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Android Application for Car Black Box with Cloud Storage

Wan Hazimah Wan Ismail
Universiti Kuala Lumpur
UniKL MIIT, Jalan Sultan Ismail,
Kuala Lumpur, Malaysia
wanhazimah@unikl.edu.my

Herny Ramadhani Mohd Husny
Universiti Kuala Lumpur
UniKL MIIT, Jalan Sultan Ismail,
Kuala Lumpur, Malaysia
herny@unikl.edu.my

Clarence Indit Anak Janang
Universiti Kuala Lumpur
UniKL MIIT, Jalan Sultan Ismail,
Kuala Lumpur, Malaysia
clarence.indit@gmail.com

Norhaiza Ya Abdullah
Universiti Kuala Lumpur
UniKL MIIT, Jalan Sultan Ismail,
Kuala Lumpur, Malaysia
norhaizaya@unikl.edu.my

Abstract— **In Malaysia, a lot of concern is directed towards road accident statistics which rises alarmingly high especially during the festive breaks. Evidence from the accident cases are very important for investigation purpose in order to know the root cause of the incident. Normally, the evidence can be obtained from the black box recorder of the vehicles. Car black box is a car travelling data recorder where it used in a car as digital electronic recording equipment. The data from the car black box is vital as it can be used for both the police and insurance companies in reconstruction of the events before the accident or related crimes. Besides that, it will also bring a number of benefits for the car's owner. Therefore, the rising of new technology nowadays has brought a lot of revolution in new invention of car black box. It brings to new invention of traditional car black box into new type of mobile application car black box which is design for android smartphone. Smartphone has been chosen as a medium for this application since everyone is using smartphone as a part of their life need as its mobility and convenience to users. Besides that, the requirement based on android application able to help them solve their problems in daily life is high. Car Black Box Mobile Application with Cloud System was developed to allow the car user to record video and Google Maps route as their evidence if user was involved in a car accident or related crimes. This application able to protect the data from loses and ruined by the unauthorized user where it has cloud data backup system and it also implemented AES-128 encryption method in order to secure the data. It is very significant to have this application as it can help the car's owner, police and insurance companies for investigating car accidents or crimes according to the evidence.**

Keywords—Car Black Box; AES Encryption; Android; Android Application.

I. INTRODUCTION

Nowadays, automobiles have become one of the important needs in our daily lives. The numbers of vehicles have grown exponentially since it makes people's lives easier and better.

According to The Nielson Global Survey of Automative Demand [1], Malaysia was the third place in the world of car ownership which is 93% compared to other South-East Asia company such as Philliphines and Indonesia. Malaysia also has the highest incidence of multiple car ownership globally with 54% of households having more than one car. Based on this increment, the number of road accidents have also kept in pace with this number [2]. Statistics that revealed by the Bukit Aman Traffic Unit shows that in 2014, there were about 65,883 accident cases on Malaysian roads involving car drivers and motorcyclists. According to this statistics, the accident cases was at least 5.4 percent higher than the 62,519 cases that recorded in 2013 [3].

By having a car black box that mounted inside the car, it can minimize the accident cases since the car black box able to record, save, display and print the speed, mileage, time, and also other information about the car condition that related to driving safety. Besides that, it also plays an important role in preventing fatigue driving, over speed and motoring offences, analyzing the accident, enforcing traffic management and transportation, restricting the driver's malpractice, and as well as ensuring driving safety of the car [4]. Car black box can also be used as car forensic not only for car accident cases but also for any related crimes where it able to record the incident that could be critical clues for investigating the car accidents or crimes [5].

It is very valuable to have a car black box nowadays since our society can realize significant benefits from it. In the past, because nobody could get accurate information about a car accident, the responsibility was often based on presumption. It makes that someone who was actually a victim was sometimes mistaken for an offender. All of these problems able to be solved by having the car black boxes where the real victim can be indentified by watching the recorded evidence video [6].

Besides that, the stored data also increasingly being used to identify safety problems in cars and as evidence in traffic accidents and criminal cases.

Even though there is great significant of having the car black box mounted on each car, but not all of the cars installed with the car black boxes. This is due to the costing and privacy issues. Therefore, the new invention of car black box has been developed. This application was developed for car users where it's able to record video and Google Maps route as evidence for some incidents that happened such as car accident, street viewing, and crimes.

The application was based on mobile application which used Android as a platform. Android application has been chosen since it was free and easy to install into users android smartphone. Besides that, it is more cost savings and also in line with technological advanced. The application also integrated with the cloud system which makes this application differs from the existing applications.

The features that have in the Car Black Box Mobile Application with Cloud System are, able to record real-time actions when users drive on the road and at the same time able to record the Google Maps route, and the data able to save on the cloud storage. It can give an advantage for user to save their evidence if the accident or any related crimes happened. The function of the cloud system is to act as a backup storage for the device which is the car black box application. All the data were saved to the cloud storage in order to prevent the data from lost or damage because of any incidents such as car crash or steal by the thief. Moreover, the application also implement some security features on it in order to create high valuable to this application. The security methods that been implement in this application are authentication and encryption. Authentication has been applied to authorize the person who can view the data while encryption is to protect the data from being edited or manipulated by unauthorized person.

For the overall function of this application, it consists of four modules which are recorded, authentication and encryption, decryption, and backup. The details at the following:

- Record Modules
  This application able the car users to record video with the route from the Google Maps when they drive on the road. This function allows the user to prove evidence by using the recorded video from the application to solve the problems if the car user involved in the accident or any related crimes.
  - Authentication and Encryption Modules
    This function is for users to encrypt the recorded video to prevent from lost, edited or manipulated by the unauthorized person. The authentication function is to protect the recorded video been accessed by another person without permission.
  - Decryption Modules

Decryption phase is a phase where the car users want to view the recorded video that been encrypted from the application.
- Backup Modules
  By using this application, it allows the car users to make backup by uploading the recorded video to the cloud storage. This process can prevent the evidence from lost, damaged, or missing during the accident or any related crimes.

The details on the method used and the process that involved for the development of the application will be discussed on the following section.

II. METHODOLOGY

Car Black Box Mobile Application with Cloud System is a software based project. The method that been used to develop the application is based on Android platform. The version of the Android Operating System that able to support this application is Android 4.0.3 or higher. This application also is integrated with the cloud system. Dropbox has been chosen as the service to support the backup function that has in this application where all the data can be uploaded to the cloud storage. Besides the backup function, this application also able to encrypt and decrypt the recorded video for the security purposes. The encryption method that been implemented for this application is AES-128 encryption.

A. Android Application

The Android Operating System is an open source operating system where it was currently developed by Google Company since 2005 until today. The Android Operating System was design based on Linux where the operating system primarily written in Java and it was primarily used in mobile devices such as smartphones [7]. It also based on the modified version of the Linux kernel 2.6 and it was licenced under Apache since Google owns the Android Operating System. Besides that, it was run under the Dalvik Virtual Machine or as known as VM and Java Based object oriented application framework.

A Mobile Application or most commonly known as an App is a short form called by smartphone user. It is a type of application software where it was designed to run on smartphone or tablet. Mobile Applications was made with the same function as an application that have on personal computer to let users experience the application similar services as personal computer.

Currently, the development of mobile application has evolved and it was very helpful invention for user to bring PC-based applications everywhere and anywhere [8]. The most widely application that been developed was based on android platform [7]. An android applications is a Java-based programming language software application where it was run under android platform. In order to run the android applications, android platform was invented for mobile devices where it run Android Operating System.

Even though an android application can be made available through the website by developers, most of the android application are published and uploaded on the android market in Google Play. This will make the number of android mobile application in android industry increased. The android applications can be found free or priced on both android market features. Android developer able to download the software such as Android Software Development Kit or as known as SDK tools from the android website. This SDK software can be used for developing an android application. The SDK software comprises with sample of codes, tools and some relevant document that related with android application development [7].

B. Dropbox Cloud Storage

Dropbox Cloud Storage is the latest form of web storage services that provided user with multiple connected servers comprise a cloud. Cloud storage describes a method of configuring server that can give a flexible way to allow user to use the most affordable and reliable web infrastructure. The existing of cloud storage technology help a lot of programmers to solve the traditional server problem that usually require high cost hardware and maintenance compares to cloud storage where it is more affordable cost for standalone system. Cloud storage services only charge user for what the resources they used in the cloud services feature. This can make user able to customize their own cloud storage according to their system requirement [9].

Beside that, cloud storage have it own security feature to protect the data and keep it safe on storage. Information that hosted in the cloud storage was protected by cloud host system. It is against hardware failure where the system is automated backups to ensure that data server stay safe. Cloud system is hard to be attack by hacker across of the network because of the concept of cloud service and security features that has been implemented on the system. Based on the security features, it makes the cloud system impossible to shutdown by DoS attack [10]. The existing of cloud hosting able to assist a lot of programmers to host their system with more advanced technology compare to traditional server.

C. AES Encryption

Advance Encryption standards (AES) is one of the famous encryption nowadays, since the ability to secure the data with complex calculation that make it difficult to decrypt by the attacker. AES encryption was came from the results of a three-year's compilation by United State Governments called National Institute of Standards (NIST) to find the best encryption for government used to encrypt their sensitive data safely [11].

AES encryption method also known as Rijndael where this encryption was adopted by National Institude of Standards (NIST) as a Federal Information Processing Standard. However, WinZip with AES encryption available in two different strengths which were 128-bit AES encryption and 256-bit AES encryption. The strength between these two methods was based on the size of the encryption keys where it been used to encrypt the data.

Besides that, the strength of AES encryption can be compared through the size of AES encryption bit where the more bits was better. For this case, 256-bit AES encryption was stronger than 128-bit AES encryption. However, both of these encryption methods able to provide significantly greater security compared to other encryption method [12]. The security of users' data were depends not only on the encryption method, but it also depends on the strength of users' password. A strong password can be find in length and composition that user made and the measures' user take to ensure that the password is disclosed from unauthorized third parties.

D. Comparison of Existing Application

There were various types of car black box that exist in the market. Most of the existing car black box able to record the video and information that related to car crashes or accidents. Besides that, the system able to help user to limit their car speed in accident-prone areas and send a message to emergency service and family member. The system also was mounted on the car system.

TABLE I.   COMPARISON OF PREVIOUS SYSTEM

Application	Features	Advantage	Disadvantage
Caro0 Pro [13]	Provide a feature for user to record video audio, speed of vehicle and send an emergency report via SMS and call.	The application using android smartphone which it easy for user to get it because nowadays people are using smartphone.	The application is expensive and doesn't have backup data for application.
Wireless black box report [14]	Provides a MEMS accelerometer and GPS tracking system to track vehicle speed and current location.	The system able to track vehicle speed and find current location. This system will send a message to emergency medical service and family member if car driver involved in accident.	This system only can be implement by authorized person and only record speed of vehicle.
Car Black Box with Speed Control [15]	Provides an availability for limiting the vehicle speed in accident-prone areas and record audio and video.	This system able to limit vehicle speed when in accident-prone areas. Besides that, it able to record audio and video.	The system require a lot of device to complete this system and more cost needed.
Car Black Box Mobile Application with Cloud System	Provides an availability for user to record real-time video with AES-128 encryption method and cloud storage for backup the video.	Car driver can record real-time video, encrypt their evidence and save their evidence into cloud storage services to prevent data from lost because of car crash.	The application only support android platform and just for android user.

The differences between the existing system and car black box mobile application with cloud system where the system was based on android mobile application and more focused on security of the recorded data that can be used as an evidence. Table 1 shows the comparison between the previous system with the system that been developed according to features, advantages, and disadvantages.

III. DEVELOPMENT

The development of the mobile application was based on the software platform which is android. The hardware needed for this application was a smartphone that support android operating system. The main process of the development was the integration between the application and the cloud system. All the programs were being developed by using Java and XML Programming. The details of the development process were discussed in the following section.

A. The Process Flow of the Mobile Application

In this system, there were four modules that have been developed which are recorded, authentication and encryption, decryption, and backup. According to Fig. 1, it shows the process flow that related with the four main modules of the application. For the record module, user able to record the real-time video and the video was saved in the android database which is SQLite database. Besides SQLite database, the recorded video also been saved in the cloud database. The storing process was synchronized between both databases. During the recording process, the Google Maps route was also being recorded. For the encryption module, the video that's been recorded was encrypted by using WinZip AES encryption in order to secure the data from being edited, deleted, and manipulated by the unauthorized person. The authorized user only can decrypt the recorded video since the application has an authentication system for security purpose. The application synchronizes the video automatically in order to do backup to the cloud database.
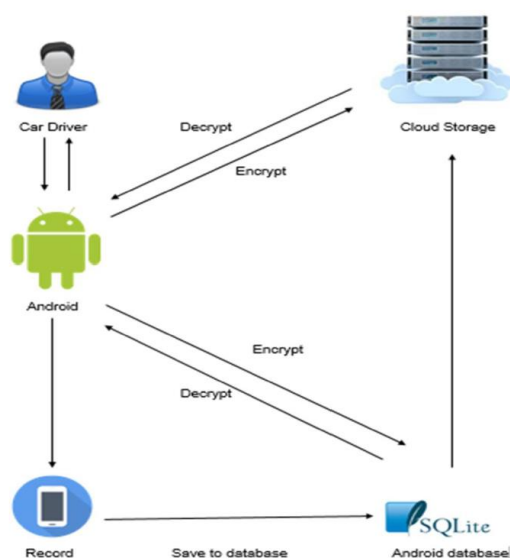

Fig. 1 Process Flow of the Mobile Application

B. The Integration Process of Mobile Application with the Cloud System

The cloud system that been used for this application is a Dropbox. Dropbox is a free web cloud storage services. In order to integrate the application with the Dropbox service, it has to prepared the Application Programming Interface (API) key through the website to give developer authority to integrate the application with the Dropbox service. The integration process was programmed by using Java source code with the API key that been given through website in order to connect the Dropbox services with the application. Fig. 2 shows the Dropbox website to obtain the API key.
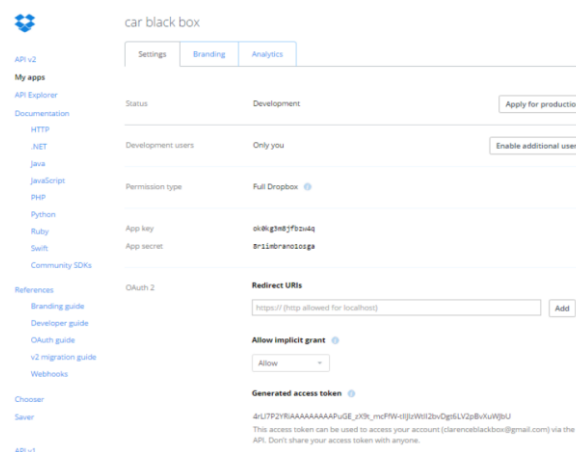

Figure 2 Dropbox Website for API Key

C. The Mobile Application Development

The software that was used for this application is Eclipse Java Development Tool. Java language was used in developing this system because of the compatibility, and robustness. In order to use the application, user need to login to the Dropbox service before able to record the video. During the recording process, the Google Maps route also been recorded automatically, then the recorded video will be uploaded to the Dropbox storage as a backup. The route that been recorded as an evidence is shown in Fig 3.

Figure 3 Example of Google Maps Route

The recorded video that been stored in the database has been encrypted by using AES encryption method. For the decryption process, user need to enter the private key as shown in Fig 4.
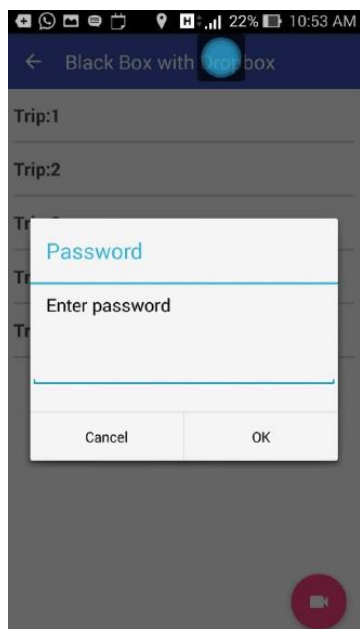

Figure 4 Interface for Authentication

IV. RESULTS AND FINDINGS

During system development, there were two categories of testing has conducted which were based on the system's functionality, and user acceptance. For the functionality of the system, there were three type of methods that been implemented

which are unit testing, integration testing, and system testing while for the user acceptance, User Acceptance Test (UAT) has been implemented. The testing process are needed for all development of the systems since this process able to measure the compliance of the system with its specified requirements. The feedback from the actual users also important in order to make sure that the system able to handle the required tasks in real-world scenarios, according to specifications.

A. Results of Functionality Testing

During the unit testing process, any errors on the source code of the system was tested. This process involves in problem solving of code errors in system development until it meets the expected outcome. After the correction on source code errors has been done and the system working like it was expected, the system can be evaluated through integration testing. Integration Testing also known as integration and testing (I & T). Integration testing is a system development process where the unit has been combined and tested through multiple ways to give the best results. It able to identifies problems on the system when units are combined. Therefore, it was very important to be implemented where it can identify errors on the system units.

In this testing process, there were five modules that were tested. The modules are Dropbox login, authentication and data encryption, video record and Google Maps tracker, upload recorded data to Dropbox, and logout. The results according to these test cases were shown in Table 2. This testing process was conducted by the developer of the system.

Table 2 Summary of the Funtionality Testing Results

No.	Test Cases	Test Condition	Expected Result	Actual Result
TC_01	Dropbox Login module	To test the integration of the Dropbox login with car black box application	Dropbox login can be done through car black box application	Pass
TC_02	Authentication and Data Encryption module	To test the authentication of the application, and encrypt/decrypt the recorded data by using AES encryption method	Able to authenticate the authorized user, and able to encrypt/decrypt the recorded data	Pass
TC_03	Video Record and Google Maps Tracker module	To test the recorded video and Google Maps tracking record	Both functionality work as expected on application	Pass
TC_04	Upload Recorded Data to Dropbox module	To test the uploaded function of the recorded data to Dropbox cloud service	Recorded data able to be uploaded to Dropbox cloud service	Pass
TC_05	Logout module	To test Logout functionality	The application able to logout successfully	Pass

B. *Results of User Acceptance Test (UAT)*

The application was tested on a group of 20 respondents where the respondents were the android smartphone user. The respondents need to install the application on their own smartphone. Once the application installed on user android smartphone, the users were started to use the application with provided guidelines. Based on this testing, users were evaluated the application interface and the use of functionality features on the application according to set of questions that been given. All questions were measured based on Likert Scale of five points ranging from strongly agree to strongly disagree. This questionnaire was used in order to evaluate user acceptance of the application and the results can be used for the improvement of the application in the future.

For the results of the UAT, it shows that the application is beneficial to the user since it able to assist the investigation process if accident or related crimes happen. Besides the mobility, this application also implemented the security features where the recorded video able to encrypt and decrypt. Therefore, the recorded video can be protected from being edited or manipulated by unauthorized person.

CONCLUSION

Car Black Box Mobile Application with Cloud System is the application that based on the android platform. This application able to record the video that can be the evidence if car crash or any related crimes happen while in the car. Besides video, the application also able to record the Google Maps route. The significant function of this application which difference from the existing applications is it integrated with the cloud system where this cloud act as a backup system.

By having this function, it able to prevent the evidence from lost, damaged, or missing during the accident or any related crimes. The other uncommon function that has in the application is where it implemented security features. The application able to encrypt and decrypt the recorded video that been uploaded to the cloud storage. Based on this function, it able to prevent the recorded video from lost, edited or manipulated by the unauthorized person. Besides that, this application also secure since only the authorized user able to access to the application. It is very significant to have this application because its mobility and convenience for every users. By having this application, the high costs of accident investigation will be reduced. Analysis of accidents and their causes can improve driver awareness in identifying and avoiding hazardous situations.

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