Department of Computer Science
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COMP4801 Final Year Project

A Mobile Application to help the Elderly to avoid Telephone Deception

Individual Report

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Abstract

Telephone deception has always been a common crime in Hong Kong and in recent years, it has increased in frequency and severity. In 2021, about one-third of the crime is related to deception and leads to over 800 million HKD loss due, which was the highest in the last five years. In order to slow or reverse this pathetic trend, our project has implemented a mobile application tailor-made for the elderly and their family members, to protect the potential victims, the elderly, from the telephone deception. The major feature of the application is sending warning notifications to family members, once the elderly receive a malicious call. There are also other features such as real-time location tracking, and call history review for the family members to track the activity of the elderly. In the coming future, the project team is going to enrich the feature set and deploy the application in cross-platform so that it can support users from different platforms. With this application, it is hoped that the number of telephone deceptions will have a significant depreciation in the future, and lead to enhancement of the public security of Hong Kong.

Project details and deliverables can be found on https://wp.cs.hku.hk/fyp21027/
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## Abbreviations and Acronyms

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<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>App</td>
<td>Application</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>UI</td>
<td>User Interface</td>
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<td>URL</td>
<td>Uniform Resource Locator</td>
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1. Introduction

1.1 Background and Motivation

The following subsections will introduce and analyze the situation of telephone deception in Hong Kong, as well as the importance of this issue. Also, related work will be discussed and compared to our project to show the necessity of developing a new mobile application.

1.1.1 Overview of Crime and Deception in Hong Kong

In the past few years, the crime rate in Hong Kong has been increasing by a decent percentage. Moreover, if one take a closer look and analyze different types of crime, one can find out that deception has been escalating at an abnormal rate.

As shown in Fig.1.1, there is an increasing trend in overall crime as well as deception crime. One can see the increasing trend started in 2018, and escalated significantly in 2020. The number of deception cases is more than 15000, which is almost double the previous years, while the average of the previous 9 years is less than 8000. One can also see the deception/crime ratio, as shown in Fig.1.1, about one-third of the crime that happens in Hong Kong is related to deception, and it remains increasing according to the latest data in 2022 [1]. There is no doubt that deception is an important issue in Hong Kong, but on the other hand, if suitable measures could be taken to solve this issue, the overall crime situation can be ameliorated significantly.
The increase in deception is a worrying issue. To solve this issue, one may need to study what types of cases happen the most and tackle them specifically. According to the statistic provided by the HK Police Force [4], among all types of deception, telephone deception caused the most significant amount of loss of over 800 million in 2021.

1.1.2 Telephone Deception in Recent Years
Telephone deception, also known as phone scams, refers to malicious phone calls from criminals that tend to make similar promises and threats, or ask you to pay in certain ways [5]. Telephone deception has always been a common crime in Hong Kong and in recent years, it has increased in both frequency and severity.

During the COVID-19 pandemic period, extensive use of internet communication makes people more susceptible to deception. Moreover, the bad economic environment has also contributed to motivating people to commit crimes. Combining these factors, one can see the significant surge in deception attempts.

Number of Telephone Deception Cases and Amount of Money Loss in 2016 - 2021

From Fig.1.2, one can see that the number of deception cases has once decreased to the lowest point in 2018, at 615 cases. And the number of cases is under control for about 2 years. However, the number has escalated again in 2020, to 1193 cases, and the amount of money losses increased substantially. The total amount of money lost in 2020 and 2021 was even higher than that of the sum of 2016 to 2019 total loss and caused over 800 HKD
millen loss [4]. Furthermore, the amount of loss highlighted in red in Fig.1.2 show the increase in severity. One can expect that 2022 will have a high chance of wiping the record.

1.1.3 Elderly and Telephone Deception

With telephone deception being the focus, further investigation has been made to identify the trend and the age group of victims.

The majority of the victims of telephone deception are the elderly. As the elderly do not have the ability to distinguish deception calls, they are always the most vulnerable group to telephone deception. The elderly usually receives phone calls from fake government officials asking them to make payments to certain bank accounts due to legal issues. Some criminals even pretend to be their relatives and ask them to transfer money for emergency purposes. The Elderly in Hong Kong has suffered serious financial losses in these telephone deception cases. Moreover, the largest scale telephone deception in Hong Kong history also happened in this age group.

Fig.1.3 News of HK’s biggest phone scam

In April of 2021, the record of money loss in deception has been broken by a telephone deception case (Fig.1.3). Criminals pretend to be Mainland Officials and request the 90-year-old elderly woman to transfer money due to legal issues, resulting in more than HK$250 million lost in a single telephone deception case. That was not only a breaking news in Hong Kong [3], but also caught the attention of the general public about the scam cases of the elderly.
The younger citizen who is aware of this issue may take preventive actions to protect their family members to avoid being the next target. In this case, using call block applications might be one of the measures.

1.2 Related Work
As mentioned in section 1.1, telephone deception has always been a common crime. During these years, many predecessors have tried to solve this issue. One of the most successful works is the HK Junk Call database. It collects millions of telephone numbers reported by users that are related to sales, deception, or advertising which is defined as junk calls. Furthermore, the database keeps updating, and users can help to report junk call telephone numbers as well. On top of that, it has once opened the API key for mobile application developers to develop call block applications. Some famous call block applications such as Whoscall, Jima Caller and Call Defender using the HK Junk Call database are the cases in point.

Whoscall was first released in 2010, and now it has expanded its business worldwide over 31 countries or regions. The application provides the feature to identify and decline incoming calls if it is classified as junk call in their own database, which they claim to be the largest database in East Asia. [6]

![Fig.1.4 Advertisement of Whoscall Premium](image)

However, the free version of Whoscall does not have access to the full database. The database auto-update feature is not able as well. Also, the application screen has a lot of
advertisements which may lead to trouble for users if they misclick it. Users have to pay for the premium version as shown in Fig.1.4 if they want to access the full features or have a better experience. For those senior users, they may not willing to use the application due to the payment issue.

Jima Caller is another call block application, which is developed by a local company. This application uses the HK Junk Call database to support its call block features. Moreover, this application is specifically designed for Hong Kong users, thus, it provides a localized algorithm to analyze the scam number patterns.

![Fig.1.5 Advertisement of Jima Caller (left)](image)

![Fig.1.6 Jima Caller Settings Screen (right)](image)

From Fig.1.5 and Fig.1.6, one can see some of the demo usages of Jima caller. At the bottom of Fig.1.5, one can see that Jima Caller is default using the autoblock feature with their AI classification of possible scam numbers. However, the AI classification of the phone numbers being the selling point of the application is also the shortage of this application. The application adds a phone number to the black list by their algorithm. Unfortunately, the algorithm is not always correct. Many users have reported that their friend’s or family members’ numbers were accidentally blocked by the app due to the misclassification by the algorithm. Currently, the feature of Jima Caller still has room for improvement, and it is not the perfect choice for elderly users.

Call Defender, another call block application, was developed by the same company that developed Whoscall. It is specialized for Hong Kong users, and mainly makes use of the HK Junk Call and Whoscall database as supplementary.
As shown in Fig.1.7, Call Defender has a rich set of functionality and users can make adjustments in detail. For younger users, it seems to be the best choice among the three call block applications that have been mentioned. However, such an application is not user-friendly for the elderly. This issue is not only limited to Call Defender but in fact, all of the existing call block applications required complicated settings, so that they will not accidentally block friendly incoming calls. The elderly may be able to use them or customize the application by themselves. Moreover, most applications are using text-heavy interfaces combined with small buttons which may cause input errors for the elderly. Consequently, elderly users having poor user experience may lead to giving up the applications as a result.

In fact, even though the call block applications have been released for more than ten years, the number of telephone deception cases is not under control yet. This is because criminals change their telephone numbers very frequently and it is impossible for any database to collect all of the numbers. And if the numbers are not in the database, the call blocker feature highly relies on the user settings or the algorithm classification quality. Moreover, these applications required complicated settings. Combined with the UI design
that is not suitable for the elderly, the majority of the victims of telephone deception are not protected by these apps.

To deal with this issue, our project will develop another tailor-made mobile application for the elderly and provide additional unique features that are different from the existing call block apps.

1.3 Objectives
This project aims to implement a mobile application tailor-made for the elderly and their family members in order to protect the elderly from the telephone deception case. The main feature is to alert and provide more information about the elderly’s activity to the family members, such as real-time location tracking and call history checking to see if there is any malicious call record. There will be two sets of user interface and features, specialized for the elderly user and family member users respectively. Hoping that with our new application, the increasing trend of deception cases can be ceased.

1.4 Project Contribution
Telephone deception has always been a tough issue that many predecessors have tried to solve. Still, telephone deception holds an important position among overall crimes in Hong Kong. Moreover, the rise of deception cases contributes to the majority increase in the number of crimes in Hong Kong in recent years. Our project aims to solve the issue, to protect the general public from deception. Hope that it can reduce the crime rate and enhance the public security of Hong Kong.

1.5 Outline of the Report
The report is divided into four chapters. The first chapter introduces the telephone deception situations as well as the related work of predecessors. It also provides the objectives of the project and elaborates on the significance of our work.

In chapter two, the methodology of the project will be explained in detail. Why and how the features are being designed. The backend concept and the considerations will be introduced. The external resource will be introduced. As the application is designed for the elderly, the simplicity of the user interface takes an important role, so it will be discussed in a separate section as well.
In chapter three, the final deliverable of the project will be presented. The application features will be introduced in detail as well as the backend features. The challenges and the measures that have been taken will be presented, and the future work plan will be mentioned as well.

In chapter four, a conclusion of this report will be provided. It sums up the major contribution of the project with a highlight of the major features of the application.
2. Methodology

2.1 Introduction
This chapter introduces and justifies the design concept and features of the mobile application. Section 2.2 introduces the feature design and considerations during the development stage, as well as how the backend logic should work like. Section 2.3 and 2.4 will introduce the platform for development and the external resources that we choose to use. Section 2.5 will talk about the application user interface design.

2.2 Design Concept
As mentioned in section 1.2, there are multiple mobile applications available for blocking malicious calls existing for years. Yet, it cannot stop the increasing trend of telephone deception cases. It is because criminals change their phone numbers frequently, and it is impossible for any database to collect all of the malicious call numbers. Hence, the call blocker feature highly relies on the user settings or the algorithm classification quality which makes the application unreliable in this case. Not all of the elderly are familiar with their smartphone, not to mention those complicated application settings. Nevertheless, another reason that the elderly are the major target of telephone deception is that they do not have the ability to handle deception calls, even with the help of those applications.

In order to deal with the above issues, our project will implement an alternative mobile application that is tailor-made for the case of the elderly and their family members. Both the elderly and the family members have to install the application on their mobile phones, but they will have different sets of user interfaces and features. The main application for elderly users required zero settings and should have a user-friendly interface. It mainly provides data upload features and a basic call history checker, and both of them should be done in the background automatically. On the other hand, a companion application for the family members will do all of the settings including the connection with the elderly main app. This design can highly reduce the difficulty for the elderly to use the application and provide a better user experience to the elderly.

In terms of features provided, the most important feature of the application is to detect suspicious incoming calls and notify family members about that. Also, family members are able to check the call history of the elderly with the HK Junk Call classified result to see if there is any suspicious call record. In order to achieve this result, the application makes use of Google Real-time Firebase to store and transmit the data. To make it easier to understand, a diagram demonstrating the data communication logic of the application is provided below.
Fig. 2.1 The logic of the application

Fig. 2.1 demonstrated an example usage of the application. Assume that the family companion app has finished the connection setting. When a phone calls the elderly, the application will first check whether the number is in the contact list of the elderly. If it is in the list, the app will directly update the call record in the firebase and no further checking will proceed. Otherwise, it will check the phone number with the HK Junk Call database and send a warning notification to the elderly if it is malicious. After that, no matter the check result is safe or malicious, the call record and the check result will be uploaded to the firebase. For those family members who connected with the elderly will automatically download the latest call history of the elderly and they will receive a warning notification as well if there is any malicious call record. Hence, family members can contact the elderly immediately right after a suspicious call is received and make sure that the elderly did not get deceived.

Secondly, family members can check the real-time location of the elderly through the application. This feature is designed for those family members who are busy at work and inconvenient to be disturbed by the notification. With these features, they can check the activity of the elderly whenever they have time so that they can contact the elderly once they have found something abnormal. For example, if the elderly’s location is reported at the bank right after she received a malicious, that may be a signal for the family members to take action. In case the elderly is missing, family members can find the location of the elderly easily through our application as well.

Our design concept is to provide more information about the elderly’s activity to the family members. Different from all the existing applications, we aim to assist users in
making suitable actions in time instead of interfering with the normal user activity. So, there will not be a forced call block feature. The following section will introduce the development platform and external resources of our project.

2.3 Development Platform
The application will be developed with React Native, which is an open-source UI software framework that allows users to develop cross-platform applications. Although Android phones are much more popular than iOS among the elderly in Hong Kong, we aim to satisfy the needs of stakeholders from different telephone operation platforms. Developing in a cross-platform framework can reduce the difficulty when publishing the application.

2.4 External Resources
This section will introduce the external resources that are being used to support some basic features of the application.

2.4.1 HK Junk Call Database
As mentioned in section 1.2, HK Junk Call is the largest phone number database in Hong Kong. Many existing call block applications are using this database as well. Our application will use this database to support the phone number checking feature as well. However, HK Junk Call has stopped accepting application programming interface (API) key applications since 2017. As our application cannot directly link with the database, we will use the web scraping method to catch data through the website.

From Fig.2.2, one can see the structure of the HK Junk Call URL. To check a telephone number, one can simply change the number after “/?ft=” and it will return the resulting webpage for that phone number. The example above should return a webpage reporting the number belongs to HKU and it should be on the white list. After that, our application needs to do web scraping to capture the result and display it in the interface.
2.4.2 Google Maps
Google Maps is the most popular mapping service around the world, sharing over 80% market share for mobile apps [2]. It provides a free maps API for mobile, and the API has native support for JavaScript, the same programming language used by React Native. The project team believe integrating Google Maps into our application could help us to deliver reliable location-based features.

![Google Maps](image)

Fig.2.3 location tracking with Google Maps API support
Furthermore, with this API, users can switch to Google Maps application to search for the fastest paths to reach a specific location, as shown in the lower right corner of Fig.2.3. In case the elderly is missing in an abnormal location, family members can always search for paths to reach the elderly through the external application.

2.4.3 Firebase
Firebase is a platform developed by Google for creating mobile and web applications. It is free of charge and allows real-time updates and retrieving data in the database. Our application makes use of it to store and update the real-time user’s activity. React Native Firebase package that we used, is an officially recommended collection of packages that brings React Native support for all the Firebase services [7]. As it is officially supported, it is a convenient choice of database for react-native platform developers.
2.5 User Interface Design

As the application is tailor-made for the elderly, the user interface must be as simple as possible. All features and options must be easy to understand. As mentioned in section 2.2, most of the settings can be done on the linked family member’s side, and the elderly need not do any initial setting. Thus, there are only a few buttons required on the elderly’s application. The following Fig.2.5 is an example of a user interface that is suitable for elderly users.

![Simple user interface](image)

From Fig.2.4, one can see that there are only a few buttons on the screen to reduce the complexity of the application. The icons of the function are easy to understand and memorize. Also, the font size is large enough for the elderly with eye disease to read. Enlarging the buttons can prevent the elderly from making mistakes when playing with their phone as well.
Fig. 2.5 iPhone navigation menu

Fig. 2.6 Samsung navigation menu

Fig. 2.5 is screenshots from iPhone iOS 15. For iOS, icons are used as the main indicator for different functions and use text descriptions as support. Navigation with text combined with icons makes users easier to understand each feature of the application in case they are not familiar with it. Moreover, it can help users to choose the feature without reading the text for long terms after they memorize the meaning of each icon, hence, boosting the selection speed of users when trying to find a specific feature.

On the other hand, from Fig. 2.6 of Samsung One UI 3.1, we can see a text-based UI. The lack of icons requires users to read the text to select features that they want. In addition, beginner users may not understand the text description when they first use the app. For example, in Fig. 2.6, “Recents” is used to represent recent calls. However, the term recent can have different meanings in different situations, and it may cause misunderstanding of the feature of this app. To avoid this situation, our application navigation bar will make use of icons and be similar to the iPhone menu example.

Last but not least, the language of our application UI takes an important role in providing a better user experience. As the main target users of the project are senior users, it is important to know if they can read and with how many kinds of language.
From Fig.2.7, one can see the result that less than a quarter of the elderly in Hong Kong can read two kinds of language. From this result, it seems that using a traditional Chinese user interface would make more sense than an English user interface. This consideration will apply to our final deliverable as well.

2.6 Summary
This chapter explained the design concept of the features in detail, explaining the reasons and the necessity of the feature design. The platform of development and all external resources that will be used are introduced. The user interface consideration and design are presented with some ideal examples that we are trying to follow. In the next chapter, the final deliverable and results of the project will be presented.
3. Results and Discussion

3.1 Overview
This chapter presents the final deliverables of the project. Section 3.2 introduces the application and the backend usage in detail. Section 3.3 describes the challenges that we have faced as well as the solution that we used. Section 3.4 provides the upcoming future works that we may implement afterward.

3.2 Deliverables
This section introduces the final deliverables as well as the backend and database. The final implementation of the application consists of two versions of the application. One is for the elderly, and the other is for family members. These two applications have similar features and user interface sets, but they are not exactly the same. The following subsections will go through it one by one.

3.2.1 Navigation and Language
The application consists of three pages, which are the location screen, call history screen, and connection screen. Both elderly and family members share the same outline of the navigation bar. It allows users to switch from the screens by tapping the icon or text area.

Fig.3.1 Navigation bar

As mentioned in section 2.5, a navigation bar with icons can help users to recognize the pages, enhance the selection speed, and avoid misunderstanding. Due to these reasons, our navigation bar (Fig.3.1) makes use of icons to provide a better user experience.

Furthermore, our application is using traditional Chinese UI because most of the elderly in Hong Kong can only read one language according to section 2.5, Fig.2.8, and we assume that it is traditional Chinese.
3.2.2 Location Screen
The default screen displayed when the user launches the application is the location screen. It provides a location tracking feature and will show the user or connected user location on a map view with a maker.

Fig. 3.2 Screenshots of location screen
Fig. 3.2 shows the screenshots of the location screen. As mentioned in section 2.4.2, our project used Google API to provide the map view feature. Users can switch to Google Maps application with the button on the lower right corner if they want to find a path to reach the marker location. Both of elderly app and the family companion app can see the location screen, but the difference is that the elderly main app displays their location directly and then upload the latitude and longitude coordinates to the firebase database. On the other hand, the family companion app downloads data from firebase and displays the connected user’s location on their screen instead of showing their own location.
3.2.3 Call History Screen

The call history screen can be displayed by tapping the middle icon in the navigation bar. This page includes two main features, which are checking a telephone number, and displaying call history.

![Call History Screen](image)

**Fig.3.3 Screenshots of call history screen**

Fig.3.3 shows the screenshots of the call history screen. One can see the screen is split into two parts to serve the two features. The phone number checker in the above allows users to input any phone number to check if it is safe or malicious. This search feature is supported by the HK Junk Call website. As mentioned in section 2.4.1, due to the technique reason, we are using the web scraping method to catch the search result. The result will be displayed to the users with a notification message.
Fig.3.4 Notification of phone check result

One can see the display format of the notification message of the phone check result from Fig.3.4. The notification message will not replace each other. Each time the user search for a phone number will produce a separate notification message.

The second part of this page is the call history display. It will display at most 10 call records starting with the most recent one at the top. This part will automatically check the call history to see if it is malicious and display the result in different colors and formats, as shown in Fig.3.3. Similar to the manual phone number search feature, the application is using the web scraping method to catch the result from the HK Junk Call database. For the elderly main application, it will fetch and display the results, and show a warning notification if there is a malicious call. For the family companion application, it has to connect with the elderly main app with a user code (will be introduced later) in order to receive a notification. The demonstration of the logic flow is introduced in section 2.2, Fig.1.8.

Fig.3.5 Warning notification of malicious call record

Fig.3.5 shows the notification bar when the elderly received a malicious call. This notification will pop out no matter the elderly accepted or declined the malicious call.
3.2.4 Connection Screen
The last part of our application is the connection screen. The biggest difference in terms of the user interface of the elderly application and the family companion application is on this page.

The elderly app connection screen only shows the user code on the screen. There are no buttons or other features on this page in order to reduce complexity. The text and the user code font size enlarged a lot for the elderly user as well. For the family companion application, there is an input text box to type in the user code of the elder. By default, the code is set to null, and the location screen and call history screen by default is directed to null user as well. After connection, the connected user code will be displayed on the top of the screen. The application will automatically get data from the database and update the location screen and call history screen as well.

The user code is generated with [1-9A-Z] random combination of 8 characters length. We intentionally exclude the number 0 from the combination set to avoid confusion when
distinguishing the letter “O” and the number “0”. The code is stored in the local storage of the user’s phone once they downloaded the app and it cannot be changed. We use this user code system to avoid the inconvenience of creating a user account, furthermore, the elderly may not be able to memorize the account number and password. Assigning the code for users can avoid users using duplicated code or illegal code when registering. There are $35^8$ combinations of user code and allowed the same number of users to register the elderly main app, and there is no limitation on the number of family companion users connecting to each user code. The number of possible combinations also enhanced the security so that normal users can hardly hack into another user’s code without asking the elderly app user.

### 3.2.5 Background Database

The code pairing system not only enhances the user experience, but also reduced the complexity of the database.

![Firebase database structure](https://fyp-project-337408-default-rtdb.asia-southeast1.firebaseapp.com/)

**Fig. 3.8** Firebase database structure

Fig.3.8 shows the database structure of the Firebase. One can see that the structure is very clean and simple with user code as the key value, and having two dictionary of location and call records under the user code. The simple structure has highly reduced the difficulty of database management.

### 3.2.6 QR Code for Download Applications

In order to help the elderly to download the application with a faster approach, the project team decided to provide QR code for the elderly to scan and download the application.
One of the roadblocks for the elderly using the smart application is the lack of Google account or forgetting the password of their account. In that case, they could not install the application from Google Play Store. Also, they may feel complicated to find and install a specific application from the store. To solve this issue, the project team has uploaded the .apk of both the applications to google drive instead. The elderly just need to scan the QR code, and the application will be automatically installed.

3.3 Challenges
During the development of the application, the project team has faced multiple challenges, and some have forced us to change the design of the application. There are three major challenges which are the HK Junk Call anti-scrape issue, iOS permission issue, and performance issue. The following sections will introduce them accompany by our solutions.

3.3.1 HK Junk Call Anti-Scrape Issue
As mentioned in section 2.4.1, HK Junk Call is chosen to support our basic phone number checking feature. However, as it has stopped to providing API key for developers, our application cannot directly use the database. The phone check feature has to use the web scraping method to catch data through the website instead. While this approach seems feasible, during the testing stage, the project team found out that the website has implemented anti-scrape measures. The website has IP detection, and each IP can only search for at most 20 phone number within a certain period of time. After that, the site would require the user to do a Captcha or human verification to verify that IP is not a bot. This anti-scrape mechanism would lead to failure in telephone number information retrieval of our application.
Our solution to this issue is to limit the number of searches within our application. After initializing upload, the application will use an algorithm to reduce the number of checks for the background auto-check feature. Firstly, if there is no new record, the application will not perform phone number checking. The application would check the date-time and the phone number of the most recent call and match with the history to see if there are any new records. Secondly, it would check and display only the 10 most recent records instead of showing all of them. Thirdly, skip the check if the phone number is in the contact list. After we adopt the above three reduction measures, we have completely solved the error for the background phone checking feature.

### 3.3.2 iOS Permission Issue

Originally the project team aim to develop a cross-platform application for both Android and iOS elderly users. However, we have faced difficulties in implementing certain features on iOS. A prime example is the call history access on iOS devices. Since iOS focuses a lot on users’ privacy, it blocks application developers from accessing call history on iOS devices, which is a serious roadblock that we could not overcome at this moment.

As a result, our current deliverable is an Android-only application. And we will try to provide the similar feature but with a different approach in the next deliverable in the future.

### 3.3.3 Performance Issue

As shown in section 2.2, Fig.2.1. Currently, the connection and communication between the elderly application and the family companion application are highly reliant on the firebase. Thus, the frequency of background data upload or download would highly affect the performance of the applications. On the other hand, the frequency of data transmission in the background would also affect the battery usage and processor usage. The project team wants to reduce the background usage while keeping high performance at the same time.

To achieve the expectation stated above, the project team decided to split the code into two sets and add some extra checks before it proceeds with the background features. There are two sets of usage, the first set is auto check phone numbers and uploading data to firebase. This set of code is for the elderly application and we added extra checks before it uploads to database such as datetime and phone record check as mentioned in section 3.3.1. If the checks do not pass, which means that there is no update in call history,
the application would only perform location updates and skip the rest of the call history related tasks.

Next, for the family companion application, the background task would only download necessary call history data from the database. We removed the location-auto update feature when the application is in the background. Family members need to open and switch to the location screen of our application in order to get the latest location of the elderly. This design is reasonable because the location tracking feature relies on the map view display instead of coordinates. So, there is no use for family members to keep updating the location of the elderly without turning on the application. With these modifications to the background tasks, the application can highly reduce the background usage while keeping the high performance at the same time.

3.4 Future Works

As mentioned in section 3.3.2, the project team is yawned to deploy the iOS version of the application. However, due to the policy of iOS, it is currently impossible to migrate to iOS in the absence of our main features. Alternatively, even though the elderly application is not able to deploy in iOS, the family companion application which requires no permission from the phone should be able to deploy the iOS version. Because of the time constraint, we cannot finish this step for the final deliverable. In the future, the project team will try to deploy the iOS version of the companion application as the first step toward the cross-platform target.

Currently, the application will send warning notifications if and only if the elderly received a malicious call. In the future, we would like to let the user of the family companion application select when would they receive a warning notification. For example, receive a notification whenever the elderly has a new call record, or a receive notification when the number is not in the contact list of the elderly. This feature is possible and relatively easy to implement.

In the first presentation, Dr. Tam has given us an insight into the optional call forwarding feature through the application. After that, the project team has done some research on how to utilize this feature. The major concern is that this feature may collide with the “no-setup” policy of the elderly application, as elderly users must choose from multiple connected devices and select one to forward the incoming calls. And there might be a security issue if family members can do this setup on their side. On the other hand, the project team has another idea that we may combine the auto-check phone number feature with the phone forward setup in the setting of the phone, to provide an optional
forwarding feature. The family member of the elderly should set up the waiting call forward through the phone settings. After that, our application will auto-check the incoming call number and put the incoming call in waiting state. Then, the call would be forwarded to the specific family member with the help of our filter feature. This feature is still in the conception stage, the project team will try to implement it if it is found to be feasible and useful in the future.

3.5 Summary
This chapter presents our final deliverable in detail. The elderly application and the family companion application are presented with the backend logic as well. The challenges encountered and the corresponding measures that have been taken are introduced. In addition, the future work of the project is well planned for implementation. We may start working on it after the presentation and hopefully it can be finished before the exhibition.

4. Conclusion
Telephone deception cases have been increasing decently in the past few years. In 2021, about one-third of the crime is related to deception and lead to over 800 million HKD loss due to single type of crime. In order to cease this pathetic trend, our project has implemented a mobile application tailor-made for the elderly and their family members, to protect the elderly from telephone deception. Hopefully, with the help of our application, the elderly in Hong Kong could be protected from criminals.

While existing call blocking applications may not be suitable for the elderly, our project provided a tailor-made design for them. The simplicity of the setup and the user-friendly interface is well prepared for the elderly. The application sending warning notifications to the family members can enhance their awareness about the elderly’s safety. Real-time location and call history tracking can provide extra information for the family members to assist the elderly in advance. With this application, it is hoped that the number of telephone deceptions will have a significant depreciation in the future, and lead to the enhancement of the public security of Hong Kong.
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