall percentage of accidents, one can never completely diminish its occurrence. Many of these accidents may also result in injury to the driver of the vehicle or the passengers, leaving them unable to call emergency dispatchers or their loved ones. In addition, the time between the accident and when an immediate contact is notified has significance in determining whether a person will suffer prolonged injuries. Quick response to an accident, or at least notifying an able person such as a family member, can help reduce such injuries. Therefore, this research benefits:

**Motorcyclists** The majority of motor vehicle accidents are related to motorcycles. Many of these accidents also resulted in dead-on-arrival cases. A family member that is notified of the accident may be able to transport the driver or passenger of a motorcycle to the nearest hospital if injuries are minimal and if allowed by medical authorities.

**Youth Demographic** The majority of motorcycle accidents occurs with younger age groups; people who are in their mid-20s to early-30s. Although there may be many reasons why measure of central tendency point to this age group, there is also other statistic that states most users of smartphones also revolve around the same ages. A younger motorcyclist is more likely to benefit from an “accident detection” application.

**Close Relations** Immediate family members and close friends will be notified of any positive detection and they may take appropriate action; whether to contact emergency dispatch, travel to the accident site themselves, or provide any other additional support. Being aware of any accidents can help ease family members.

**Computing Field** A motorcycle accident application will be made available for future improvements. This can be a starting point for future researchers who want to improve upon the application, such as integrating it with systems for emergency vehicle dispatchers.

## 1.4 Scope and Limitation

The researchers expected the following topics and preconditions to be within the scope of the research: Statistics show the Android operating system is now the leading operating system for smartphones. A wider audience, those using Android, can benefit from an accident detection application if and when the application is developed. In addition, it would take a much larger team and effort to test and develop an application for both the Android OS and Apple's iOS, the operating system for iPhones; effort that is outside the time constraint allowed to the researchers. Therefore, the Android Operating System was the foundation of this application. The official Android SDK available from the Android Developer website was used, as well as the standard Android installation on the smartphone.

Motorcyclists are the most prone to motor vehicle accidents, even accidents resulting in fatalities. Therefore, the scope of the research is set around motorcyclists, and *not* all motor vehicles; meaning cars, trucks, public utility jeepney (PUJs), etc. are excluded from the research. It requires too much effort to test the application within the setting of a car, a truck, a PUJ, etc. The researchers focused their efforts surrounding the leading reported cases of motor vehicle injuries, which are motorcycle accidents.

In the event of an accident, the application is able to locate the coordinates of the user and transmit those coordinates to the designated contacts using Google Maps.

The researchers assume that the users of this application will be under a data plan, or own adequate “load”, to allow the transmittal of SMS and mobile data. There are a variety of data plans accessible to the public that allow for a fair amount of data to be used. “Globe [Telecom] has provided subscribers various PowerSurf plans with data caps ranging from 20MB up to 1GB depending on their prices” (Noda, 2013).

The researchers assumed the following as limitations of the proposed study: Many owners may still be using smartphones with an older version of the Android Operating System. These phones may or may not have the hardware to support the latest Android OS version. Therefore, the researchers assumed that users of the application will have hardware capable of supporting the more recent versions of the Android Operating System, arbitrarily from version 4.0 (“Ice Cream Sandwich”) and beyond.

If the smartphone were to be damaged during an accident and rendered incapable of use, the application will not be able to function as intended.
Areas of the city may or may not be included under the user’s data plan coverage or GPS coverage

During testing, the smartphone was subjected to physical manipulations with either a dummy or a participant. However, no live testing (using actual motorcycles in motion) was conducted due in part to the safety of the participant.

# CHAPTER 2 REVIEW OF LITERATURE

Statistics from the Online National Electronic Injury Surveillance System (ONEISS) have suggested an increasing number of motor-vehicle accidents, specifically accidents related to motorcycles, as well as an increase in the number of deaths related to these accidents. Fifty-one percent of vehicular crash-related injury cases reported in the second quarter of 2012 were motorcycle accidents (ONEISS, 2012). By the first quarter of 2013, the percentage rose to fifty-nine percent (ONEISS, 2013). The objective of this research was to be able to notify immediate contacts of the person involved in such accidents, so that they may take appropriate action. Expectedly, there is a high probability that a motorcycle accident will be accompanied with the driver falling from his vehicle. However, related fall-based researches have only focused on real-world falls pertaining to the elderly, and related accident-detection researches mainly talk about automobile (cars) accidents. This research has tried to cover this gap by addressing falls from motorcycle accidents, using smartphone sensors.

One major concept used in this research is fall-detection. Current technology allows smartphones, which have become more powerful with the inclusion of sophisticated sensors such as accelerometers and gyroscopes, to be able to detect fall-conditions. Several related researches have stated that smartphones are in fact capable of detecting falls and analyzing real-time data. Implementing the powerful Android G1 phone for their *PerFallD* system, Jiangpeng Dai et al. (2010) "propose utilizing mobile phones as a platform for developing pervasive fall detection system." The aim for their research was to provide an alternative to fall-detection services by utilizing smartphones instead of existing commercial products. Their experimental results exhibit "superior detection performance and power efficiency." Martín et al. (2012) states, "… smartphones may facilitate acquiring, logging and even processing personal, environmental or social data, captured through virtual and/or in-device physical sensors." Although their work "focuses on exploring the use of smartphones to perform activity recognition," it is also closely related to our work in that internal sensors of the smartphone (accelerometer, gyroscope and magnetometer) were used to determine real-time activities. Their results show that with these sensors, they were able to achieve an 88% accuracy. In *A Survey on Smartphone-Based Systems for Opportunistic User Context Recognition*, it states, “Studies of the range of magnitude and the frequency range of acceleration generated by the body during daily life activities confirm that the capabilities provided by accelerometers embedded in current mobile phones are sufficient for detection of almost the same range of activities as with the current wearable approaches” (Hoseini-Tabatabaei et al., 2013). These three works have suggested that smartphone sensors are capable of detecting several types of daily activities. The activity that was focused on in this research was the act of falling.

Under the concept of fall-detection is the technology of inertial sensors. These are usually sensors that measure the physical motion of an object. The two primary sensor used to determine a fall is the accelerometer and gyroscope. Related research have chosen these two sensors primarily because of their low power cost and more abundant data. “The power consumption of accelerometers is very small compared to other sensing modalities, for instance, the LIS302DL power consumption is less than 1 mW” (Hoseini-Tabatabaei et al., 2013). The gyroscope in mobile phones consume very little power as well: “MEMS-based gyroscopes are considered to have very low power consumption” (Hoseini-Tabatabaei et al., 2013). For perspective, the study of Carroll & Heiser (2010) shows that on average, the HTC Dream smartphone uses only 26.6mW in a suspended state and 161.2mW in an idle state. The Google Nexus One consumes only 24.9mW in a suspended state. This shows that the power consumption of accelerometers of less than 1mW is negligible compared to other activities on the smartphone. Acoustic sensors are not used as the data gathered from it is currently insufficient for the purpose of detecting traffic accidents due to sound clipping from the actual crash as well as background noise, making differentiation between events difficult (White J. et al., 2011). A visual sensor was not considered; the smartphone would most likely be inside a container, like a pocket or bag, while riding a motorcycle.

Several algorithms were considered when detecting a fall using accelerometers. However, the work of Kangas et al. has resulted in one of the more accurate algorithms available; “The results indicated that fall detection using a tri-axial accelerometer worn at the waist….is efficient, even with quite simple threshold-based algorithms, with a sensitivity of 97-98% and specificity of 100%” (Kangas et,al, 2008). This research has modeled the second algorithm tested by Kangas et al., in which the algorithm (START OF FALL + IMPACT + POSTURE) will first monitor when a fall is initially happening, followed by the detection of the impact, and lastly monitor any change in posture.

Most related works, including the group of Kangas et al., are involved with threshold algorithms, algorithms that initiate an event once a certain condition has been met, or a certain threshold value has been recorded. For this research, the threshold value referred to the acceleration of the smartphone during the start of the fall; “The start of the fall was determined as the [graphical] pit before the impact, total sum vector ($SV_{TOT}$) being equal or lower than 0.6*g*” (Kangas et al., 2008). The total sum vector equation is as follows:

$$SV = \sqrt{(A_x)^2 + \left(A_y\right)^2 + (A_z)^2},$$

where $A_x$, $A_y$, $A_z$ is the acceleration in the x-, y-, and z-axis respectively, as seen in Figure 2.1. The sum vector will be the total acceleration experienced by the smartphone. A person standing on the surface of the Earth would typically experience 1g (g = acceleration of gravity). However, a sum vector value far below 1g, such as 0.6g, is a very good indicator that an individual is falling. Thus, the sum vector will be the first of three factors indicating a fall.

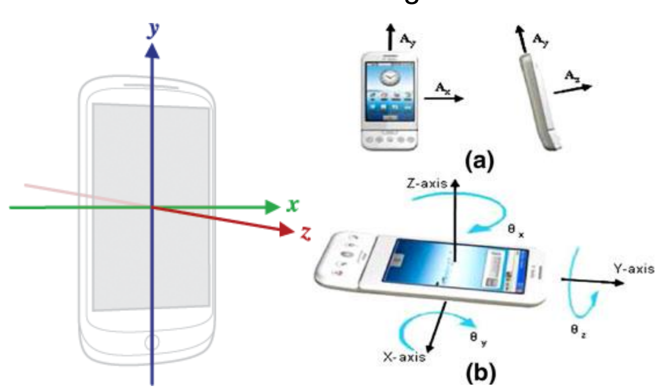


*Figure 2.1 Respective axes of the smartphone*

The second phase of this algorithm is the detection of the actual impact. Under an acceleration-versus-time graph, one can see the characteristics of a fall and impact scenario.

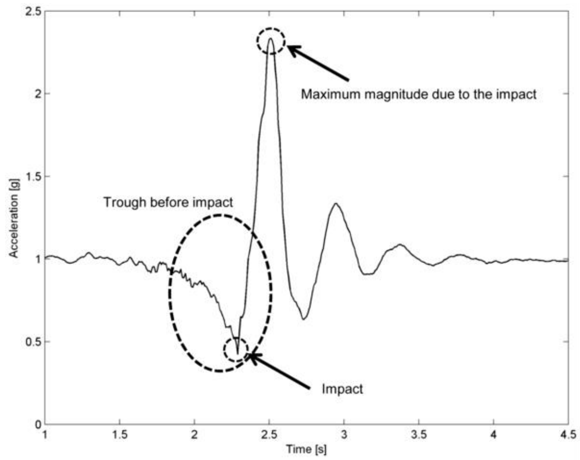


*Figure 2.2 Bagala et. al, Prototypical acceleration sum vector of a fall. This real-world example illustrates components that are common to many falls.*

In Figure 2.2, the trough right before the lowest point in the graph is where the threshold value lies. Beginning from the lowest point of the graph to the peak, the sudden spike in the graph indicates the actual impact. Our application modeled this same characteristic to detect if an impact has occurred.

Once the threshold value was crossed, and an impact was identified, if there was a sudden change in posture or orientation of the smartphone, detected by the gyroscope, then it was highly likely that a fall has occurred.

Figure 2.3 simplifies the algorithm the researchers will use:

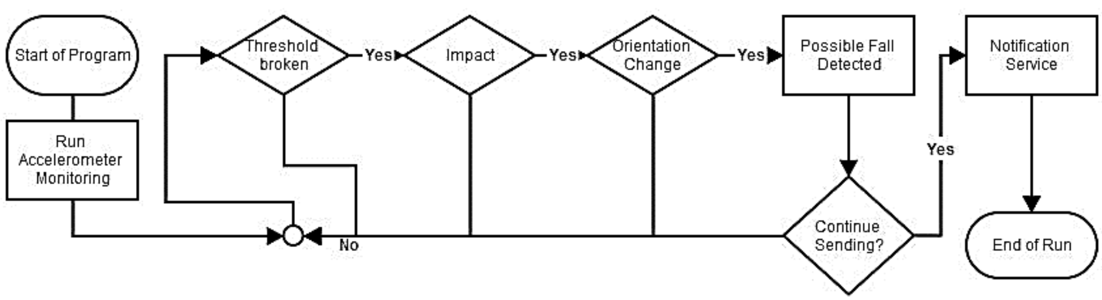


*Figure 2.3 Basic diagram outlining the algorithm used to detect fall conditions*

One additional point concerned with the algorithm is the location of the sensor on the body for positive outcomes. Bourke et. al modeled their 2010 research using the Kangas algorithms and mounted their tri-axial accelerometer on the waist. This method proved to be the most effective for the group. As stated by other research groups, “the waist is a popular location for fall-detection system” (Noury et al., 2008a), “as it provides reliable indications of full-body movement, in addition to its ease of acceptance by allowing attachment to an existing waist band” (Mathie et al., 2004). Research focusing on waist-mounted accelerometers are relevant to this study because it is the closest location from the typical pockets where sensors can still be accurate.

An article from the *Ride Apart* website, written by Wes Siler, features a list of ten common motorcycle accidents, all of which have a high probability of the rider falling from their motorcycle. The most common accident is when a car turns left in front of you. A collision in this scenario would result in the motorcycle driver being hit anywhere along the left side of the motorcycle. Other common accidents are the lowsider and highsider. The lowsider is characterized to occur usually in a turn and caused by the rear tire losing its grip on the road’s surface. The motorcycle will then fall towards the side it is leaning on and will slide to a stop. A highsider is characterized as a violent rotation of the bike around its long axis. The rear wheel typically loses traction, skids, then suddenly gains traction. This motion almost certainly assures the rider will flip head first off their motorcycle. Other common accidents involve entering a corner too quickly, a car changes lane into you, a car hits you from behind, wet roads, and more. All of these common accident scenarios have a probability of the driver being ejected from his motorcycle even at slow speeds.

Several commercial products have focused on alternative methods of detecting fall conditions. However, these alternatives were not conducive to the study intended by this research. The fall detection system from Brickhouse (BrickHouseSecurity.com) requires two devices; the portable sensor that a user will carry which will sense whether or not a fall has occurred, and the tele-base unit responsible for communicating an emergency response upon a positive trigger. Other researches that focus on fall detection, such as from Paoli et al., consider a wearable component. In their testing, the sensing node, with no user interface save three buttons, was attached to a belt worn around the waist. A related research in rehabilitation by Patel et al. suggests a full body unit with sensors, embedded within the fabric, which will “extract clinically-relevant information from physiological and movement data” (Patel et al., 2012). The suit would also communicate with the smartphone, displaying data. Although these methods all detect fall-conditions, it would not be beneficial in the context of vehicular accidents. The Brickhouse product, as well as the research done by Paoli et al., would both be more beneficial for home use by the elderly. A full body unit, as tested by the group of Patel et al., would not be feasible as well; it would require the user to don the “suit” before every instance of travel. A more pervasive form of alert, such as through the smartphone alone, would be more consistent with motorcyclists.

Chapter two discusses several of the past researches done that are related to this research. It first discusses the background of the problem in which there are rising motorcycle accidents. The researchers proposed an application in which these accidents can be detected by using a smartphone. Fall detection is then described. It involves a three-step algorithm where the smartphone sensors are utilized to determine a fall condition. The algorithm used will model the algorithm used by the group of Kangas et al. Lastly, chapter two touches upon alternative methods used by other researchers that may be less conducive to this research.

# CHAPTER 3 RESEARCH METHODOLOGY

## 3.1 Research Environment

The locale of the research is limited to the area around the University of San Carlos Talamban campus of Cebu Philippines. The positioning system is limited in support only to the Philippines.

## 3.2 Research Respondents

The target population of the research's application is student motorcyclists. The actual research respondents are the general populace. The study uses random sampling of respondents. The target sample size is 30, chosen to reflect public opinion.

## 3.3 Research Instruments & Sources of Data

The research uses a researcher-made simple closed structured questionnaire-survey to handle measurement of public perception. Measurement and quantification of relevant data, like orientation and acceleration, will come from the use of the sensors built in the smartphone itself. Other sources of pertinent data include national statistics and physics publications.

Data gathered from the use of built-in sensors may result in semi-biased results and physical simulations of motorcycle crashes cannot be conducted in actuality for safety and legal reasons. For these reasons, a controlled environment was necessary to produce and gather meaningful data. The questionnaire-surveys are simply tabulated and analyzed in Microsoft Office Excel.

## 3.4 Research Procedures

### 3.4.1 Gathering of Data

Data from the sample is gathered using a questionnaire-survey, where each element (person) is questioned only once. This will quantify the public opinion on the possible demand and economic feasibility of the research. Additional data related to this is regarded to past national statistics regarding motorcycle incidents and accidents.

### 3.4.2 Treatment of Data

Data gathered through the survey is analyzed using Microsoft Office Excel by way of summation of data and creation of graphs. The data will then be presented through a tabular form containing the summarized results of the questionnaire-surveys. Any outlier data or elements with missing responses were omitted.

## 3.5 Design and Implementation

The software development process for the research is an iterative and incremental model. Each component of the application is treated as a separate application and developed using a mini-waterfall model. Revisions are done any time during the development process.

### 3.5.1 Analysis Phase

Existing researches have focused on pedestrian and elderly fall-detection schemes. Fall-detection algorithms vary from research to research. Use of acceleration, g-force value, sudden spikes, and changes of orientation are common techniques utilized by these researches. Of relevance to this research is the use of threshold-based algorithms which begins active assessment of falling only when a certain threshold, like g-force, is broken.

The researcher-made system employs the use of a modified Kangas et al.'s vector summation algorithm. The application also observes stricter timeframes to compensate for the discrepancies between pedestrian and motorcycle falls, mainly due to the difference in physical capabilities (acceleration, g-forces). Other parameters are modified for this same reason. This system also adds another element, visual location based on GPS.

Few of these existing systems used techniques to deal with false positives and negatives to promote accuracy as fine-tuning of the systems themselves were done beforehand. Those that did utilized the creation of a 'critical time period' wherein the situation is assessed by way of manual termination by user if fall is false. This system also uses this technique as motorcycle falls are more erratic than pedestrian ones.

This phase will produce a document specifying and assessing the target goal, features, possible problems that may arise, and assumptions.

### 3.5.2 Design Phase

The application model utilizes the Android operating system and its accompanying programming language for application development. Google Maps is implemented in the system as an external application. The design scheme requires the use of Smartphone sensors, mainly the accelerometer, as well as its telecommunication capabilities.

The sensing algorithm is the algorithm that is used to detect the occurrence of a fall/crash. It implements a critical duration of time wherein false positives and negatives are discerned.

The telecommunication algorithm is a sub-program that sends a message and notification to correspondents that were assigned beforehand. The information sent includes the time of incident and location in the form of a URL. This URL is used to pinpoint a location using Google Maps on the recipient's device.

The system employs the system shown in Figure 2.3 to assess the occurrence of an accident. This is the flow of events that the application is expected to accomplish during a certain run of the application.

The user interface consists of 3 major screens. The first screen is the main menu from which a user can access the other two screens: the calibration settings, and the phonebook. The calibration screen is responsible for adjusting the program's algorithms dependent on motorcycle build, usual leaning angle, among other factors. The phonebook is where contacts that would be notified when a crash occurs would be displayed and modified.

As of this phase, prototypes of these components are finished, with their accompanying documentation regarding methods, functionalities, and variables.

### 3.5.3 Implementation Phase

The system is composed of five components: user interface, system configuration, monitoring process, data processing algorithm, and notification service. The smartphone itself is a physical constant that, for the purposes of this research, is assumed to be placed in a waist container (small bag, pocket), or a backpack.

The deliverables of this phase are the actual completed components of the programs that may or may not be subject to further revisions dependent on the results of the testing and evaluations.

### 3.5.4 Testing Phase and Evaluation

Debugging is done on each of the components. Each component is proofed for functionality, and then assembled into an application. The unevaluated compiled application is then installed on the test phone, and will be subject to software and physical testing.

## 3.6 Testing and Evaluation

Onboard sensors are tested to their default values and telecommunication capabilities are assessed to their neutral capabilities to create a baseline model for software testing. Variables that are relevant to the algorithm are created as to simulate different motorcycle accident circumstances.

Physical testing is conducted in a controlled environment. In a given motorcycle accident scenario, thin mats are placed appropriately in a spacious room to the possible areas where the smartphone may impact.

A person who has that phone in his person would then throw himself in a way that would emulate that scenario; this can alternatively be done by throwing only the phone itself. The recorded data and its accompanying result are used to check detection success.

Once tested for accuracy, the final application is assembled and completed. Necessary tests are undertaken again for thoroughness. The application may be updated steadily for possible commercial use in the future.

# CHAPTER 4 PRESENTATION, ANALYSIS AND DISCUSSION OF RESULTS

## 4.1 Motorcycle Accident Scenarios

For this objective, the researchers took to online resources to determine the most common scenarios that cause motorcycle accidents. The Royal Society for the Prevention of Accidents (RoSPA), have outlined the most common motorcycle accidents on their website. MotorcycleAccident.org, RidersPlus, and RideApart also lists several more scenarios.

The RoSPA website states that bends on country roads, collisions at junctions, collisions while overtaking, and loss of control are the most common types of motorcycle crashes. Most of the motorcycle riders are trained to drive within towns and cities but not on country roads, which require a different set of skills and knowledge. Because of this, many motorcycle riders are often inexperienced with the bends (especially tight bends) that occur on country roads and sometimes enter them at too high a speed. Collisions at junctions is also another common motorcycle accident. These may occur if other drivers fail to stop or give way to the motorcycle rider, or if they fail to spot the narrow profile of the motorcycle. Research also shows that other drivers “have difficulty judging the speed of a bike and underestimate the bike’s time of arrival.” Overtaking can also be another cause for motorcycle accidents. Other vehicles may be hidden from view while maneuvering past stationary or slow traffic, especially within packed vehicles. This reduces the motorcycle driver’s maneuverability and reaction time to a minimum. The final common motorcycle accident that RoSPA outlines is loss of control. The two main reasons for this are shunts and road surface conditions. Shunts, or rear-ending, occur when there is very little room between the motorcycle and the vehicle in front of it or behind it. Lastly, road surface conditions such as poor weather conditions, gasoline or oil, mud, gravel, or manhole covers may cause the rider to loss control of their motorcycle.

Both RidersPlus and RideApart state that one of the most common scenarios conducive to motorcycle accident is when a motorcycle goes straight through an intersection and a vehicle is making a left turn on the opposite side of the intersection. Many drivers making the left turn will fail to spot the narrow profile of the motorcycle, which is exacerbated by the fact that the motorcycle may be moving at top speeds. Both sites also state that entering a curve at too high speeds causes motorcycle accidents. The motorcycle cannot maneuver in time because it is going too fast. Rain, leaves, and gravel on the road results in the motorcycle losing traction which can cause a rider to lose control of his vehicle. As stated by RoSPA's website, as well as on RideApart, shunts or rear-ending is once again one of the most common scenarios for accidents. RideApart also adds that a car changing into the rider's lane or a parked car's open door are often common types of accidents.

### 4.2 Accident Detection Algorithm

Our research was modeled after the Kangas et. al Algorithm which consists of three phases. First, was to detect if the object is falling. Next, was to observe if an impact had occurred. Last, was to detect if there was a change in posture or orientation of the object.

Falling was observed by utilizing the built-in tri-axial accelerometer and using its outputted values to calculate the sum vector of the acceleration recorded for each axis. Impact was detected by using the same accelerometer and monitoring for a spike in the collected values. Change in orientation was ascertained through the use of the on-board gyroscope of the test phone.

This algorithm was implemented in our application through the use of a single Monitor class, supported by the Java Math and SensorManager classes. The Monitor class is responsible for starting and stopping the monitoring phase, connecting to the phone's built-in sensors and extracting its values, and determining if an impact has occurred and if the orientation of the phone has changed. The following is a short pseudocode sample outlining the Monitor class.

```
class Monitor{
   onInstantiation(){
      initialize field members;
      create Dialog to display "Accident detected!";
   }
   onSensorChanged(){
      determine if accelerometer or gyroscope data;
      if(accelerometer data){
         compute sum vector;
         if(sum vector is below 0.6g){
            monitor for 1.2 seconds;
            check if impact occurred during 1.2 seconds;
            if(impact & rotation occurred){
               display "Accident detected!" dialog
               start countdown timer to send messages;
            } else{
               reset class field members;
            }
         }
      } else if(gyroscope data){
         compute if rotation has occurred;
      }
   }
   checkIfImpact(){
      check if accelerometer data has a spike in values
   }
   startMonitoring(){
      reset field members to default;
      start accelerometer;
   }
   pauseMonitoring(){
      stop accelerometer;
   }
}
```

### 4.3 LifeCycle Android Application

The research output is that of a motorcycle accident detection Android application specifically targeting Android version 4.0 “Ice Cream Sandwich”. The development environments for the Android Application are the IDEs Eclipse Luna and Eclipse Juno. The testing and deployment device is a Samsung Galaxy S3 Mini, running on the operating system Android 4.2.2. The device is assumed to have a built-in accelerometer and gyroscope, and has access to a mobile data plan that is capable of handling the data transmission necessary for location services and messaging.

The application consists of four main modules: Monitoring, Location Tracking, Local Data Storage, and Messaging. The Monitoring module is responsible for the bulk of the processing as it handles the monitoring of the accelerometer and gyroscope hardware.

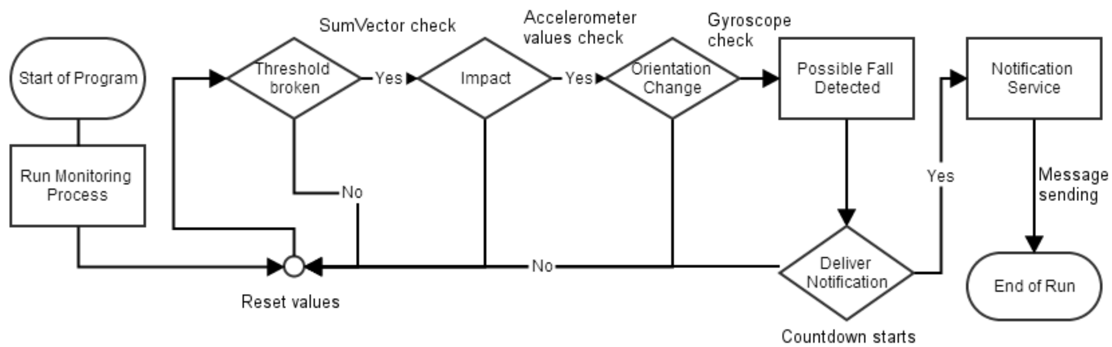


*Figure 4.3.1 Detection and Notification Flowchart*

In Figure 4.3.1 is the flow of events that handle accident detection. The values used to check for accident detection are reset every time the process stops unsuccessfully or successfully, so as to avoid complications. The other modules support the execution of the application, and reside mostly in the Notification Service.

Within the Notification Service is the Location Tracking module, which is liable for the retrieval of the user's current location upon detection of the occurrence of an accident. The information produced by this module is the user's current coordinates. The following is a short pseudocode sample of the Location Tracking module handled by the LocationTracker class.

```
class LocationTracker{
  constructor(){
     Build Google Api Client;
     Set location request parameters (interval, fastest
     interval, priority);
     Connect to Google Api Client;
  }
  onConnected(){
     Request for location update based on location request
     parameters;
  }
  onLocationChanged(){
     Try and obtain street address from current location
     coordinates;
     Remove location updates;
     Disconnect from Google Api Client;
  }
  ifSettingsChecked(){
     Check if phone settings allow application to get
     location using GPS and network-based sources;
  }
  hasLocation(){
     Checks if location has been found;
  }
}
```

The next module, Local Data Storage deals with the storage of the user's personal and medical information, and the contacts to send messages to upon accident detection. The Messaging module handles the actual notification, by using the data stored in the Local Data Storage module, and the retrieved location data from the Location Tracking module.

The application has three prominent screens: the main screen, the user data screen, and the contacts list screen. The main screen is responsible for the execution and pausing of the accident monitoring function, and most other user interactions. The user data screen is where personal and medical data of the user is inputted and stored; this data may be used by emergency response units and paramedics to administer the correct medications and procedures in the case of an accident. The contacts list shows all the contacts that will be notified in the occurrence of an accident.

The application upon fresh installation and execution will redirect the user through the user data and ntacts list screens for the purpose of initializing the application. Once user data and contacts are defined, the application is ready for accident monitoring.

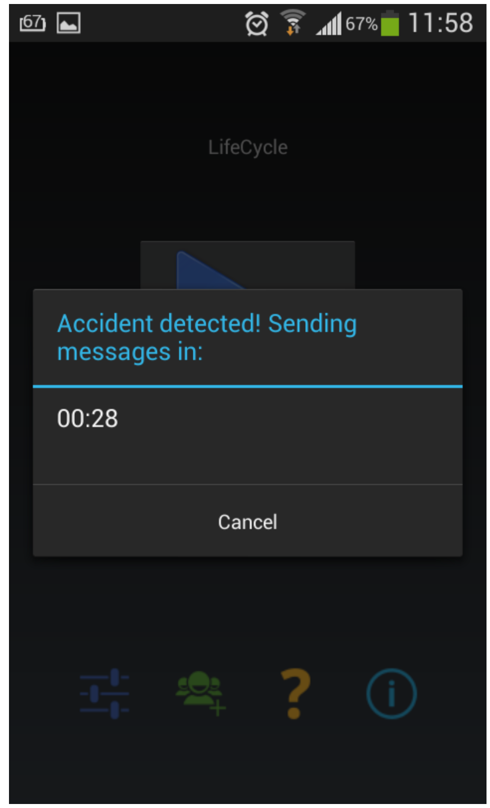


*Figure 4.3.2 Accident Dialog*

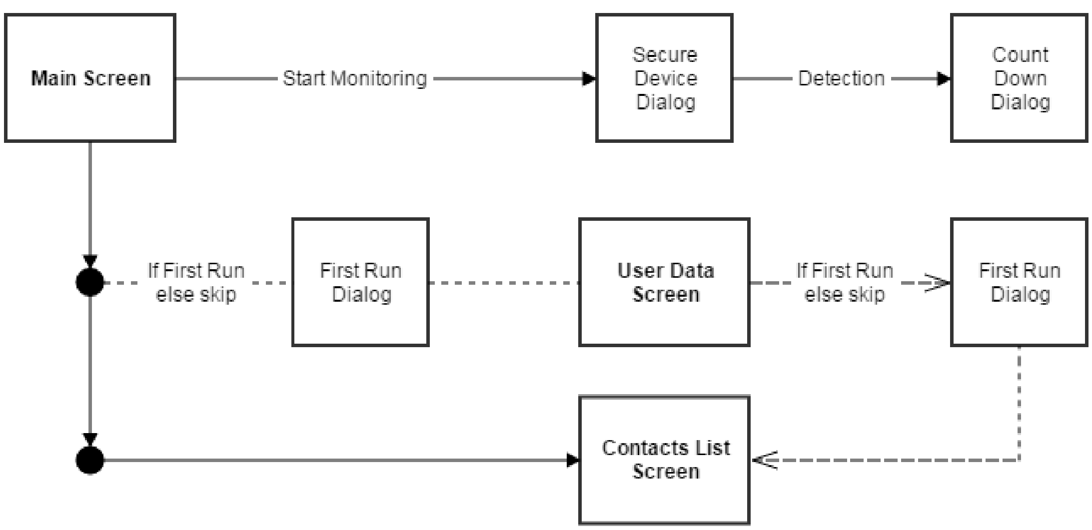


*Figure 4.3.3 Application General Screen Flow*

The user presses the ‘Play’ button in the main screen to start monitoring for accidents. After which, a dialog will appear that instructs the user to secure the device in his pocket or bag, lasting for 45 seconds before the application’s monitoring formally starts. Upon detection, the device will show a countdown of 30 seconds during which a loud alarm sounds. This is done to allow the user to cancel the Notification Service from executing and sending the location and information to his list of defined contacts, in the case of a false positive.

For each contact, the application will send a series of messages that contains the user’s custom message for that specific contact, the user’s retrieved location, and the user’s medical information: blood type, medications, allergies, and conditions. The location of the user can be graphically produced by following the URL provided by the message to a Google Maps coordinate. The following is a short pseudocode sample of the Messaging module.

```
class Message{
  sendMessage(){
     Get user medical information;
     Get contacts list;
     For each contact, send message containing user medical
     information, custom message, and location;
  }
}
```

The application has certain constraints placed on the data and system it is on. The User Data screen disallows the blood type and antigen of the user to be left blank. Additionally, the user's medications, allergies, and conditions have their default values set to 'None'. This is done to ensure that those who receive the notification are aware of the user's medical data and may respond appropriately.

The Contacts List screen and Main screen make sure that the user has defined at least 1 contact to notify before monitoring. This also implies that each contact must have a set and defined number before being recognized as a valid contact.

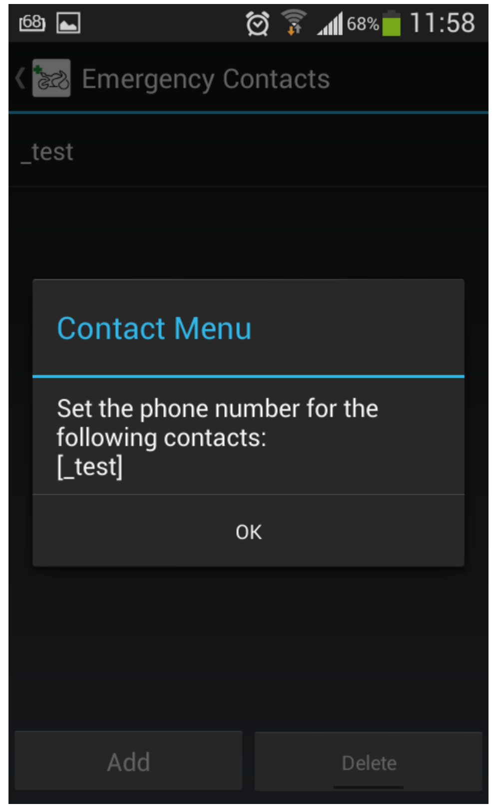


*Figure 4.3.4 Contact Number*

## 4.4 Tests and Evaluation

The testing environment included our own physical area (table and floor) for dropping the testing device, a simple yoga mat to dampen the fall, the Samsung Galaxy S3 Mini as the testing device, and csv/txt files used to record the accelerometer and gyroscope data during the fall. The height from the floor to the table was 74.2cm while the thickness of the yoga mat was 5mm.


*Figure 4.4.1 Samsung Galaxy S3 Mini SM-G730A with Ballistic Hard Case*

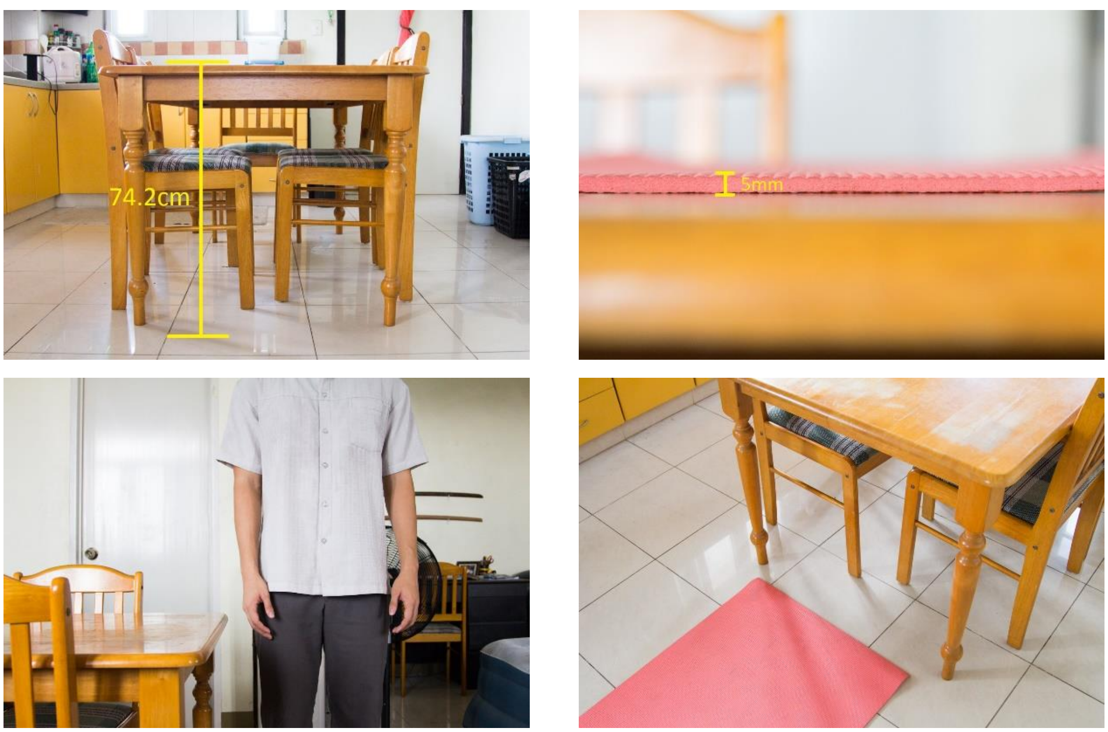


*Figure 4.4.2 Physical test environment*

Our test phase was comprised of four orientations, each with five trials. The four orientations include a rolling fall from the front, left, right, and back side of the test device. The following are photos that illustrate each orientation, as well as the test data collected.


Figure 4.4.3 Four fall orientations for testing

| Front | Trial | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Accident Detected | Y | Y | Y | Y | Y |
| Number of Contacts | 3 | 3 | 3 | 3 | 3 |
| Messages Sent | 3 | 3 | 3 | 3 | 3 |

Table 4.4.1 Front orientation trial data

| Back | Trial | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Accident Detected | Y | Y | Y | Y | Y |
| Number of Contacts | 3 | 3 | 3 | 3 | 3 |
| Messages Sent | 3 | 3 | 3 | 3 | 3 |

Table 4.4.2 Back orientation trial data

| Left | Trial | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Accident Detected | Y | Y | Y | Y | Y |
| Number of Contacts | 3 | 3 | 3 | 3 | 3 |
| Messages Sent | 3 | 3 | 3 | 3 | 3 |

Table 4.4.3 Left orientation trial data

| Right | Trial | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Accident Detected | Y | Y | Y | Y | Y |
| Number of Contacts | 3 | 3 | 3 | 3 | 3 |
| Messages Sent | 3 | 3 | 3 | 3 | 3 |

Table 4.4.4 Right orientation trial data

The data shows that the application was consistently able to detect the occurrence of an accident across all four different types of fall orientations. It was also able to notify and send the pertinent data and information about the user to the defined contacts. The following shows sample data collected from the right-orientation trials:

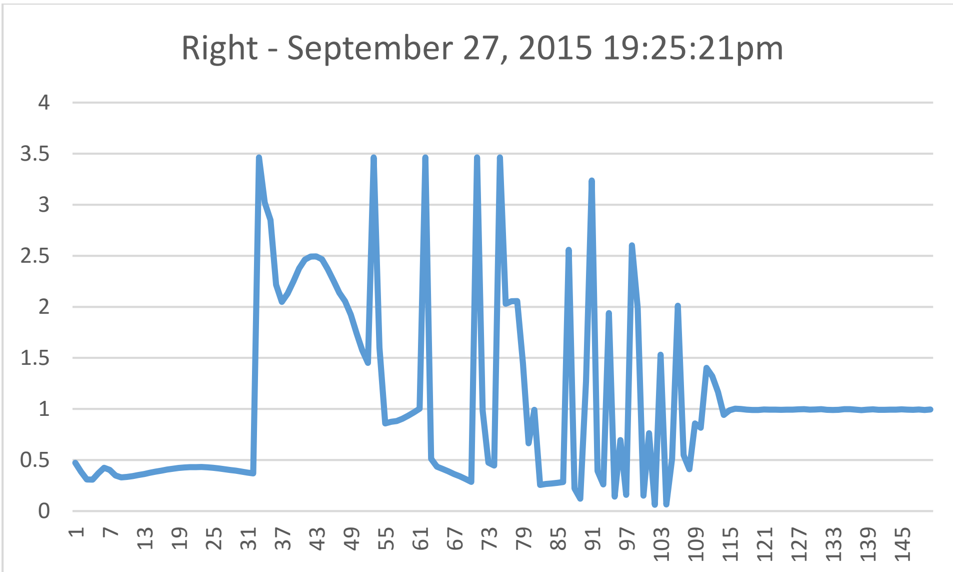


*Figure 4.4.4 Sample Accelerometer Data*

The chart models the characteristics of a fall and impact. The early values can be seen to be below 0.6g which indicates the falling action of the test device. A sudden spike to roughly 3.5g indicates the first impact against the ground, while subsequent jarring values show the effect on the accelerometer due to the test device bouncing. Lastly, the chart normalizes back at 1g at the tail-end which shows the test device at rest.

It is interesting to note the limitation of the accelerometer for the test device. Certain falls displayed several peaks at 3.464031g which shows the maximum value the accelerometer can register on this particular device. Although this value is sufficient enough to detect falls occurring at a height of 74.2cm, this may still be too sensitive and the application may detect falls from lower heights, the result being a negative detection. The maximum value an accelerometer can detect is solely device-independent and there is a possibility this characteristic may be observed in other devices. Further testing should be done on other devices at lower heights to determine if they would be just as sensitive as the current test device.

Aside from the application testing, the researchers also conducted a quick online survey using Google Forms to determine the general mood of respondents concerning motorcycle accidents and the need for this application. The following section outlines the responses for the questions from the forty-nine respondents.

Of the forty-nine respondents, thirty-three (67%) were males while sixteen (33%) were females. The vast majority, forty-seven out of forty-nine, were also between the ages of 17 and 25. Twenty-one (43%) respondents have personally driven a motorcycle while twenty-eight (57%) have not. Surprisingly, the majority of respondents (45%) do not have immediate family members that own or drive a motorcycle, while 25% have one family member that owns or drives a motorcycle. Only about 10% of the respondents have 4 or more family members that own or regularly drive a motorcycle. While most of the respondents have zero family members that drive a motorcycle, they have at least four or more friends that do drive a motorcycle.

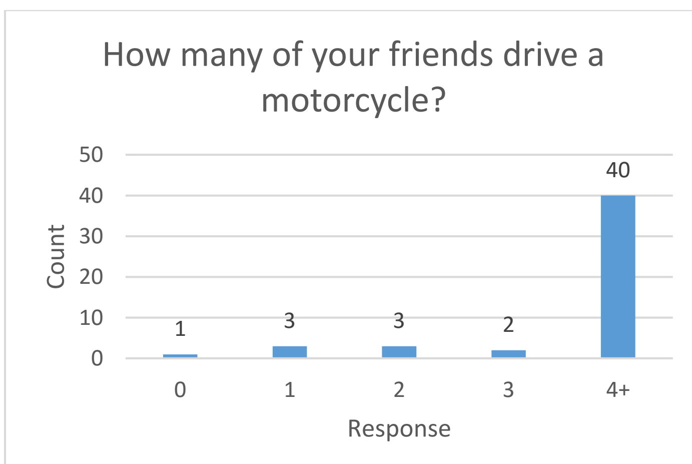


*Figure 4.4.5 Survey Question Response*

When asked if they thought the application would be useful for motorcycle drivers, 41% thought it would be highly useful (response 5), and 27% thought it would be moderately useful (response 3). The same trend can be seen when asked if they thought the application would be useful for motorcycle passengers.

Forty-five percent thought it would be highly useful (response 5), 24 % thought it would be mostly useful (response 4), and 22% thought it would be moderately useful (response 3).

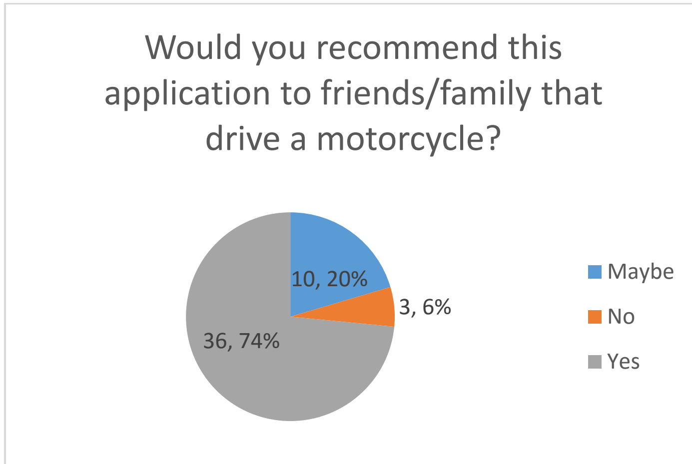


*Figure 4.4.6 Survey Question Response*

Given that many of the respondents also know many people whom drive a motorcycle, the respondents would mostly recommend an application that could detect motorcycle accidents to the their friends and family. The survey also shows that many respondents 37% find it quite alarming (response 4), and 41% find it very alarming (response 5), when they hear of a motorcycle accident.

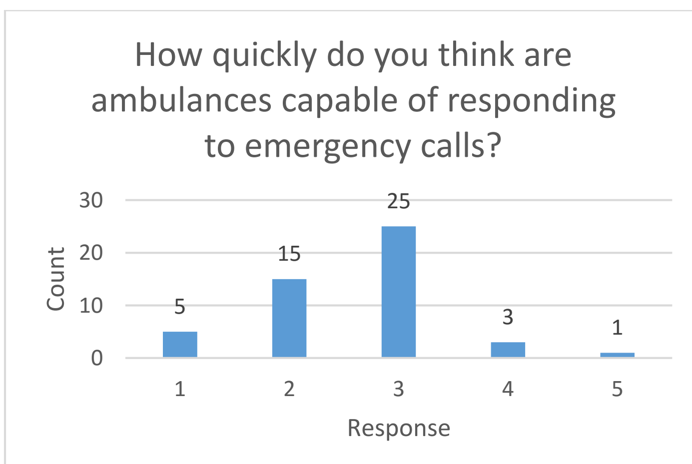


*Figure 4.4.7 Survey Question Response*

The majority of respondents (response 3, 51%) feel that ambulances or only moderately quick to respond to emergency calls; thirty-one percent feel ambulances are somewhat quick (response 2) to respond to calls while very few (8%) feel that ambulances are quick (response 4 & 5) to respond to calls.

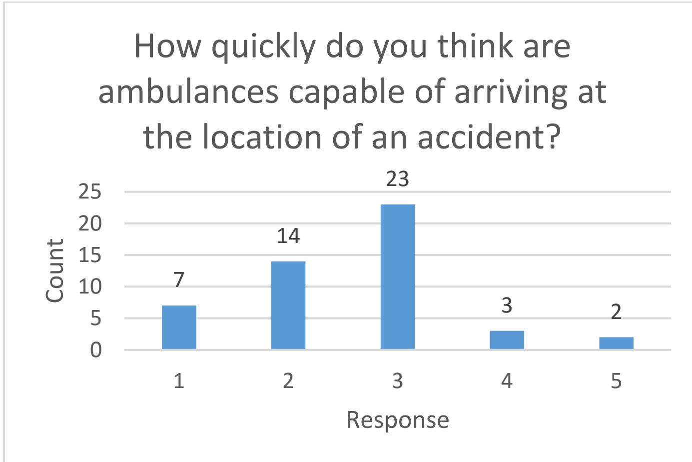


*Figure 4.4.8 Survey Question Response*

The same trend can be seen when asked how quickly they think ambulances can arrive at the location of an accident. Most feel ambulances are only moderately quick to arrive (response 3) and somewhat quick to arrive (response 2). Very few feel ambulances are quick to arrive (response 4 & 5).

Further questioning shows that if the application were offered at a low cost, about half would consider purchasing it while the other half was unsure. Many (60%) also felt that the application would be highly useful if it were directly linked to emergency response teams instead of simply send a message to family and friends. Respondents would be more likely to spend money on the application if it were linked to ERT.

This section has covered this research's test and evaluation phase starting with data collected from the smartphone and ending with data collected from the survey. Our evaluation of the data from the smartphone has shown that the application can detect impacts and change in orientation as well as send text message to supplied contacts. The survey indicates a common consensus that the application would be useful for motorcycle riders as well as passengers and that respondents only have a moderate confidence in the capabilities of the emergency response

# CHAPTER 5 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The researchers were able to develop a mobile motorcycle accident detecting application, barring physical limitations and constraints. This application has a strong chance of success in determining and detecting the actual occurrence of an accident. Additionally, the application is capable of notifying defined recipients the location and stored medical information of the user. The study was also able to ascertain the public opinion on the utility of mobile applications for the express purpose of security and safety, with majority stating that such applications are useful and recommendable.

The researchers' were able to observe several important findings. Utilizing the Kangas et. al algorithm, smartphones are capable of detecting falls from waist height, calculating if an impact has occurred, and determining if there has been a rapid orientation change. With this, smartphones can be used to monitor motorcycles for possible accident scenarios. Additionally, the Android operating system has features that are more than capable of building such an application. Programmers have access to tools that allow sensor manipulation and location tracking which aids in building a reliable smartphone application.

Another discovery was made during testing; the researchers found there was a low upper limit to the values the accelerometer can obtain. With the Samsung Galaxy S3 Mini, the upper limit of the sum vector was 3.464031g. Although this is sufficient to detect waist-height impacts, further testing should be done to see if it is viable for detection of accidents with larger scopes, higher falls, and bigger situations. i.e. real motorcycle accidents.

The researchers also found that location tracking does not require any subscription to a mobile data plan. Initially this was the assumption, however upon development and testing, the location of the application user can in fact be determined with the smartphone's GPS capabilities or nearby cell towers without spending currency on a data plan. Currency would only be required to send the messages to the defined contacts.

The research was able to produce a mobile application of a previously device-dependent implementation. Instead of utilizing commercial products that made the user equip a custom-made device for detecting falls, the researchers' application can emulate the same function with any Android device that meets the application's constraints of having built-in sensors and having a system version higher than Android 4.0. It was also able to notify multiple contacts at once automatically, immediately after a positive detection. The resulting application can be built upon by future researchers interested in further studies and implementation of similar mobile applications.

The researchers, however, were not able to deal with several issues with the implementation and testing of the application. The researchers recommend building a more presentable user interface for the application, in accordance with the best practices of Android interface design. The researchers also propose the inclusion of a built-in graphical interface of the user's location in the form of a Google Maps screenshot or implementation. An actual connection to Emergency Response Units and paramedics with the employment of this application is also exemplary.

The researchers advocate the streamlining of the detection process by utilizing a more explicit and consistent form of multithreading as opposed to the Android system's built-in implicit concurrency support. More study may also be done on the capability of smartphones and telecommunications carriers to consistently send multipart text messages, as compared to sending multiple text messages, noting that these two different implementations would consume the same amount of currency regardless.

The researchers also recommend further study into the hardware capabilities of smartphones to detect and record large amounts of force, speed, and orientation as compared to its current incarnation as devices with sensors that are sensitive to small amounts of these values. In line with this, harsher and stricter testing of the application is recommended. Specifically, harsh, live testing of the application in motorcycle accidents inside a controlled and safe environment is ideal.

Lastly, future researchers can look into making the monitoring aspect of the application a background service, instead of making it a stand-alone application. That way, the application can continuously run and the user no longer needs to start the application every time they are driving. Researchers would have to see how this would impact power consumption and if it is a viable method for monitoring accidents.

## DEFINITION OF TERMS

**Accelerometer** is a device that measures the acceleration a certain object experiences on a given axis by using a mass at rest as a frame of reference. Some accelerometers can only measure on one axis, while others can measure on at most three axes; the x-axis, y-axis, and z-axis

**Algorithm** refers to a logical procedure, or a set of instructions, used to solve a problem or perform calculations

**Application** is a software designed to run or execute on a computer to perform useful tasks. Mobile applications are thus applications designed for use on mobile devices such as smartphones or tablets.

**Automobile** is a vehicle intended for use on roads, which transport people rather than goods, and typically have four wheels on two axles.

**Android Operating System** is an operating system, owned by Google Inc., primarily designed for mobile devices such as smartphones and tablets.

**G-force (g)** aka **Acceleration of Gravity** is the acceleration of any object moving under the sole influence of gravity, which is $9.81 m/s^2$. A normal value of *g* exerted upon a person on the surface of the Earth is 1g.

**Global Positioning System (GPS)** is a navigation system maintained by the United States government that utilizes satellites in medium Earth orbit to provide location and time information to anyone with a GPS receiver.

**Gyroscope** is a device used to measure or maintain the orientation of an object.

**Open Source (software)** is the development or production of computer software with its source code licensed and made accessible to the general public for study, alteration, and distribution.

**Operating System** refers to a collection of essential software that manages computer hardware resources. Several functions of an operating system include memory management, file system management, security, input/output management, etc.

**Smartphone** is a cellular phone with more advanced capabilities which allow it to perform extended functions such as connecting to the World Wide Web, playing media, capturing photographs, utilizing GPS navigation, having a touchscreen interface, etc.

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# APPENDICES

## Appendix A | Transmittal Letter 1

Computer Science Department
University of San Carlos
P. del Rosario Street
Cebu City, Philippines 6000

To Whom It May Concern,

Enclosed is an application for detecting motorcycle accidents and delivering emergency messages to preconfigured contact numbers. This thesis research was composed in compliance with the requirements for the Degree of Bachelor of Science in Computer Science of the University of San Carlos. It is titled *Motorcycle Accident Detection Application for Android Smartphones*.

Under Chapter 1 of the report, the Rationale of the Study, Statement of the Problem, General and Specific Objectives, Significance of the Study, and Scope and Limitation are outlined. Chapter 2 covers a number of related researches under the Review of Literature. These past researchers help rationalize the algorithms explained in this report. Chapter 3 discusses the methodology that will be used to complete the research.

The purpose of the application is to provide a way for immediate contacts of the user to be informed that the user has just been in an accident. This allows the contacts to take action they deem necessary. Although within the report there are statistics provided that describe the current numerical figures in motorcycle accidents, it must be clarified that the purpose of this application is not to reduce the number of motorcycle accidents in a given time period. Instead, the primary role of this Android application is to act as a bridge between the user and his close relations in times after a motorcycle accident has occurred, when the user may be injured or unconscious.

Sincerely,

| | |
|---|---|
| Rafael Bacus<br>BS Computer Science Student | Carl Patrick Agbisit<br>BS Computer Science Student |

endorsed by adviser: Archival Sebial, MSCS ____________________

**Appendix A | Transmittal Letter 2**

Respondent Address

Dear Respondent,

We are students at the University of San Carlos and are conducting a survey concerning motorcycles and an accident detection application. Recent statistics have shown an increasing percentage of motorcycle accidents in the Philippines, as well as an increase in dead-on-arrival cases. Our group is proposing an application on Android Smartphones that will be able to detect a motorcycle accident by using the onboard sensors to determine if the driver has fallen from his vehicle. Once an accident has been identified, an emergency message will be sent to contact numbers preconfigured by the user of the application. Along with this message, the location of the user will be sent as well.

We are interested to know if such an application would be beneficial to those who drive a motorcycle, or even those who have relations with motorcyclists. Enclosed is the questionnaire. Please feel free to ask us any questions that you may have concerning this survey.

Thank You.

| | |
|---|---|
| Rafael Bacus | Carl Patrick Agbisit |
| BS Computer Science Student | BS Computer Science Student |

endorsed by adviser: Archival Sebial, MSCS ____________________

**Appendix B | Research Instruments**

The following are likely instruments the researchers will use to complete this research:

- Android Smartphone capable of supporting at least Android Operating System Version 4.0 “Ice Cream Sandwich”
- Eclipse Integrated Development Environment (IDE)
- Android Software Development Kit (SDK)
- Application Development Tools (ADT) plugin for Eclipse IDE
- Questionnaire:
    1. Gender
    2. Age
    3. “Have you personally driven a motorcycle before?”
    4. “How many members in your immediate family own or regularly drive a motorcycle?”
    5. “How many of your friends drive a motorcycle?”
    6. “How useful would this application be for motorcycle drivers?”
    7. “How useful would this application be for motorcycle passengers?
    8. “Would you recommend this application to friends/family that drive a motorcycle?”
    9. “How alarming is it to you when you hear of a motorcycle accident?”
    10. “How quickly do you think are ambulances capable of responding to emergency calls?”
    11. “How quickly do you think are ambulances capable of arriving at the location of an accident?”
    12. “If this application was offered at a low cost, would you purchase it?”
    13. “How useful do you think this app would be if it were linked to emergency response teams?”

14. “Are you more likely or less likely to spend money on this app if it were linked to emergency response teams?”
15. “Are you subscribed to a mobile data plan where you have internet access?”

**Appendix C | Timetable of Activities**

| | April | May | June | July | August | September | October |
|---|---|---|---|---|---|---|---|
| Review Android API | * * | | | | | | |
| Design Classes | * * * * | | | | | | |
| Survey/Data Gathering | * | | | | | | |
| Code Fall Detection Algorithm | | * * * * | * * | | | | |
| Code User Interface | | | * * | * * * * | | | |
| Test & Evaluate Application | | | | | * * | * * | |
| Revise Application | | | | | * * * * | * * * * | |
| Finalize Project | | | | | | | * * * |

* one week

## Appendix D | Budget

| No. | Item | Cost |
|---|---|---|
| 1 | Used Android Smartphone | 3000 Php |
| 2 | Sports Mat | 400 Php |
| 3 | Printing Costs | 1500 Php |
| 4 | Load | 300 Php |

# USER'S MANUAL

## 1. Introduction

### 1.1. System Requirements

The user must own an Android Smartphone running on Android 4.0 or higher and the smartphone must have both an accelerometer and a gyroscope present. The user must also be able to send text messages to other phones, which may include additional charges (load) depending on their network carrier.

### 1.2. Installation

The user must use the compiled apk file of the application stored in the user's phone to install the application. In order to do this, the user must allow the smartphone to install applications from unknown sources.

1. Access the phone settings and look for Security
2. Under Device Administration, check the setting for Unknown sources which will allow the installation of apps from sources other than the Play Store.
3. Navigate to where the apk file is stored and install the application

The application will request permission to send SMS messages (which may incur additional charges), obtain a precise location (GPS and network-based), and read contacts from the phonebook (adding contact to emergency contact list).

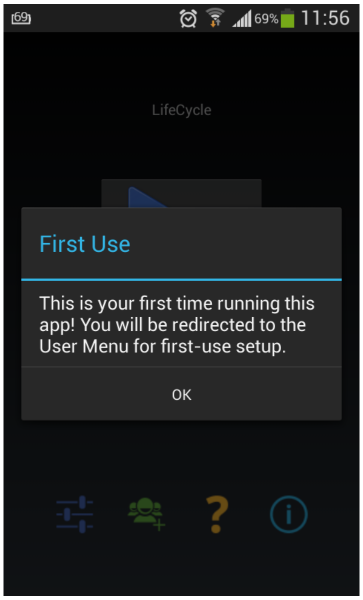
## 2. Getting Started

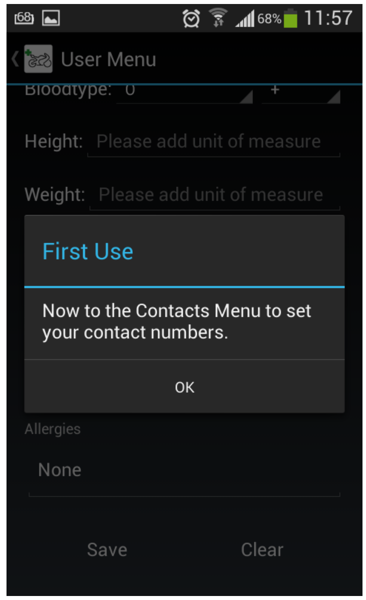
On the user's first run of LifeCycle, they are guided through the application to input their personal and medical information. The user's blood type is a required field and must be set before they can continue. After, the user can then populate their list of emergency contacts. Each contact must also have their phone number set. Once at least one contact has been provided, the application can allow the user to monitor for an accident.

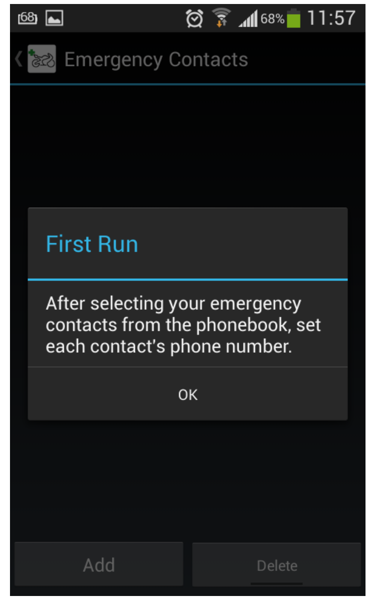
## 3. Main Menu

### 3.1. First Run

As mentioned previously, the user must navigate through each menu and setup the application on their first time use.

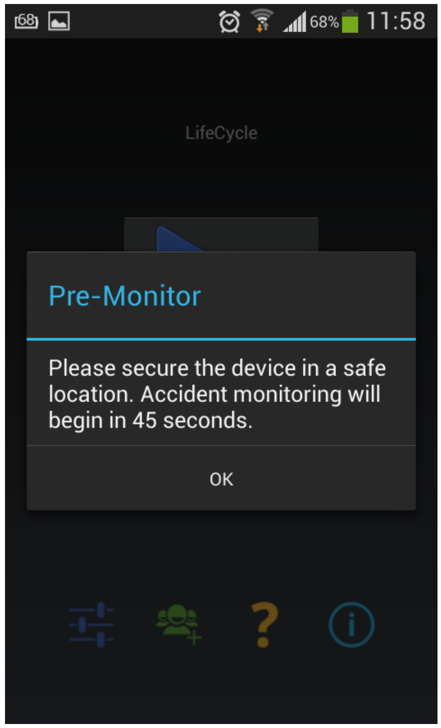


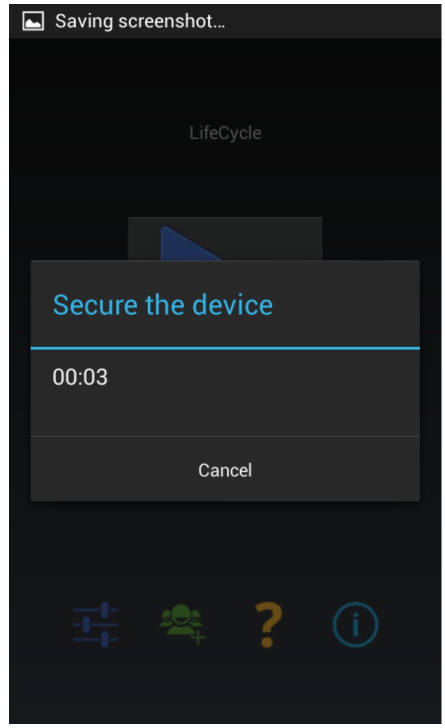



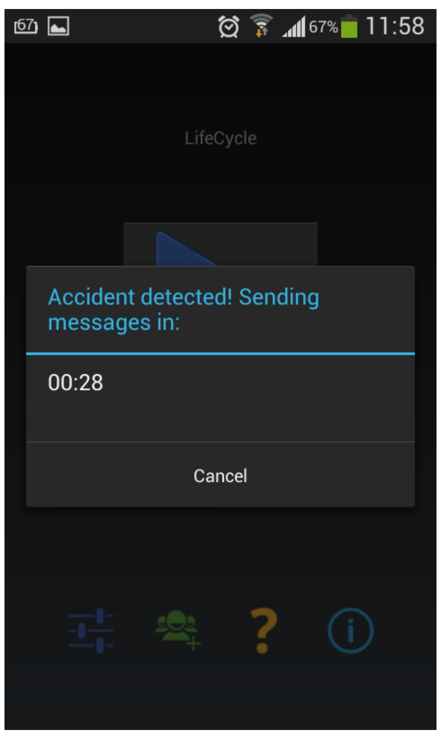

### 3.2. Monitoring Phase

After providing all required information, the user can then begin monitoring for accidents. Simply press on the [Play] button and the user will be given 45 seconds to secure the device in a safe location. The most recommended location would be in the motorcycle's compartment or in a jacket pocket. The user is advised **NOT** to use their phone once they are operating the vehicle, for their own safety.




### 3.3. Detection Phase




Once an accident has been detected, the application will begin a countdown timer, giving the user an opportunity to cancel the message-sending functionality of the application. This feature was designed in order to prevent sending messages during a false accident, such as dropping your phone during normal use.

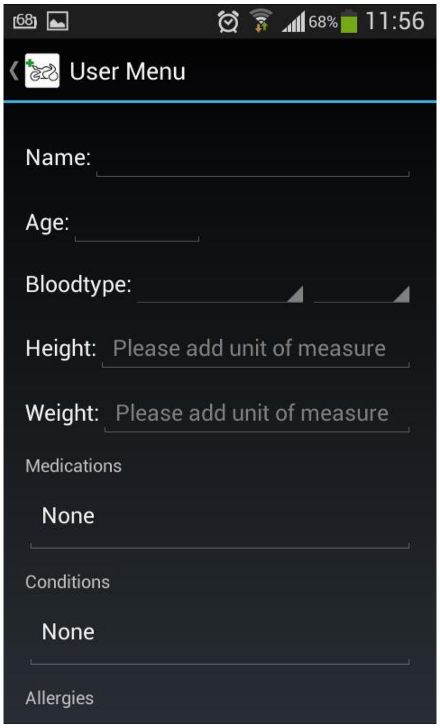
While the countdown timer is running, the application will obtain the user's present location either through the smartphone's GPS functionality or through network-based sources such as Wifi or cell towers nearest to the user. The application will prioritize network-based location tracking because it is much faster than GPS location tracking and requires less power but is less accurate than GPS.

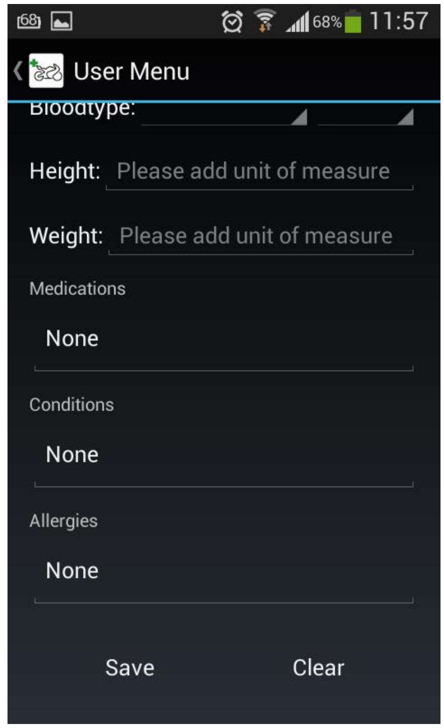
Additionally, the application will play an alarm sound while the countdown timer is active. This serves a multi-purpose by letting the user know that the application has detected an accident and the countdown timer has started, as well as giving the user an anchor to focus on in the event they are mildly or severely disoriented after the accident.

If the user has not cancelled the message-sending functionality, all contacts listed in the user's Emergency Contacts list will be notified of the accident. They will receive the user's emergency message, location via Google Maps link, and medical information (blood type, medications, conditions, and allergies).

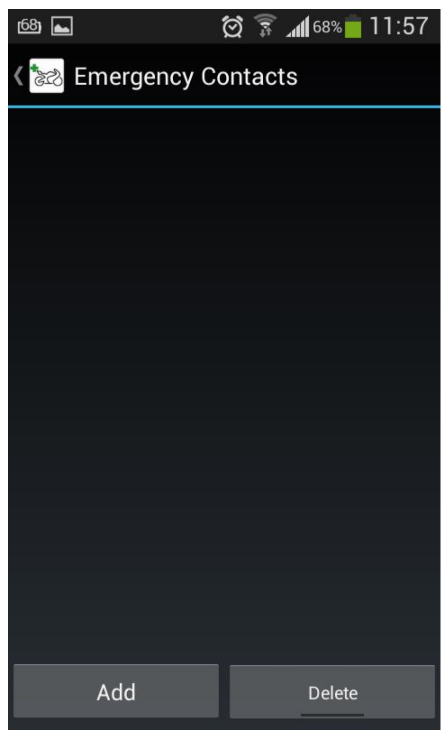
**4. User Menu**

In this screen, the user is able to input and modify his personal and medical information. All of the fields in this screen are optional, except for blood type. The values of conditions, medications, and allergies all default to "None" if they are left blank. The user stores this data into the application by pressing the [Save] button. The user is also able to clear the stored data associated in this screen by pressing the [Clear] button.



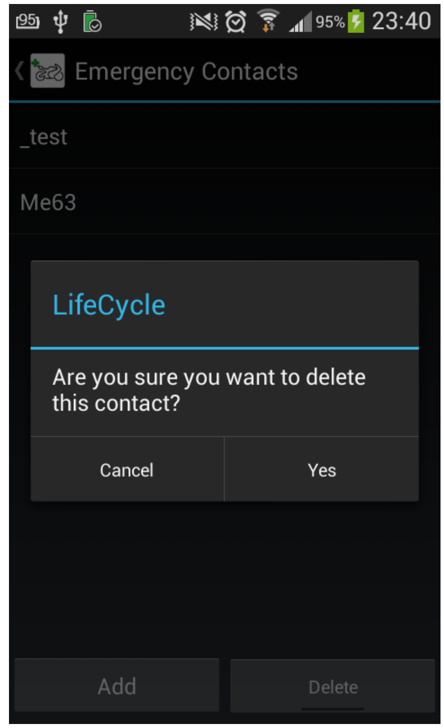




## 5. Contacts Menu




The Contacts menu screen is responsible for storing and editing the list of emergency contacts that will also be the recipients for the application's accident notification. The screen is initially empty, but will require the user to define at least one emergency contact before it safely exits out of the screen.

The user can add contacts by pressing the [Add] button. This will prompt the user to select a contact from his phone's contact list. The user must then select a phone number to associate with that contact by pressing that entry in the contacts menu, pressing [Select a number], choosing the appropriate number, and clicking [Save].




The user is also able to delete contacts by pressing the [Delete] button. This lights up the button, and selecting a contact will prompt a dialog to appear, asking for confirmation if the user really wants to delete that contact from the emergency contacts list.

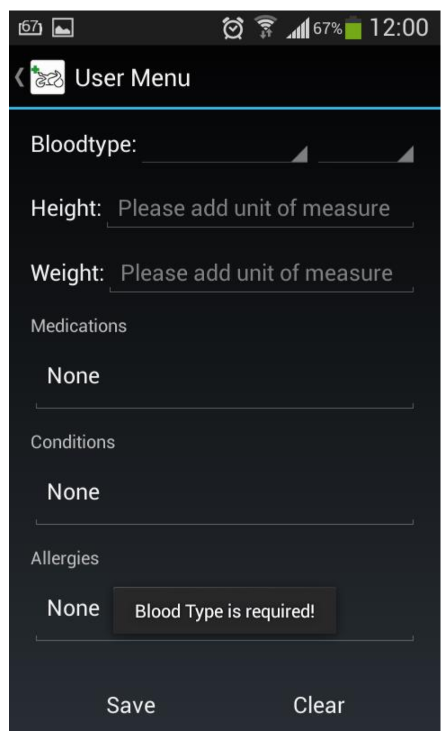
## 6. Messages

"First Use: This is your first time running this app! You will be redirected to the User Menu for first-use setup."

Description: This message will only appear upon the first time use of the application.

Action: The user simply clicks "OK" and will be redirected to the User Menu.

"Blood Type is required!"



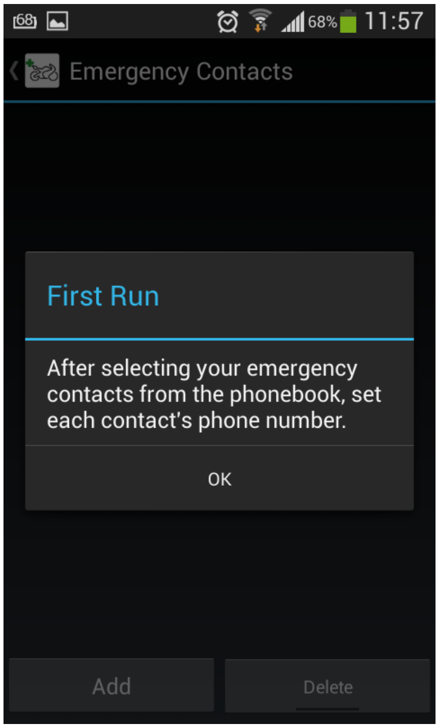

Description: The user will be notified of this if they have not selected their blood type in the User Menu.

Action: The user must select their blood type (O, A, B, AB) and an antigen (+, -).

"First Use: Now to the Contacts Menu to set your contact numbers."

Description: This message will only appear upon the first time use of the application.

Action: The user simply clicks "OK" and will be redirected to the Contacts Menu.




"First Use: After selecting your emergency contacts from the phonebook, set each contact's phone number."

Description: This message will only appear upon the first time use of the application.

Action: Users must set the phone number of each contact before they can exit the Contacts Menu.

"Must have at least one contact"

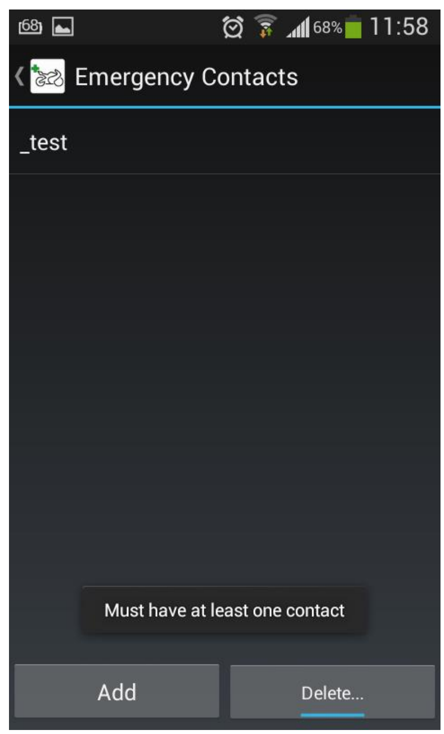
Description: This message will appear if the user attempts to delete all contacts. A minimum of one contact must always be in the emergency contact list.

Action: The user must add another contact before deleting the contact they wish to delete.

"Contacts Menu: Set the phone number for the following contacts: []"

Description: This message will appear if the user attempts to leave the Contacts Menu when at least one contact's phone number has not been set yet.

Action: For each contact, the user must set a phone number.




"Pre-Monitor: Please secure the device in a safe location. Accident monitoring will begin in 45 seconds."

Description: The message displays every time the user presses the [Play] button.

Action: The user simply clicks “OK” and the application will begin monitoring.

“Secure the device: 00:XX”

Description: This message will appear once the Pre-Monitor dialog has been closed upon clicking “OK.”

Action: The user is given 45 seconds to secure the device in a safe location.

“Accident detected! Sending messages in: 00:XX”

Description: This message will appear once an accident has been detected.

Action: The user can decide within 30 seconds to let the timer finish, in which the application will send out the messages to each emergency contact, or the user can click “Cancel” to stop the timer.

“Pre-Monitor: You have not set any emergency contacts.”

Description: This message will appear if the user attempts to start monitoring when there have been no emergency contacts set.

Action: The user must navigate to the Contacts Menu and set at least one contact.

**CURRICULUM VITAE**

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Civil Status: Single

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University of San Carlos
Bachelor of Science in Computer Science
Tertiary Level (2012 – Present)

Ateneo de Davao University
Bachelor of Science in Computer Science
Tertiary Level (2011 – 2012)

Alpharetta High School
Secondary Level (2007 – 2011)

Hopewell Middle School
Intermediate Level (2004 – 2007)

Manning Oaks Elementary School
Primary level (1999 – 2004)

**Technical Skills**

Programming Languages: C, Java, HTML, CSS, JavaScript, PHP, SQL
Slim3 MVC Framework / Google Datastore
Android Development
CodeIgniter PHP Framework

**Work Experience**

Savvysherpa Asia Inc. (Internship)

**Trainings**

N/A

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Religion: Agnostic
Civil Status: Single

**Education**

University of San Carlos
Bachelor of Science in Computer Science
Tertiary Level (2012 – Present)

De La Salle University
Bachelor of Science in Computer System Engineering
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Caritas Don Bosco School
Secondary Level (2006 – 2010)

Caritas Don Bosco School
Primary Level (2003 – 2006)

Colegio de San Juan de Letran Intramuros
Primary Level (2000 – 2003)

**Technical Skills**

Programming Languages: C, Java, HTML, CSS, JavaScript, PHP, SQL
Spring3 MVC Framework
CodeIgniter PHP Framework

**Work Experience**

Alliance Software, Inc. (Internship)

**Trainings**

N/A