



UNIVERSITY OF AUCKLAND

BTech 451

End-of-Semester Report

Smart devices assist the conservation of biodiversity

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1. Introduction

This project is compulsory course to the 4th year students who majoring in Bachelor of Technology (IT) degree. The project has two parts, which they are Btech 451A in the first semester and Btech 451B in the second semester. Given some fairly specific problem, I am required to design and implement a solution for this problem. It needs students to guarantee 8-10 hours of work per week in the first semester, and 16-20 hours of work per week in the second semester.

In this report, I start from the project overview which introduces the basic information of my project. Secondly, I provide some research results that I have done in the first semester. Afterwards, hand-painting graphs of User Interface (UI) for my application would be displayed, and comments about design would be given following the each graph. Then I discuss how to implement my design with some capture images about source code. At last, I give summary including achievements I have got and possible improvements for remaining part of my project.

This report is not the final version for the whole project, it only shows a detailed account of the work done in the first semester. I will keep hard-working in next semester. And the final version of this project will be published at the end of this year.

2. Project Overview

The purpose of this project is to develop a smart device to assist the conservation of biodiversity. According to the aim of effectiveness, the developer has given the specific requirements in detail about the functions of the smart device. Doing this project is also the process of learning, such as working skill, knowledge about mobile application development etc.

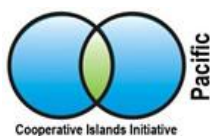
2.1 Background

“Invasive species” is the subset of introduced Species. If a species is introduced artificially into one area where it has never appeared and it has the ability to grow and spread quickly in local without any human intervention, and it becomes the local pollution which is a threat to the local biodiversity, can be called the “invasive species”^[1]. Since invasive species is harmful to the local biodiversity, the ability of founding invasive species and conservation of biodiversity shows its importance.

Invasive species projects are more complicated than many other conservation activities. Invasive plant management projects, in particular, are usually complex and long-term. Hence, invasive species projects cannot only relay on environmental investigators’ manual working. It is very necessary to develop a smart device application (mobile-phones’ application) to help environmental investigators to manage the invasive species. So effective programme prioritisation, design and implementation are essential to assist managers to monitor and evaluate the effectiveness and accountability of an invasive plant object. The collection, management and analysis of data are central to the success of projects.

2.2 Company Information

This project comes from The Pacific Invasive (PII).



The Pacific Invasive Initiative (PII) is leading capacity development organisation for invasive species management in the pacific region.

Operation from The University of Auckland since 2004, PII works with Pacific agencies (both government and non-government organisations) to strengthen their capacity for managing invasive species. Building long –term institutional relationships with agencies to empower confidence and encourage self-reliance is an essential component of our capacity development work. More information on PII and its work can be found at <http://www.pacificinvasivesinitiative.org>.

2.3 Project requirement

The database that contain all species' information has been developed to agencies manage their data. However, the functions about collection, transcription, storage and analysis of those data have not been achieved yet. That requires my mobile application to complete these functions. The mobile application (cross-platform and cross device) that would be able to directly record of data (location, area searched, area treated, timing, activities, recourses used, photographs ...) in the field and transfer to the agency's database. It would also have to able to work offline, i.e. pick up location without network. In addition to, identification of plants is another area where a mobile application could assist field teams. A photograph of the entire plant or plant part (seed, cotyledon, seedling, sapling, flower, leaf, bark...) taken in the field could be matched against recording stored on the device. The specific requirements in detail are listed in following:

2.3.1 User Interface design and implementation

For this project, I have decided to develop application on mobile phone using Android Operation System. The platform for my application is Samsung Nexus. As we all known, good User Interface (UI) is the cornerstone of the mobile application. The UI of my application is required to be simple and easy to use. Hand-painting graphs of User Interface (UI) for my application would be displayed in following part – Design. And more detail of UI design principle would be discussed in the following part – Implementation. In brief, my application can be benefit from user-friendly and user-centred design.

2.3.2 Fast and accurate data entering

We can image that path in the forest is quite narrow and difficult to work through. And weather in the forest is very complex and changeful. Then the environmental investigators cannot record the data like recording data in the quiet and bright room. So how to fast and accurate data is quite important requirement for my application development. My solution for this requirement is to reduce the amount of work typed by environmental investigators as much as possible. So I would consider to design choosing mode instead of typing mode. And how to encapsulate the data and which form it should be encapsulated to are other requirements for my development.

2.3.3 Data transfer

As requirement mentioned before, client application can create and maintain information in the database. So how to build connection between client application and agency's database and how to transfer data between two sides are key requirements for my application development. Besides this, it also requires some knowledge about how to manage the data in database. This problem can be solved by "do_upload.jsp". I consider to using "Post" to send requests to receiver of server and starting the action of entering files into server.

2.3.4 Image analysis

In order to reduce the amount of work typing by clients, client can use taking photograph to find the item in database by photograph matching. So the function of image analysis is one special requirement for my application development. The effectiveness of photograph matching would reduce due to the quality of photographs. For my application, I consider to give some hints to client about the background and size of photograph taken by client in field. With this solution, image analysis would be more accurate, and reduce the possible about founding new item due to photograph matching failed.

2.4 Project Goal

By this project, I would have good blue point about how to receive, analysis, and plan and finish one project individually. As mentioned before, the purpose of this project is to develop a mobile application. So I would be familiar with all steps about mobile application development from UI design to practical programming. And lots of programming work is included in application development, I could use this opportunity to enhance my programming skill. Because this application is designed to complete some functions. That requires me to learn knowledge about the relevant functions. For instance, environmental investigators filling the information form about new invasive species needs me to know the knowledge of XML well. Another example, data is transferred from the client application to agency's database to store, and is sent from agency's data to client application. So how data is transferred

between client application and agency's database is another area where I should learn from this project.

In addition to, another quietly important skill which I can gain from this project is social skills. In this project, the mobile application is developed for other organization. I have to talk with clients from other organization face to face. It requires that I should have enough strong social skill to make good communication with strangers. So I would be able to achieve so many working skills in business and practice experience about how to make communication with partner and client, which I cannot learn from school. However, these social skills are quietly useful in my rest life when I graduate from the university.

3. Research

3.1 Knowledge about Smart Phone

The purpose of this project is to develop a mobile application on the platform of Samsung Nexus. As we all know, Samsung Nexus is a new generation of smart phone. Then this project involves the smart phone which appeared and became popular in recent years. So I did some research about smart phone, and list research result in the following.

3.1.1 Definition of Smart Phone

The so-call Smartphone is one kind of mobile phones that they have independent operating system like personal computers, and allow user to install the software or games from third party service providers in order to expanding functions, and can realize wireless network access through the mobile communication network. Smart phone can be considered as common mobile phones, which are added with smart functions. On another hand, smart phone can be considered as common PDAs, which are added with mobile phone communication function. In brief, smart phone is the mobile phone that it downloads and install software to expand the functions ^[2].

3.1.2 Characteristics of Smart Phone

Smart phone mainly have the following characteristics ^[2]:

- Have all common mobile phones' functions, such as make calls, send text messages ...
- Have ability of wireless access to the Internet, such as 3G, Wi-Fi ...
- Have the PDAs' functions, such as PIM (private information management), multimedia applications, Internet surfing ...
- Have one opening operating system. On this operating system, user can install more application to expand the functions of mobile phone

With these characteristics, my project can be realized basic on smart phone. When my application has been developed, environmental investigators can install my application on their smart phones. Then they can use application directly on their mobile phone each time when they are in working.

3.2 Knowledge about Android

The purpose of this project is to develop a mobile application on the platform of Samsung Nexus. As we all know, Android is the operating system of Samsung Nexus. Then this project involves Android operating system which appeared and became popular in recent years. So I did some research about Android operating system, and list some research results in the following

3.2.1 Android Features

Android is a Linux-based operating system designed primarily for touch screen mobile devices such as smart phones and tablet computers ^[4]. Android operating system has some its own features in following:

- Application framework supports to reuse and replace the component.
- Dalvik virtual machine is specially optimized for mobile devices.
- Internal integrated browser based on the open source Webkit engine.
- Optimized graphics library including 2D and 3D, 3D is based on OpenGL ES.
- # SQLite, used for structured data storage.

- Support multimedia including common audio, video and file format of static image (such as MPEG4, H.264, MP3, AAC, AMR, JPG, PNG, GIF...).
- GSM phone technology, still rely on hardware.
- Bluetooth, 3G, EDGE, Wi-Fi, still rely on hardware.
- Cameras, GPS navigator, accelerometer, still rely on hardware.

Development source of Android application is quite abundant. That contains equipment virtual machine, debugging tool, memory and performance analysis chart and plug-in for the Eclipse IDE.

3.2.2 Android Application framework

Android would be published with the core application package. This core application package contains Email, SMS, calendar, map, and browser and so on. All these applications are developed by Java Language.

- Views: used to set up application, contains Lists, Grids, Textboxes, Buttons, even the embedded browser.
- Content Providers: allow application use the data belonging to other application, or share the data.
- Resource Manager: access to non-code resources, such as graphs, Layout Files.
- Notification Manager: allow application to display the customer notification message in the status bar.
- Activity Manager: manage the application life cycle and provide a common navigation regression function.

Android operating system provides a framework to developer, all applications development must comply with the principles of that framework. Development of application can be treated as extension in this framework. Let us have a look at some functions provided by Android framework:

- Android.database: Contains classes to explore data returned through a content provider^[5]
- Android.graphics: Provides low level graphics tools such as canvases, colour filters, points, and rectangles that let you handle drawing to the screen directly^[6]
- Android.location: Contains the framework API classes that define Android location-based and related services^[7]
- Android.media: Provides classes that manage various media interfaces in audio and video^[8]
- Android.view: Provides classes that expose basic user interface classes that handle screen layout and interaction with the user^[9]
- Android.webkit: Provides tools for browsing the web^[10]

4. Design

4.1 Android UI Design

As we all known, good User Interface (UI) is the cornerstone of the mobile application. Good UI looks simple, and it is easy and convenient for client to use. The detailed design principles are in following^[3]:

- A beautiful surface, a carefully-place animation contributes to a sense that a powerful force is at hand.
- Allow client to directly touch and manipulate objects in your application.
- Client loves to add personal touches, because it helps them realise that the application is theirs, and is in control by them.
- Don't let client to make the same choices over and over again.
- Keep UIs simple as much as possible. Don't let client feel complex to become bored.
- Only show what I need when I need it. Hide options that aren't essential at the moment.
- Clients should always know where they are. Good UIs should have quite clear and accurate navigator.

The Design principles above are very important to the good User Interface (UI). In brief, User Interface (UI) should be user-friendly and user-centred.

4.2 My Application Design

My application design is displayed as following. In this report, just hand-painting graphs of User Interface (UI) for my application are provided. The real mobile application user interfaces' captures will be provided in the end of year report. My design may be modified in the further development.

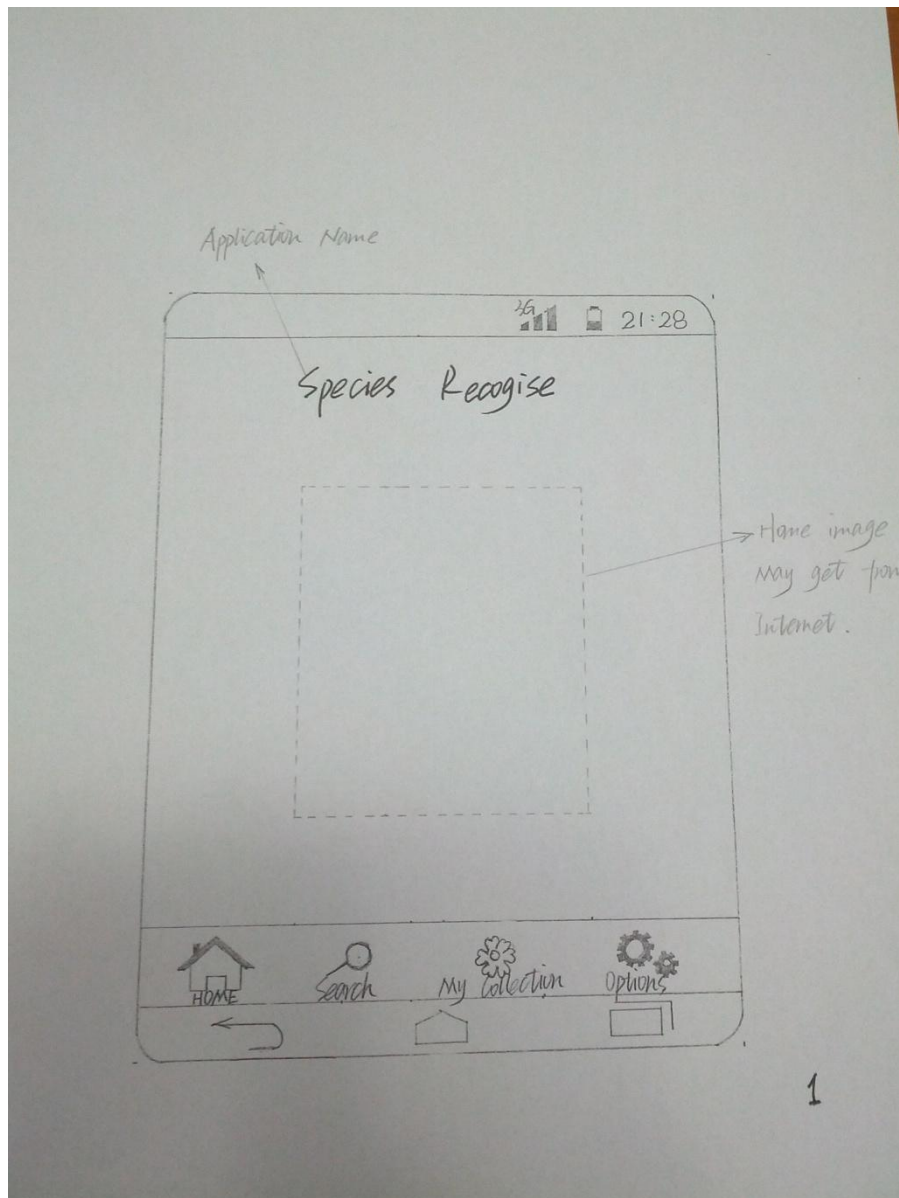


Figure 1: Home Page

This is home page. The name of my application is displayed on the top of screen centre. In the figure, the name of application is "Species Recognise", which is interim name. Home image which can be downloaded from the Internet appears in the middle of screen. It also can be changed per five seconds automatically, likes auto-player. On the bottom of screen, there are four function buttons which are "Home", "Search" and "My Collection" and "Options". Client can click each button to switch other pages.

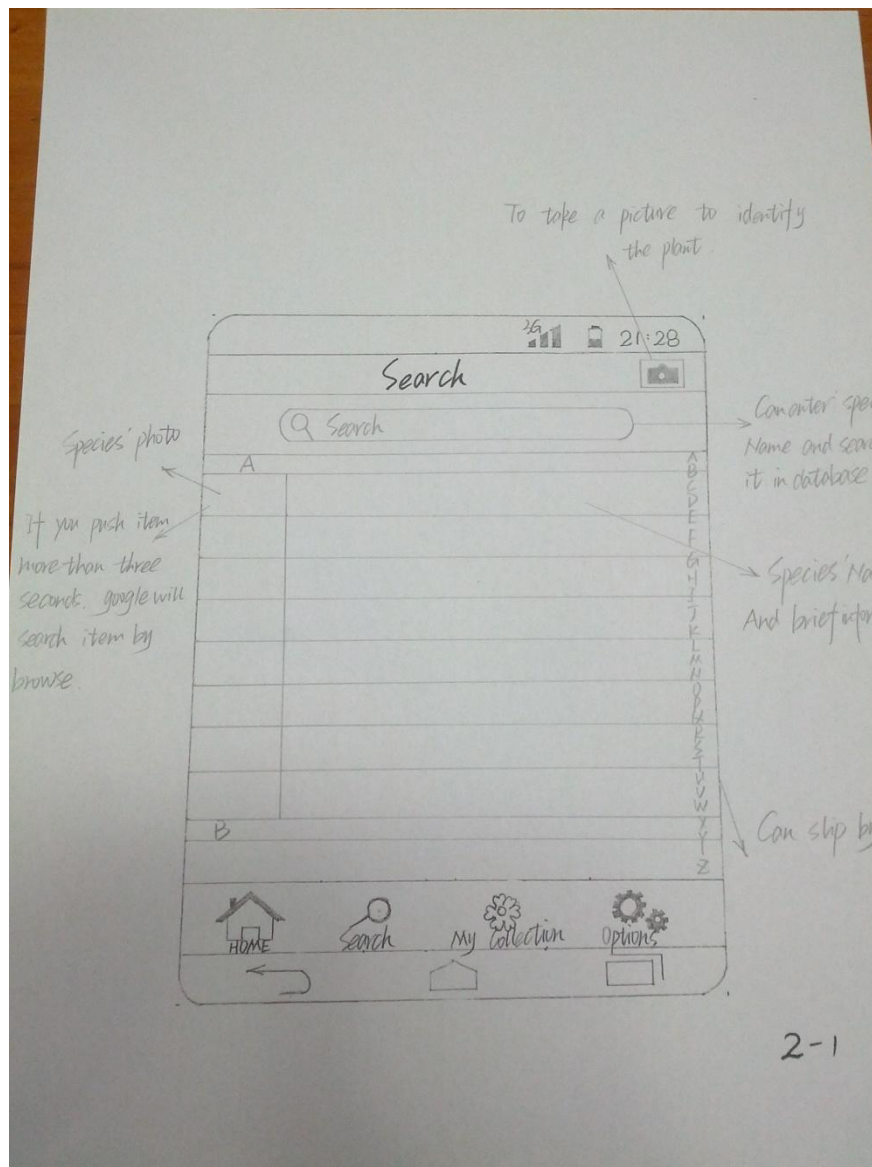


Figure 2: Search Page

Once client clicks the “Search” button, the program would switch to this Search Page. All species are listed in this screen. Each entity contains a representative photo and name of relevant species. And each entity has touchable function that allows user to view more information by clicking it. There is search bar which allows client to enter species’ name in bar and search by program automatically. If clients are not convenient to type, they can change to another search mode, which is photo marching. Client could choose “photo” button which is on the top right corner to take a photo and complete further functions.

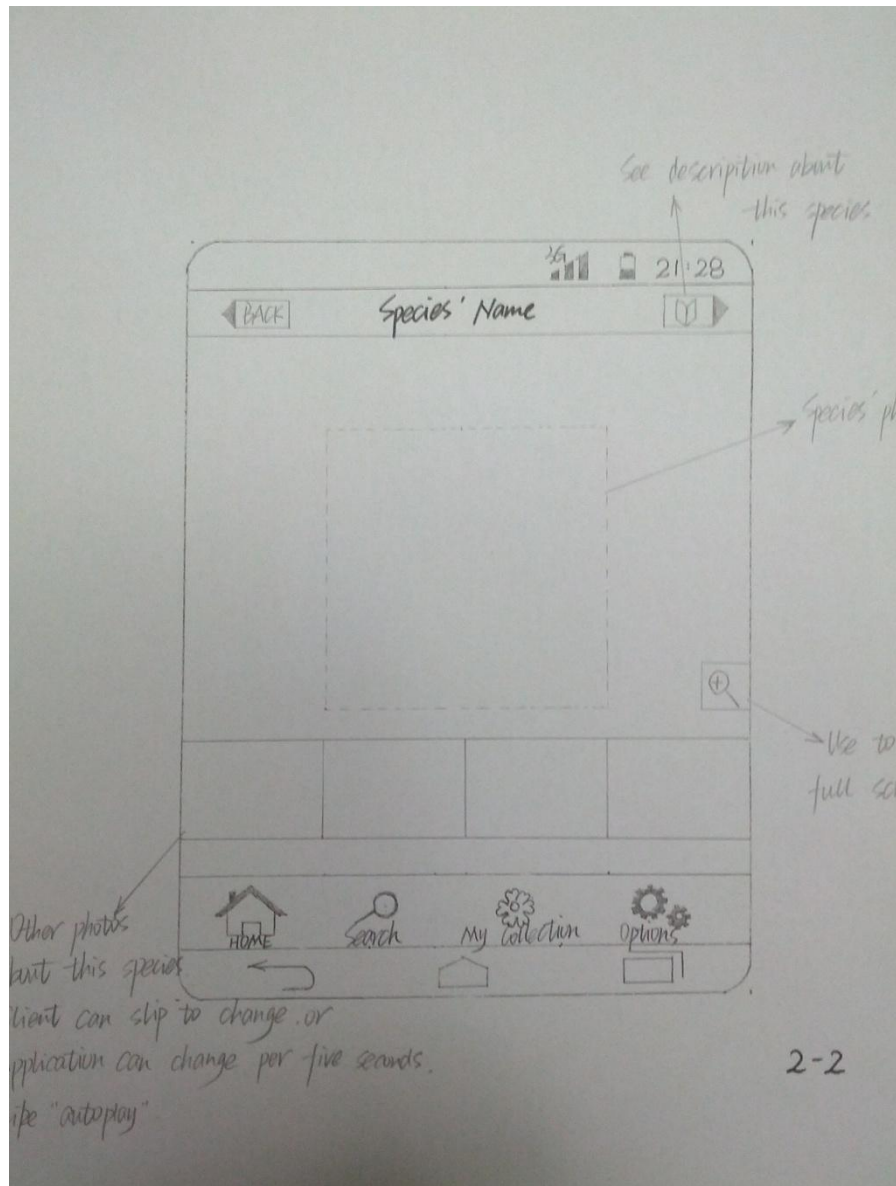


Figure 3: Species' Photos Page

As mentioned before, client would click each entity to view more detailed information. So this is page of species' photographs. The photographs of the entire plant or plant part would be displayed in loop. Client may use small tool to view full screen of specified photograph. Besides, description of species is also available.

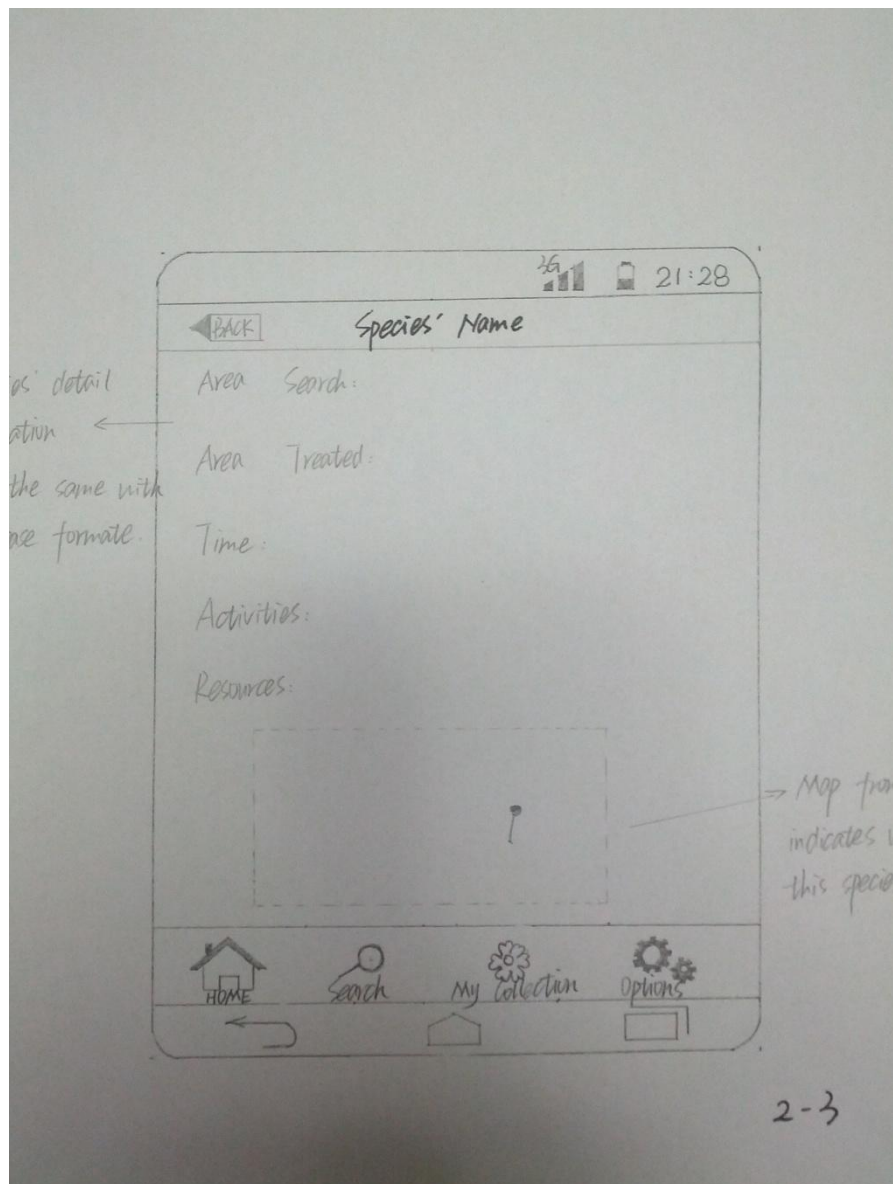


Figure 4: Species' Card Page

Species' card page appears in case of clicking "description" button on the top right corner. Detailed information can be looked up, such as location, area searched, area treated, timing, activities, resources used, etc. The format of information will be given normatively later.

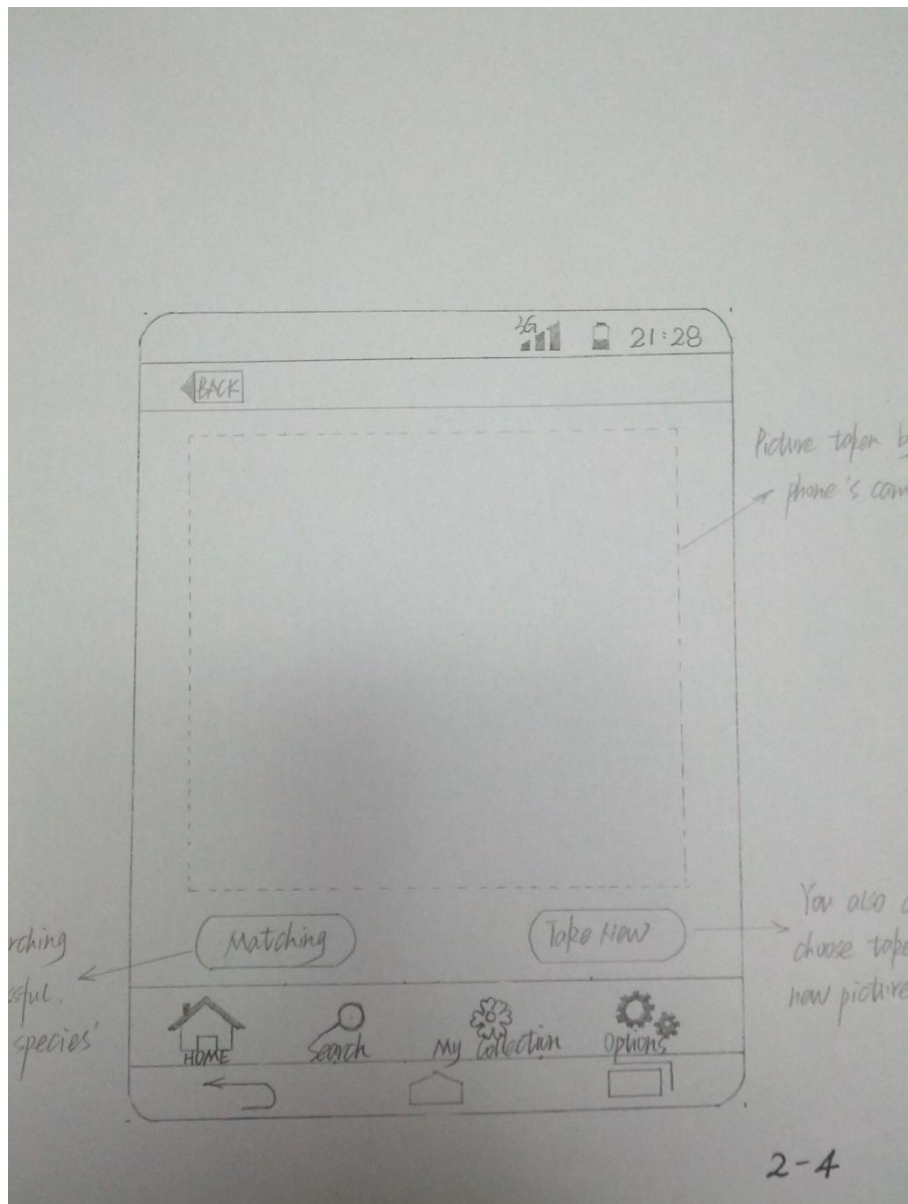


Figure 5: Taking Photo Page

When clients choose photograph marching mode, the program would call taking photograph method of mobile photo. After taking photograph, the application could switch this page to do preparation work of photograph matching. In this page, user has two options, which one is to start photograph matching and another is to take new photograph again. One point needed to be reminded is that the background of photograph has special requirements. Otherwise the effectiveness of photograph matching would reduce due to the quality of photographs.

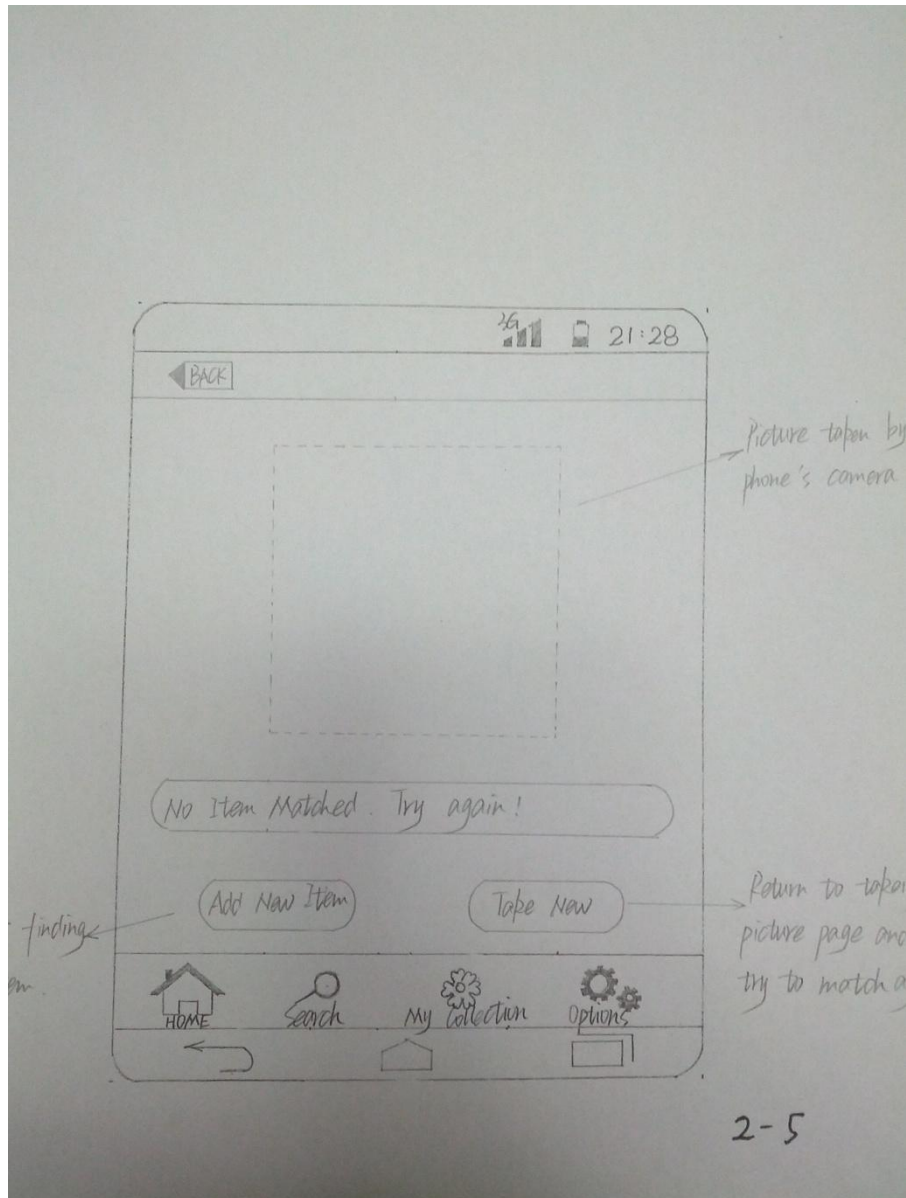


Figure 6: Not Matching Page

If the photograph matching is successful, the specified species' card which I have showed before would be display in order to be read by client. On the other hand, if the photograph matching is failed which means that species cannot found in the database. There are two main reasons resulting in this situation:

- The quality of photograph results in photograph matching failed. Client can choose to take a new photograph to try matching again.
- The species is really not in the database. Client can fill new species' card and submit it to the database, then the database may store it and let other users to look it up.

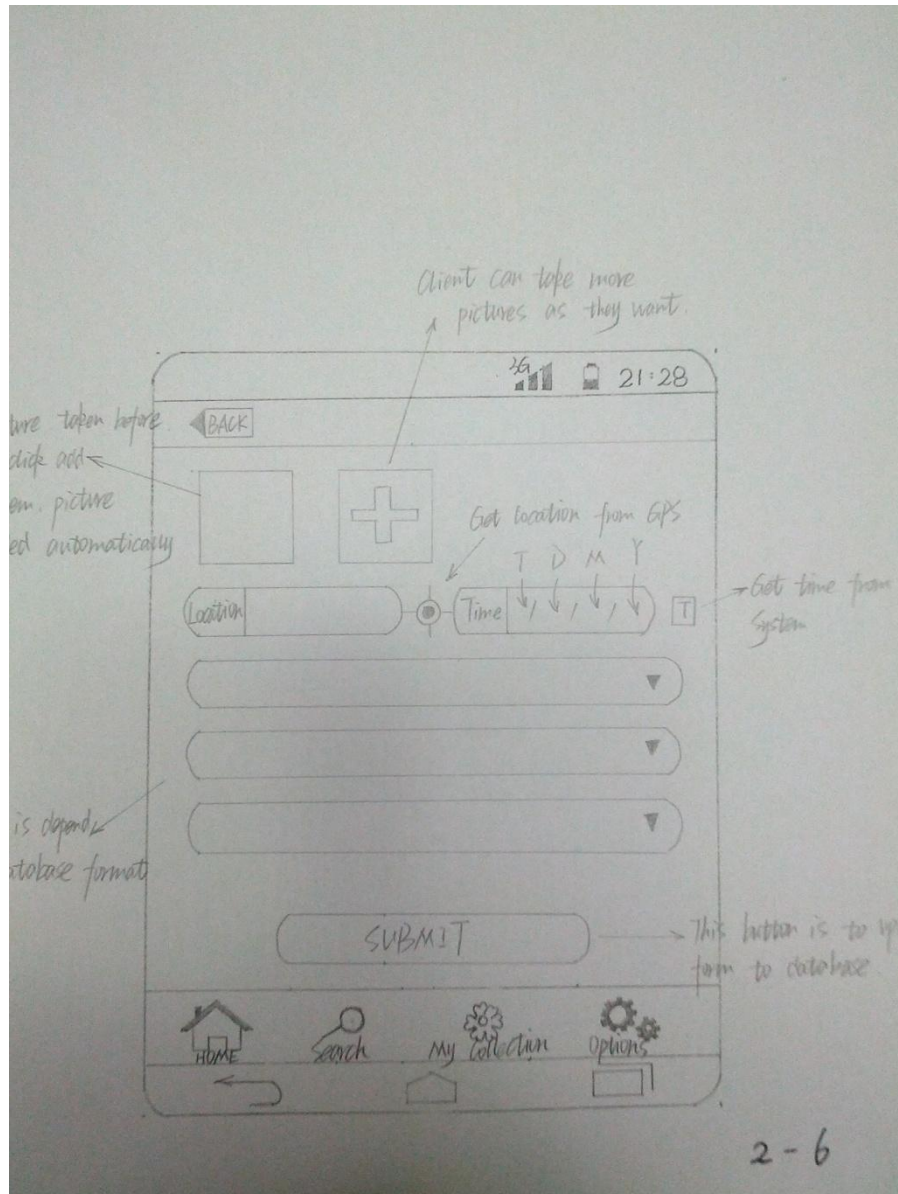


Figure 7: Adding New Item Page

Once new species is found in field, how to capture the data is quite important to environmental investigators. I have mentioned this problem in the requirement before. The format of new species' card must be the same with the format of species card stored in database, and the format of information will be given normatively later. Two new functions would be used in this page:

- It is not convenient for environmental investigators to fill the location by typing in the field. So getting location by program automatically is quite useful and helpful.
- The same solution is also suitable for the problem of timing. The program should be able to record the time automatically from mobile phone.

After capturing all information accurately, click submitting and transfer data to server.



Figure 8: My collection Page

Clients creating their own collection pages could make them easy to find specified species and read it. The layout of this page is quite similar with "search" page, and functions in page are almost the same with that.

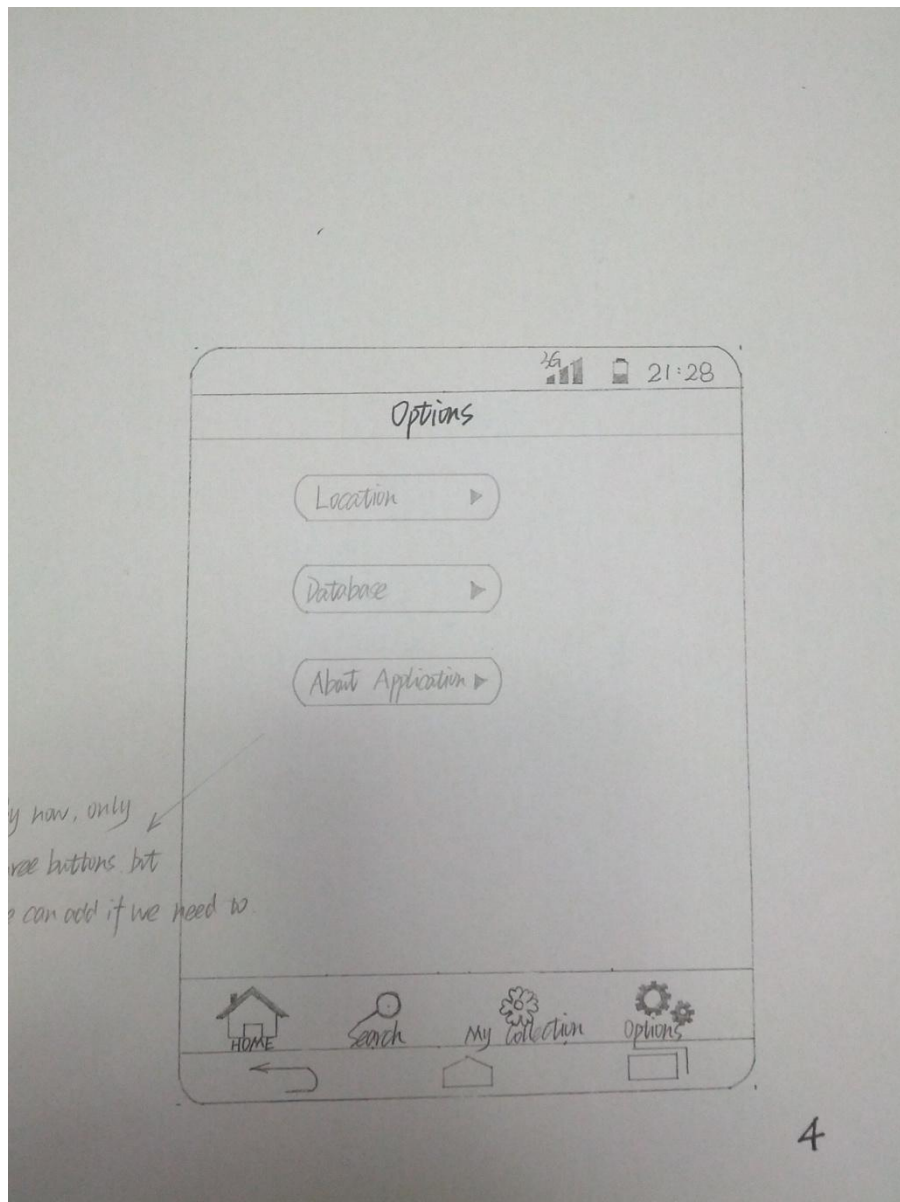


Figure 9: Options Page

At last, this is “options” page. In this page, client can set up their personal options about this application. By now, this page only has three functions:

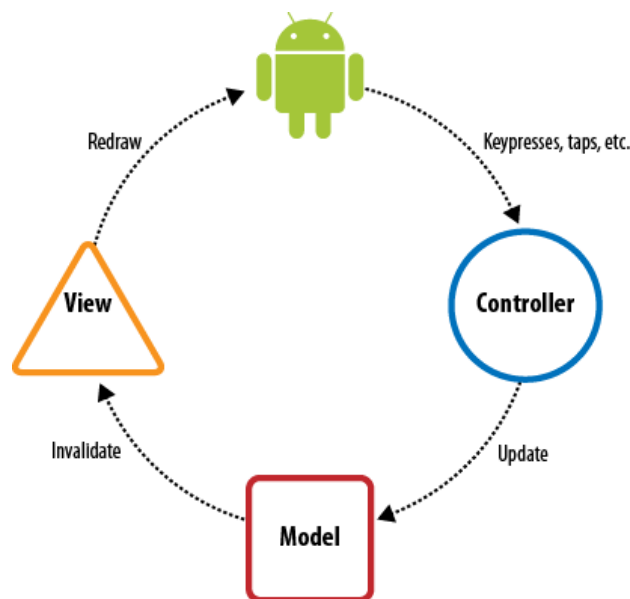
- Location: client can get coordinates from here. As the requirements, the application should be able to pick up location without being online. I would use `LocationListener()` and `MapView()` to meet this requirement.
- Database: from here, clients can view the brief situation of the database. For example, how many items have been stored in the database.
- Application: this is used to allow client to update their application to latest version. This function is considered because of further development.

Except these three functions, new function can be added into “Options” page in the further development according to new requirements.

5. Implementation

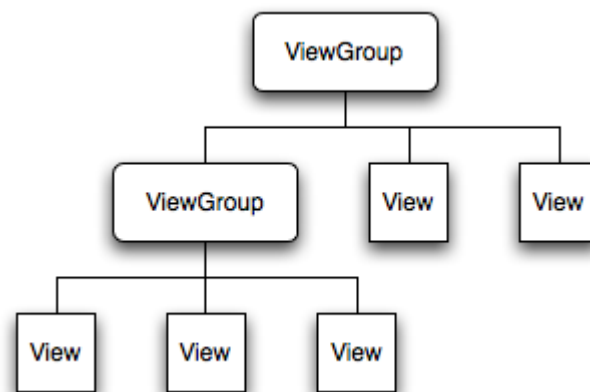
5.1 Android UI Framework

Android UI Framework likes other UI frameworks. It uses MVC (Model View Controller) mode, which provides Controller (handle user input), View (display user interface and image) and Model (save the data and code).

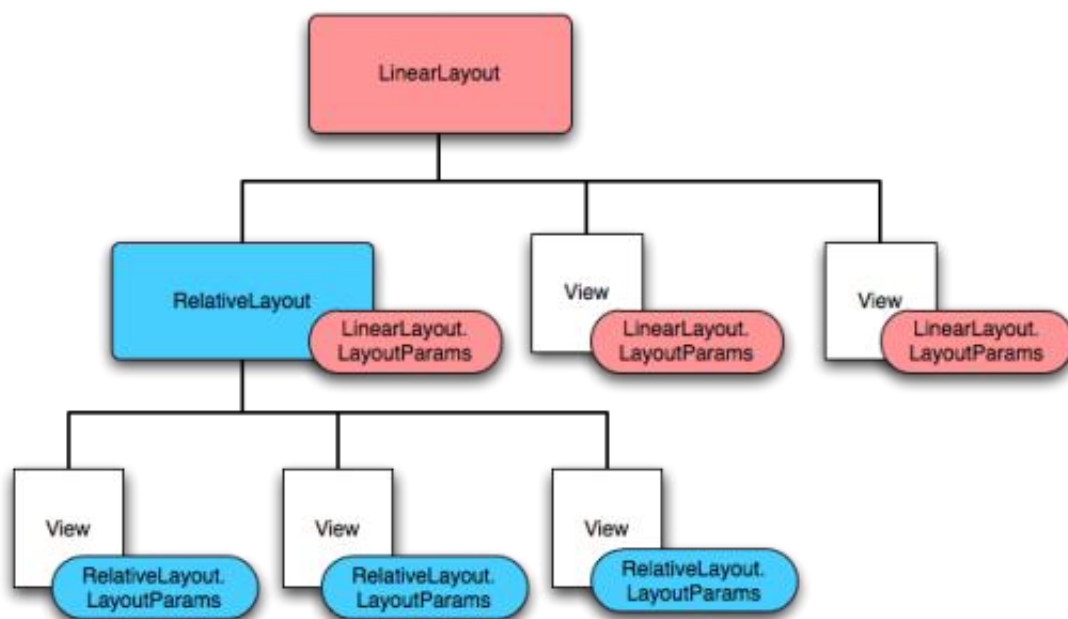


Model is the core of application, and Controller is responsible for external action of application. View is the feedback given from application to user. Let us have a look at view tree. Visual interface unit of Android is divided into two groups. One is “container” class, which inherits ViewGroup. Another is “non-container” class, which derives from View.

View tree consists of View and ViewGroup. Among of them, View is the most basic visual unit, and it exposes basic user interface classes that handle screen layout and interaction with the user. ViewGroup is a special view that can contain other views (called children.)



As the below graph shows, these layouts can form a view tree. The root layout has relations with leaf layouts. For example, if root layout is RelativeLayout, then the leaf layout can be specified with RelativeLayout.LayoutParams' attribute in order to controlling its layout in root layout.

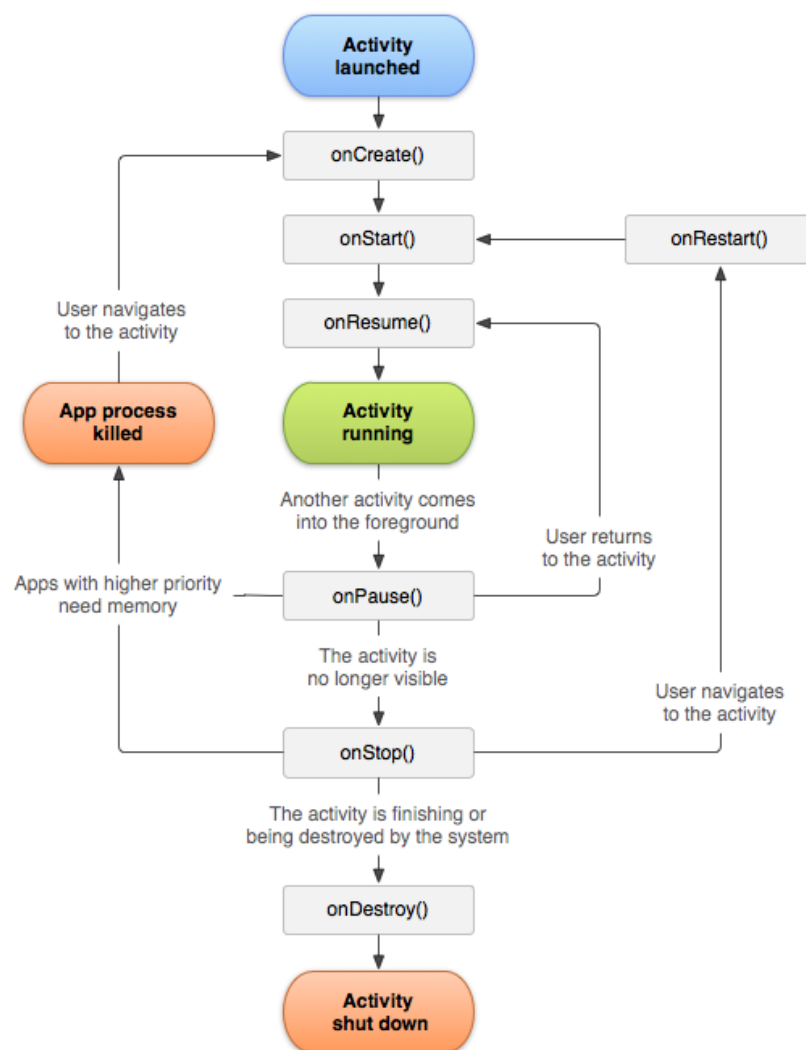


In a single thread in the user interface, controller draws user interfaces by achieving events and view from the queue. Using this way, user interface which is in a single thread makes handle method more sequential. It would reduce complexity of application and difficulty of development.

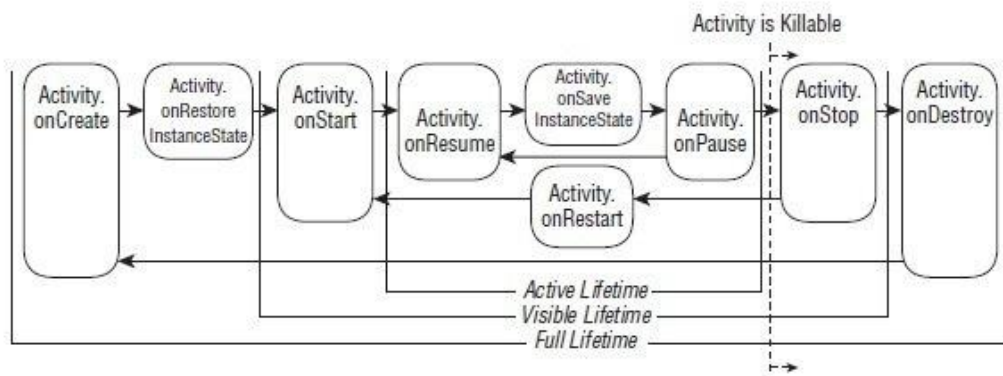
5.2 Activity Life Cycle

Activity life cycle is the process of an activity from creating to destroy. Activity has four states: Running, Paused, Stopped and Destroyed.

- **Running State:** This is a state when an activity is in the front and has focus in it. It is completely visible and active to the user^[12].
- **Paused State:** The activity is partially visible to the user but not active and lost focus^[12].
- **Stopped State:** This is a state when an activity is no longer visible in the screen^[12].
- **Destroyed State:** An activity is said to be dead or destroyed when it no longer exists in the memory^[12].



There are three kinds of activity life cycle, which are full lifetime, visible lifetime and active lifetime. Each lifetime contains different event call-back methods



Activity Full Lifetime

Activity full lifetime is the whole process from create to destroy, it starts from `onCreate ()` and ends from `onDestroy ()`. Users usually initial user interface in the method of `onCreate ()`. At the same time, it distributes variables and creates service and threads. The method of `onDestroy ()` would release this resources in the end of lifetime.

Activity Visible Lifetime

Activity Visible Lifetime is the process for interface from visible to invisible, it starts from `onStart ()` and ends from `onStop ()`.

- `onStart ()`: used to initial or start the resource.
- `onStop ()`: used to pause and stop all relevant thread, timer and service.
- `onRestart ()`: called before `onStart ()`, used to do specified handling work in the process for activity from invisible to visible.
- `onStart ()` and `onStop ()` can be called more than once.
- `onStart ()` and `onStop ()` are often used to sign in or sign out `BroadcastReceiver`.

Between `onStart ()` and `onStop ()`, activity is visible for users even if some parts of activity are invisible. In the whole activity lifecycle, sever activity visible lifetimes may exist at the same time and switch themselves.

Activity Active Lifetime

Activity active lifetime starts from `onResume ()` and ends from `onPause ()`.

- `onResume ()`: called when an activity starts to interact with the user.
- `onPause ()`: called when an activity is going into the background, but has not been killed yet.

6. Conclusion

The report shows all the works I have done in the first semester. In pass three months, I have done the website of my project, introductory seminar and end of semester seminar. In addition to, I did some research about the smart phone and Android operating system. I also made a schedule to read Android application development books in order to learn knowledge about mobile application development by myself. Therefore, I got lots of theoretical information of mobile application development from the books. For example, I got the solutions about how to implement the linear layout for my application interface, and how to use different activities to complete functions of my application. According to the interface principles, I have designed the user interface. I have started my programming work, but no more practical results can be displayed. However, I consider doing the programming part with theoretical knowledge I got before. I believe that I will have good actual results to show in the end of year report.

In brief, works about theoretical study and design in first semester have been finished as plan. And I need to keep working hard on the programming part in order to achieving actual result at the end of this year.

7. Further Plan

As mentioned before, the main work for the next semester is to working hard on the programming part. I have set up all preparation works for programming successfully. For the rest of project, I have a few practical issues to be solved. They are chiefly how to really implement user interface as design, and how to set up connection between client and server in order to transfer data, and how to realise application works without being online. If it is possible, the problem of photograph analysis would be solved as well. By the hard-working in the next semester, I believe that issues listed above would be solved successfully, and I would hand out one perfect end of year report at the end of this year.

8. Reference

- [1] Invasive Species. Retrieved June 8, 2013, from http://en.wikipedia.org/wiki/Invasive_species
- [2] Smart phone. Retrieved June 8, 2013, from <http://en.wikipedia.org/wiki/Smartphone>
- [3] Android User Interface Design Principle. Retrieved June 8, 2013, from <http://developer.android.com/design/get-started/principles.html>
- [4] Android Operating System. Retrieved June 8, 2013, from [https://en.wikipedia.org/wiki/Android_\(operating_system\)](https://en.wikipedia.org/wiki/Android_(operating_system))
- [5] Android.database. Retrieved June 8, 2013, from <http://developer.android.com/reference/android/database/package-summary.html>
- [6] Android.graphics. Retrieved June 8, 2013, from <http://developer.android.com/reference/android/graphics/package-summary.html>
- [7] Android.location. Retrieved June 8, 2013, from <http://developer.android.com/reference/android/location/package-summary.html>
- [8] Android.media. Retrieved June 8, 2013, from <http://developer.android.com/reference/android/media/package-summary.html>
- [9] Android.view. Retrieved June 8, 2013, from <http://developer.android.com/reference/android/view/package-summary.html>
- [10] Android.webkit. Retrieved June 8, 2013, from <http://developer.android.com/reference/android/webkit/package-summary.html>
- [11] Android Activity Life Cycle. Retrieved June 8, 2013, from <http://www.android-app-market.com/android-activity-lifecycle.html>