# **Research and Design for AHP Module based on Android System**

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## Abstract

Our lives have been more and more abundance after the creation of Android intelligence cell phone and the applications based on Android system have taken an important role in people's working and lives. This paper will state detailedly about the frame and application structure of Android system based a mass of material. Then AHP arithmetic based on Android will be particularly designed and analysed and put it into practice to test its performance. The result shows that AHP module based on Android is feasible and efficacious.

Keywords: Android; AHP; Analysis; Design

## **1. Introduction**

As an assistant decision analysis method, Analytical Hierarchy Process(AHP) plays a very important role in people's working and lives and almost be applied in all areas of society. AHP based on PC has completed a lot of basic work for a lot of scientific research. All kinds of intelligent terminal units have emerged along with the prompt development of mobile network technology [1]. The creation of intelligent cell phone based on Android system has made it inevitable to become a kind of work medium. The research for AHP based on Android will be very significant not only for that more and more intelligent terminal application have been affluent in the using areas of terminal units, but also for that it has improved our living quality [2].

# 2. Relevant Conception

## 2.1. Android Introduction

Nov. 5th.2007, Google published Android operating system whose core part is Linux. The system led to a new era for the operating system of intelligent cell phone. After several years' development, Android had taken a solid place in the operating system market of intelligent cell phone all over the world. The market quotient had even been 68.4% in China. Our living was more convenient and improved after the publishing of Android.

**2.1.1. Android feature:** Android platform can quickly occupy the market and accepted by the masses of customers mainly because of their peculiar advantage. In general, the features of Android basically are the following several aspects. The feature openness of the Android platform laid a solid foundation for Android development. Google Company unites a number of mobile terminal manufacturers to join Android alliance for jointly developing the standard mobile application software platform. Android alliance developing mode ensures the authority of Android, and android gets its reputation before it appeared to men. Second, the advantages of Android platform application, the advantage shows in two ways. One is the

equality between applications. Android platform greatly reduced the operator constraint ability for application, and users can use their favorite application service randomly. For example many third-party applications such as listening to music, input method, calendar service and so on. On the other hand, Android can break the boundaries among applications. Such as developers can combine the data on the Web with local contacts, calendar, location information, and gives users a new feelings. The advantage of Android APP had made great contribution to obtain more users support. The advantage of Android development is that Android platform has provided a plenty of computer practical tools for the developers, which can be used to establish the developers own APP quickly. For example, if a developer wants to develop a simple map application, he can achieve that function by only a few simple line of code, but which is quite complex on the other operating deck. The characteristics of android platform have ensured his growing, and android platform has became the biggest smart phone operating system.

**2.1.2.** Android architecture and group ware: Android system can be divided into four level structure modes. From down to top, they are Linux Kernel, Libraries and Android Runtime, Application Framework and Application. In Android system, Linux Kernel works as the bridge between hardware and software and provides system service based on Linux 2.6. For example: security, process management, drive mode, network stack, memory management and so on [3]. As the support of application framework, Libraries and Android Runtime provide Android core library, virtual computer and lot of function library. Application Framework provides a capacious stage for Android development members and it is composed of 9 functional parts which have the respective special service functions for development members' convenient work [4]. The development efficiency will be improved by using API framework and sharing the functional modules of applications. The top level of Android is application level and it's the window to contact with customers. Besides the application provided by system, the third application can be also installed.

The soul of Android Application is its groupware and any Android application is composed of one or more groupware between which the information will be transferred by Intent [5]. Several important groupware in Android system are: Activity, Service, Broadcast Receiver and Content Provider.

#### (1) Intent

The purpose of providing Intent on Android is to reduce the coupling factor among group wares. Date information can be interactive through the group wares. An Android APP has four kinds of group ware, which accomplish an android APP independently and interactively. The Intent has actually play liaison man role of these group wares. The intent can be divided into explicit intention and implicit intention. Calling Intent.setComponent() or Intent.setClass() has assigned the Intent of group ware is Explicit intention. Explicit intention has clearly specifies which group ware the Intent should transfer to. Implicit intention did not clearly specify the group ware. Android system can find the most suitable group ware by the action, category and Uri of implicit intention. As a link among activities, Intent not only can transfer data information, but also can accomplish a lot of complex activities by his own property. For example, calling dialing function directly, processing receiving messages and so on.

The property of Intent has four important attributes.

Action. Its attribute value is string, which represent a sort of common activities. Action can be set up through setAction () or by AndroidManifes.xml.

Data. Data is a operational data which generally defined by Uri form.

**Category**. Category can be use to assign the Execution environment of current action, which can be set up by adCategory() or AndroidManifest.xml. Default for CATEGORY\_DEFAULT.

**Extras.** Extras mainly used to transfer additional data which target group ware needed. It can be set up by putExtras().

#### (2) Activity

As the window of Android application, Activity groupware is one of the most basic groupware which compose application. Every Activity is a User Interface and Generally, application is composed of more than one Activities between which data is acquired and transferred by communicator Intent. Through inheriting base class android.view.View All kinds of basic controls are added, for example: TextView, EditText and Button and so on to enrich Activity. The main step to understand an Activity is to know its state. Generally, there are three states that are Active, Paused and Stopped in an Activity whose phases are indicated by the three states. System will use an onDestroy() to end program when an Activity has completed its task.

#### (3) Service

Service, same as Activity, is composed of executable codes, but the difference is that it operates in the background without visible surface [6]. Two startup ways Context.startService() and Context.bindService() can start up Service and Service keeps operating in background before device is turned off, for example, when MP3 is started up, other applications can be operated, too.

(4) Broadcast and Intent Receiver

Broadcast and Intent Receiver is a very important groupware of Android application and it deals with the notifications or requests (charging completed, new words library to be updated and so on) sent by other systems or applications. There is no visible interface for the groupware and it deals with notifications or requests via starting up relevant activities.

## (5) Content Provider

Content Provider is a groupware which provides data service in Android system and it uses standard URI interface to make data share between different applications in order to guaranty quality of data service of Android.

## **2.2. AHP Introduction**

Analytical Hierarchy Process, AHP is a kind of decision-making analysis method combined with qualitative and quantitative analysis which was created by American operational researcher Sade in 1970s and it has widely practicability for the decision-making of variety kinds of problems. It's application has been used in all kinds of fields of society so far [7]. (Such as: Economics, Management, Power distribution, Transportation, Education, Medication, Environment and so on). The main thought of AHP: For some kind of complex problem or target, all the relevant elements affecting the problem or target will be found out

and analyzed the relationship between them, and then according the relationship to order them based on hierarchy structure and it is acceptable that every hierarchy has its own rule. At last, the judgment matrix will be set up after the comparing of every element in the hierarchy. The weight complying with the rule of every element will be calculated and based on the results, the combination weight of elements in every hierarchy for the general target will be got [8]. The best solving method is picking up the most maximal combination weight by which the target is also affected the most. The advantage of AHP is that it can combine the qualitative and quantitative method to handle a lot of practical problems which can't be solved by the best traditional technology, but its obvious limit is that judging the importance comparing of any two elements in the matrix would be affected badly by the subjective opinions. If the judgment is got from a group of experts' discussing, or Fuzzy Theory of Fuzzy Math is adopted to lower the affects of the subjective opinions, the disadvantage will be overcome. AHP's Process could be carrying on by the followed four steps:

#### Step 1: Build up Hierarchy structure

The key that if AHP successes lies on a reasonable Hierarchy structure. So it'd better to make clear the relationship between elements when Hierarchy structure is set up. Generally, Hierarchy structure includes three hierarchies and they are target layer, Norm layer and Decision layer [9]. There is only one element in target layer which shows the anticipated ideal result. Norm layer is called middle hierarchy, too and it is the middle potion which affects the anticipated target and is composed of several hierarchies.

Step 2: Set up Judgment Matrix

Hierarchy structure is set up according to step1. Elements bij of judgment matrix are got by comparing with one by one of Bi and Bj of this hierarchy, and some element C of last hierarchy is as the judgment criteria for this step. So bij means the importance of Bi to Bj aimed at criteria C.

Step 3: The calculation of comparative importance and proving of coherence

It is getting the weight value of every element and test it.

(1) The calculation of weight value

First, normalizing every column of the Judgment Matrix. Show as Table 1 Equations (1)

Second, summate every row of the result last step. Show as Table 2 Equations (2)

Third, normalizing every column of the result last step and get eigenvector. Show as Table 3 Equations (3).

## **Table 4. Equations**

$$b_{ij} = {}_{b_{ij}} / \sum_{k=1}^{n} {}_{b_{kj}} (i=1,2,...,n).$$
 (1)

$$\overline{W_i} = \sum_{j=1}^{n} \overline{b_{ij}} (i=1,2,\dots,n) \text{ , and get } \overline{W} = \left[\overline{W_1}, \overline{W_2}, \dots, \overline{W_n}\right]^T.$$
<sup>(2)</sup>

$$W_i = \overline{W_i} / \sum_{i=1}^{n} \overline{W_i} \text{ (i=1,2,...,n)}$$
 (3)

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)}{nW_i}$$
<sup>(4)</sup>

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$
(5)

$$CR = \frac{\sum_{j=1}^{m} a_j CI_j}{\sum_{j=1}^{m} a_j RI_j}$$
(6)

(2) The calculation of the largest eigenvalue. Show as Table 5 Equations (4)

(3) coherence indicator CI. Show as Table 6 Equations (5). general condition, if  $CI \le 0.10$  we consider the Judgment Matrix is ok and the result is acceptable.

#### Step 4: The calculation of comprehensive importance

The main job of this process is to sort the whole Hierarchy structure. The whole Hierarchy structure sequencing is that calculation all elements weight values in the same level aimed at the decision [10]. It needs to process one by one from top to bottom and the result of single Hierarchy structure sequencing is also the consequence of whole Hierarchy structure sequencing. For example, the previous layer A which including the quantity of factors is m as A1, A2, …, Am, corresponding weights are a1, a2, …, am. The next layer B which including the quantity of factors is n as B1, B2, …, Bn, corresponding single Hierarchy structure sequencing weights for factor Aj are b1j, b2j, …, bnj. Then the whole Hierarchy structure sequencing weights show as Table 2. The whole Hierarchy structure sequencing proving of coherence: if some factors in layer B whole Hierarchy structure sequencing average random coherence indicator IRj, then layer B whole Hierarchy structure sequencing Consistency Ratio. Show as Table 7 Equations (6).



Table 2. the whole Hierarchy structure sequencing weights

# 3. Analysis and Design for AHP Module based on Android System

## 3.1. Analysis of AHP

## (1) Function requirement of AHP

AHP is an applied kind of assistance decision-making method which can be used in all areas of our lives. Now let's analyse that what functions of AHP module should have via taking an example of our life. Example: We don't know which is better when we want to buy something of which there are two kinds, A and B. The problem can be solved by AHP in this situation. According to the introduction of the second part of the article, first, AHP module should be set up. We can put the best merchandise as the target layer, and Norm layer can be determined by the merchandise's functions, price and other conditions (other characters of the merchandise). Decision layer are A and B merchandises. As Figure 1.



Figure 1. Merchandise Hierarchy

In order to get the best solution, Weights of every indicator of Norm layer for target and Decision layer for Norm layer must be got. Besides, Accordance proving value CR also should be got to test the rationality of the set-up judgment matrix. At last, weights of Decision layer should be ranked in all hierarchies. So, AHP module includes four main functional modules which are Norm Layer Weight, CR, Decision Layer Weight and Final Sort. As Figure 2.



Figure 2. Functional Module

#### (2) Analysis of AHP flow

It's an important director for module development to know clearly the calculation flow. The input of AHP begins from the judgment matrix of Norm Layer's structuring and there are roughly three steps. Step 1, customer's input is dealt with by Norm Layer Weight of AHP which input the result in to CR and judge all the results get from CR. If the conditions can't

be met, back to Norm Layer to rebuild up the matrix, and if met, move to next step. Step 2, customer's input is dealt with Decision Layer and if the value got from CR not less than 0.1, back to Decision Layer to rebuild up the matrix, and if it meets the conditions, move to next step. In theory, it isn't that Norm Layer's operation comes first, then Decision Lay, but in practice, people are used to make Norm Layer work first. Step 3, Input weights got both from Norm Layer and Decision Layer into Final Sort by which the result is dealt with to put out. As Figure 3.



Figure 3. AHP Flow

## 3.2. AHP Design based on Android

#### (1) Structure Design

In this article, the design of AHP adopts MVC(Model-View-Controller) mode which divides Showing Layer and Logic Dealing Layer to control the flow via assigning Controlling Layer. Information can be transferred by that Activity of Android corresponds with View. Intent groupware and xml documents of Android are used to control flows of modules. Model corresponds with responded activities encapsulated in Activity to deal with the required operations. The Android application structure is more clearly and the efficiency is highly improved after that MVC is applied to the software development of Android.

## (2) Flow Design

As Figure 4 for the flow of AHP based on Android. There are 6 Activities to communicate to customers in one AHP. NormMatrixActivity means the judgment matrix of Norm Layer, CRActivity means the page layout when CR doesn't meet the conditions, NormWeightActivity is the Weight of Norm Layer, DecisionMatrixActivity means judgment matrix of Decision Layer, DecisionWeightActivity is the Weight of Decision Layer, ResultActivity shows the final result. NormMatrixActivity has two jump routs, one of which is jumping to CRActivity, then back to NormMatrixActivity when the result doesn't meet the conditions of CR, the other is jumping to NormWeightActivity first, then DecisionMatrixActivity when the conditions are met. It is the same as NormMatrixActivity when the dealt result of DecisionMatrixActivity first, then ResultActivity to show the final result.

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Figure 4. Activity Jumping

## **3.3. Realization and Test**

Eclipse is applied to develop AHP in the environment of Android in this article.

As Figure 5 shows the interface of NormWeightActivity which is the executive entrance of the whole program and it means the judgment of indicator importance of Norm Layer to Target Layer. Data will be submitted to Logic Layer to be dealt with after the Enter Button is pressed when appropriate judgment value is input.

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productAHP							
准则层判断矩阵的构建							
矩阵	功能	价格	其它				
功能	1.0	5.0	7.0				
价格	0.2	1.0	3.0				
其它	0.14	0.3	1.0				
提交							
重置							
Ð	. @	ABC 2	DEF 3	DEL			

Figure 5. NormWeightActivity

It's the important function of AHP to calculate the weight of given indicator. And the calculation of CR is also an important. Now the realization code is given as followed:

// calculation CR

```
lamta = 0.0;
for (int k = 0; k < N; k++) {
  lamta += w1[k] / (N * w0[k]);
}
double CI = (lamta - N) / (N - 1);
if (RI[N - 1] != 0) {
```

```
CR = CI / RI[N - 1];
}else if (RI[N - 1] == 0) {
    CR = CI;
}
```

To test the realized AHP module and refer to the main data as table 3:

Matrix	Function	Price	Other
Function	1.0	5.0	7.0
Price	0.2	1.0	3.0
Other	0.14	0.3	1.0

Table 3. Main data

Result: Weight of A equals 0.66, Weight of B equals 0.34. As Figure 6. It indicates that A will be chosen first when data is given. The result proves AHP module based on Android is feasible and effective.



Figure 6. ResultActivity

# 4. Conclusion

AHP module based on Android can help us to make decisions and provide convenience to our lives. The structure and main groupware of applications of Android are simply introduced in the article based on which AHP calculation is analysed detailed and designed. At last, it is realized and tested and the results indicate that AHP module based on Android is feasible and effective.

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International Journal of Multimedia and Ubiquitous Engineering Vol.9, No.1 (2014)

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