

A Recommender System Based Job Application

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Declaration

We, hereby, declare that the work presented in this thesis is the outcome of the investigation performed by us under the supervision of Mahamudul Hasan, Lecturer, Department of Computer Science and engineering, East West University. We also declare that no part of this thesis has been or is being submitted elsewhere for the award of any degree or diploma.

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Abstract

Work is an important function of the human being and without work life is impossible. With job we can either fulfill our desires or family needs but the important one is we gradually attain confidence, self-respect & social status which makes us feel the part of society. When we work, we can develop new skills and can learn new things. Job is something where we can continuously discover ourselves and our potential. So, this is very important to establish an easy way to find out jobs. In spite of this to make it more effective there are so many algorithms to make a recommender system where jobs will be suggested to the users. There are so many algorithms of recommendation system but here in our thesis we have tried to build a personalized recommendation system. Importance of recommendation in searching job is very important as it will save time and also be helpful to know the neighbor member's preferences. This application contains history of similar users' job preference lists. This application also contains admin panel for the recruiters. So, the recruiters can easily post, view, edit and delete jobs. Without recommendation people can also see their desired jobs by searching with the company name or job name. When the app has been used by someone more than one time then their previous search jobs will also be shown in their respective homepage.

Chapter 1

Introduction

For self-reliance, everyone needs a job. Self-support is deeply related to employment. For, becoming self-dependent people attend educational institutions, complete study and look for jobs after graduation. So, it is the main target of a fresh graduate to look for a job. On the other hand, the use of smartphones has increased over the years having youth being the majority of users. Smartphone has become an integral part of their lives. The use of the mobile phone for searching for preferred jobs will be helpful for job seekers. We have proposed an application for job seekers to help them to find their desired jobs where the recommendation is also included. Job recruiters can also use this application for posting jobs. So, it is a great medium for a job posting and getting jobs.

1.1 Overview and Motivation

With the increase in time, the number of job seekers is increasing. But the number of jobs is not increasing with the number of populations that much. As a result, it has become a great problem for fresh graduates to get their desired jobs. In this project, we tried to make an app considering the job-seeking problem. It is a platform where people can search for their respective fields of jobs. We have also implemented an idea so that they can see previously searched jobs by others in a particular field. And if a user logs in again they can also see their previous searched jobs.

1.2 Thesis Objective

The main objectives of the proposed project are:

1. To develop an application
2. To recommend job based on the preference and neighbor's choice

Chapter 2

Literature Review

This chapter provides a discussion about existing work on recommender system.

A lot of research has been carried out in the field of job recommender systems. A variety of job recommender systems already exist by applying different methodologies [1] [2]. The bilateral job recommender system helps to provide 2-sided recommendations, CV recommender and Job recommender [3]. CASPER system tries to provide personalized recommendations to the candidate. CASPER PCF uses a two-stage process wherein the first stage, the similarity between the candidate's query and the jobs, which is done on the server-side. In the second stage, on the client-side, retrieved jobs relevance is calculated according to the target user profile and the jobs are finally sorted in the order of their relevance [4]. In their following work [5-7], Reciprocal recommender systems are also in place where a reciprocal value is calculated considering the candidate's cv information and candidate's interaction history. The final recommendations are provided by ranking based on the reciprocal scores [8]. The hybrid recommendation approach combines the content-based and collaborates filtering approach, for overcoming the limitations of each approach. In the e-recruitment domain, the hybrid recommendation approach has been applied widely. Malinowski et al. [9] apply the probabilistic model into two parts: a CV recommender and a job recommender separately and integrated the result. For matching candidates and jobs using logic-based and similarity-based matching Fazel-Zarandi and Fox [10] combine different matchmaking strategies in a hybrid approach. Hong et al tried to cluster the candidates into three major groups applying different recommendation approaches for each group cluster [25]. The generation of a user profile in the e-recruitment system, i.e. the selection of features of job applicants and job posts, has also been researched. Robertson and Smith [26] review the research on major personnel selection methods and attracting job applicants. Yu et al. [28] design a cascaded information extraction framework for mining CVS to support automatic cv management. Singh et al. [29] present PROSPECT, a decision support tool that aids in the shortlisting of candidates for jobs by extracting various information from the unstructured resumes with the help of statistical data-driven techniques. Keim [30] integrates the prior research into a unified multilayer framework using the matching of individuals for recruitment and team staffing processes. Fazel-Zarandi and Fox [31] combine different matchmaking strategies in a hybrid approach for matching candidates and jobs using both logic-based and similarity-based matching.

Android Application

3.1 What is Android?

Android is an open and free operating system based on Linux, which is mainly used for mobile terminals, panel computer such as smart phones. It is developed by Open Handset Alliance composed of more than 30 mobile phone companies and technology companies [13]. **Android** is a mobile operating system mainly developed by Google[14]. Android tries to allow developers get a more open level for more convenient software developing and allow users experience the best service quality. Via Android, mobile applications with more convenient functions can be developed.

Android will further promote the Google enterprise target achievement of "provide information for everyone at any time in any place" [11].

3.2 Origin of Android.

Android is developed by Open Handset Alliance composed of more than 30 technology companies and mobile phone companies including Google, HTC, T-Mobile, Qualcomm, Motorola, Samsung, China Mobile and LG [13]. Open Handset Alliance states that the Android platform can promote the innovation of the mobile device to allow users to experience the best service quality. Also, developers will get a new open level for a more convenient synergistic effect, ensuring the development speed of new mobile devices [13]. Therefore, the first complete, open and free mobile phone platform is Android.

3.3 Advantages of Android.

1. Android is developed by more than 30 companies in Open Handset Alliance, thus the cooperation among Google, operators, equipment manufacturers, and developers try to establish a standardized and open mobile phone software platform and form an open ecosystem in the mobile field [13].
2. Applications on the mobile devices are equal, so they can be replaced or extended, even as the core components such as the dialing program or main screen [13].
3. Applications can be easily embedded into XML, JavaScript and the style sheet, and network content can be displayed via Web View [13].
4. Android is a complete multi-task environment, so applications can run parallelly.

3.4 Android Platform Architecture

The Android architecture can be divided into four layers, application layer, application framework layer, system operating library layer and Linux kernel layer, as shown in Figure1[12].

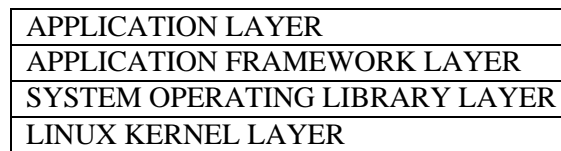


Figure 1: Android architecture layer

3.5 Software Stack of Android

We have studied about Android Software Stack which helps us to understand how Android works inside a device [15].

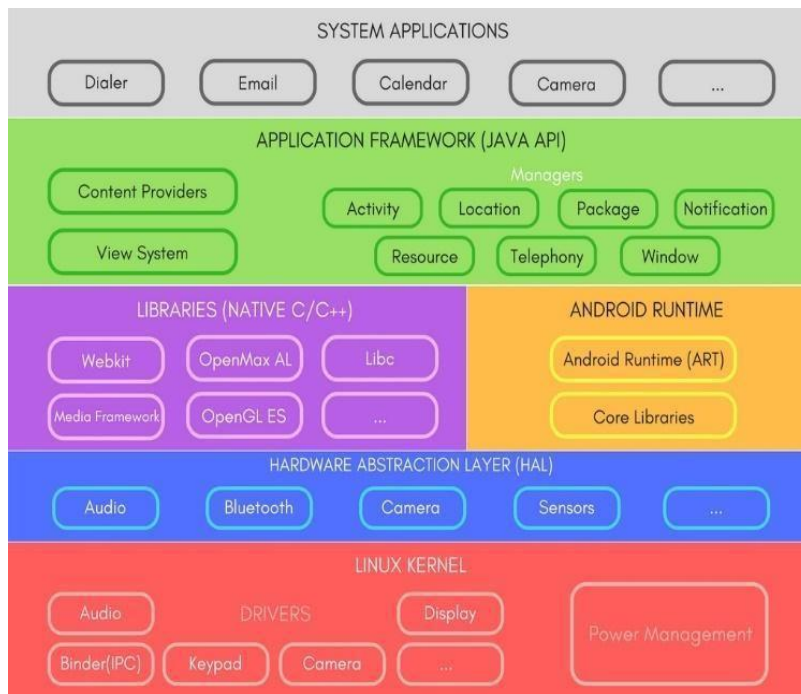


Figure 2: The Android operating system follows a layered architecture approach.

3.5.1 Linux kernel:

This layer is the main foundation of the Android Platform.

- Contains all low-level drivers for various hardware components support [15].
- Android Runtime relies on Linux Kernel for core system services like [15],
- Driver mode
- Security and more
- Memory, process management, threading, etc.

3.5.2. Hardware Abstraction Layer (HAL)

Provides Abstraction between rest of the software stack and hardware

3.5.3 Android Runtime (ART)

Designed to run apps in a constrained environment that has limited muscle power in terms of battery, processing, and memory [15]. It contains a set of core libraries that enables developers to write Android Apps using Java Programming. Since Android 5.0, each app runs in its process within its instance of ART virtual machine, which makes process management more crucial [15]. ART uses DEX files, which is a type of bytecode, specially designed for Android, which helps ART to manage memory more efficiently [15]. ART is capable of both **Ahead-of-time** (AOT) and **Just-in-time** (JIT) compilation. Before Android 5.0, Dalvik was used as Android runtime [19]. It also has a very efficient garbage collection [15].

3.5.4 Application Framework

It is a collection of APIs written in Java, which gives developers access to the complete feature set of Androids OS [15]. To enhance more in terms of functionalities of their application, developers have full access to the same framework APIs used by the core applications [15]. Enables and simplify the reuse of core components and services, like [15]:

1. **View System:** Contains User Interface building blocks used to build an application's UI, including lists, grids, texts, boxes, buttons, etc. and also performs the event management of UI elements (explained in later tutorials).
2. **Package Manager:** Manages various kinds of information related to the application packages that are currently installed on the device.
3. **Telephony Manager:** Enables app to use phone capabilities of the device.

4. **Resource Manager:** Provides access to non-code resources (localized Strings, bitmaps, Graphics and Layouts).
5. **Location Manager:** Deals with location awareness capabilities.
6. **Notification Manager:** Enable apps to display custom alerts in the status bar.

3.5.5 Libraries

This is exposed to developers through the Android Application Framework [15]. It contains C/C++ libraries used by components of Android Systems [15]. Few features include [15],

1. SQLite Library used for light in terms of mobile memory footprints and task execution and data storage.
2. Web Kit Library provides a Web Browsing engine and more related features.
3. The surface manager library is responsible for drawing surfaces of various apps on the screen and rendering windows.
4. The media framework library provides media codecs for video and audio.
5. The SGL (Scalable Graphics Library) and OpenGL (Open Graphics Library) are the graphics libraries for 2D and 3D rendering, respectively.
6. For rendering fonts, the Free Type library is used.

3.5.6 Applications

The System apps and tones of other Apps that users can download from Android's Official Play Store, also known as Google Play Store occupy the top of the Android Application Stack [5]. A set of Core applications are pre-packed in the handset like Email Client, SMS Program, Calendar, Maps, Browser, Contacts and many more [5]. This layer uses all the layers below it for the exact functioning of these mobile apps [5].

3.6 Android App Version Names

There are so many versions of android. Here are some android version names below, [16]

- Android 1.0 (2008) - **No Version Name**
- Android 1.1 (2009) - **Petit Four**
- Android 1.5 (2009) - **Cupcake**
- Android 1.6 (2009) - **Donut**
- Android 2.0 - 2.1 (2009) - **Eclair**
- Android 2.2 - 2.2.3 (2010) - **Froyo**
- Android 2.3 - 2.3.7 (2010) - **Gingerbread**
- Android 3.0 - 3.2.6 (2011) - **Honeycomb**
- Android 4.0 - 4.0.4 (2011) - **Ice Cream Sandwich**
- Android 4.1 - 4.3.1 (2012) - **Jelly Bean**
- Android 4.4 - 4.4.4 (2013) - **KitKat**
- Android 5.0 - 5.1.1 (2014) - **Lollipop**
- Android 6.0 - 6.0.1 (2015) - **Marshmallow**
- Android 7.0 - 7.1.2 (2016) - **Nougat**
- Android 8.0 - 8.1 (2017) - **Oreo**

- Android 9.0 (2018) - **Pie**
- Android 10 (2019) - Android 10

3.7 Android Studio

3.7.1 What is android studio?

3.8 Background

Android Studio is the official integrated development environment for Android application development. It is based on the IntelliJ IDEA and a Java integrated development environment for software, and also incorporates its developer tools and code editing. Android Studio uses a Gradle-based build system, emulator, code templates, and GitHub integration, to support application development within the Android operating system [16]. Project in Android Studio has one or more modalities with resource files and source code [16]. These modalities include Google App Engine modules, Android app modules, Library modules. Android Studio uses an Instant Push feature to push code and resource changes to a running application [16]. A code editor assisted by the developer with writing code and offers code completion, refraction, and analysis [16]. Then Applications built-in Android Studio, compiled into the APK format for submission to the Google Play Store [16].

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development [18]. It is available for download on windows, macOS and Linux based operating systems [19][20]. It is a replacement for the Eclipse Android Development Tools (ADT) as the primary IDE for native Android application development [21]. Android Studio was announced on May 16, 2013 at the Google I/O conference [21]. It was in early access preview stage starting from version 0.1 in May 2013, then entered beta stage starting from version 0.8 which was released in June 2014 [22]. The first stable build was released in December 2014, starting from version 1.0 [23]. Since 7 May 2019, Kotlin is Google's preferred language for Android app development [24]. Still, other languages are supported, including by Android Studio.

3.9 Android studio 3.2 features

We have used 3.2 android studio for our project. There are so many new features have added in this updated version. The special new features are like [25],

1. Android Studio Jetpack has been updated and improved. The updated jetpack has made the overall development process much smoother and easier.

2. New Navigation Editor. The new navigation editor helps developers to have a latest view of their app design and layout. It has become very much easier.

3. Android Refactoring. For a new Android extension library using the android namespace, Android has introduced a new refactoring mechanism for the Android Support Libraries.

- 4. The New App Bundle.** The new dynamic app bundle is much intuitive and smarter than the previous version.
- 5. Layout preview.** The presence of runtime data can hamper the visualization capability of the app. This can affect the app design process during the app development process. With the new layout preview, we can preview our design using sample data in the layout editor.
- 6. Slice Functionality.** Android Studio 3.2 will now create a preview of your app in Google Search results.
- 7. More new lint checks.** Android Studio 3.2 is implementing 20 new lint checks, Beyond Kotlin interoperability lint checks.
- 8. New Gradle target.** to apply all of the safe fixes suggested by the lint check directly to the source code we can use the new lint Fix Gradle task.
- 9. Metadata updates.** Various metadata, like the service cast check, have been updated to lint checks to work with Android P Developer Preview.

Proposed Work

4.1 Use Case Diagram

The Unified Modelling Language (UML) is a standard language for specifying, visualizing, constructing and documenting the artefacts of software system, as well as for business modelling and other non-software systems. The UML represents a collection of the best engineering practices that have proven successful in the modelling of large and complex system. UML diagrams commonly created in Microsoft Visio.

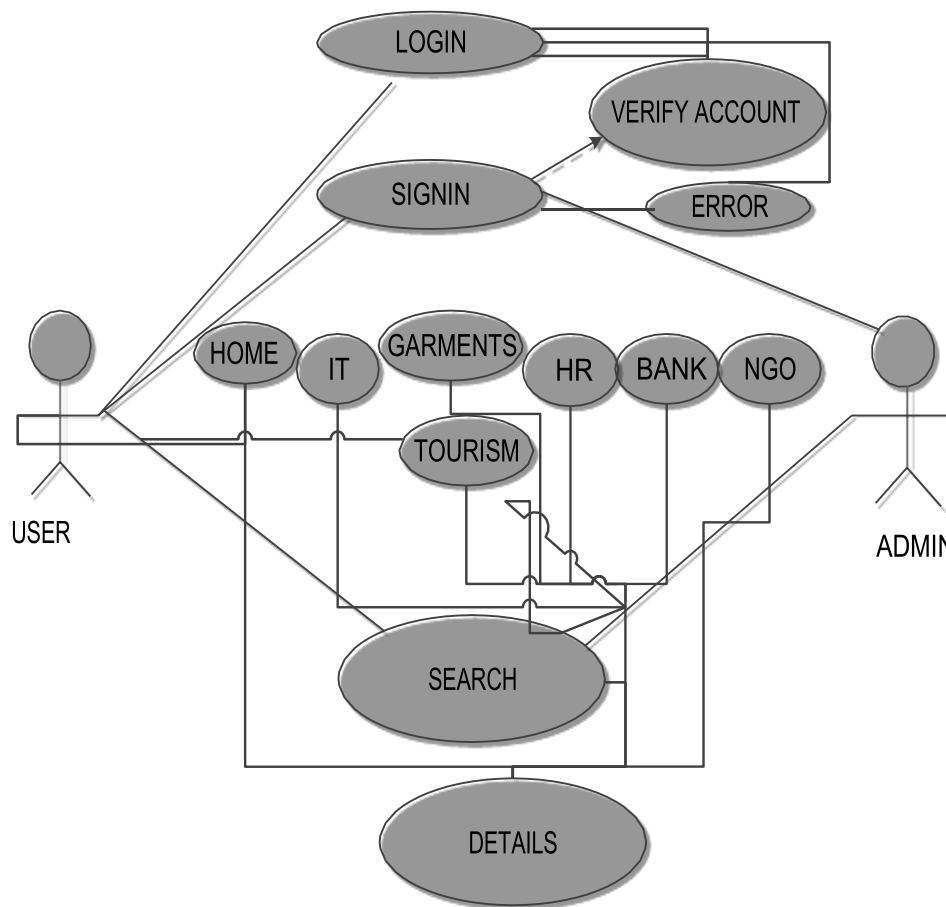


Figure 3: Use case diagram for job search android app.

4.2 E-R Diagram

An entity relationship diagram (ERD) typically serves as the main deliverable of a conceptual data model. While newer approaches to E-R modelling has developed, the E-R approach is still sited by some professionals as “the premier model for conceptual database design”.

Entities – Major categories of data and are represented by rectangles.

Attributes – Characteristics of entities and are listed within entity rectangles

Relationships – Business relationship between entities and are represented by lines

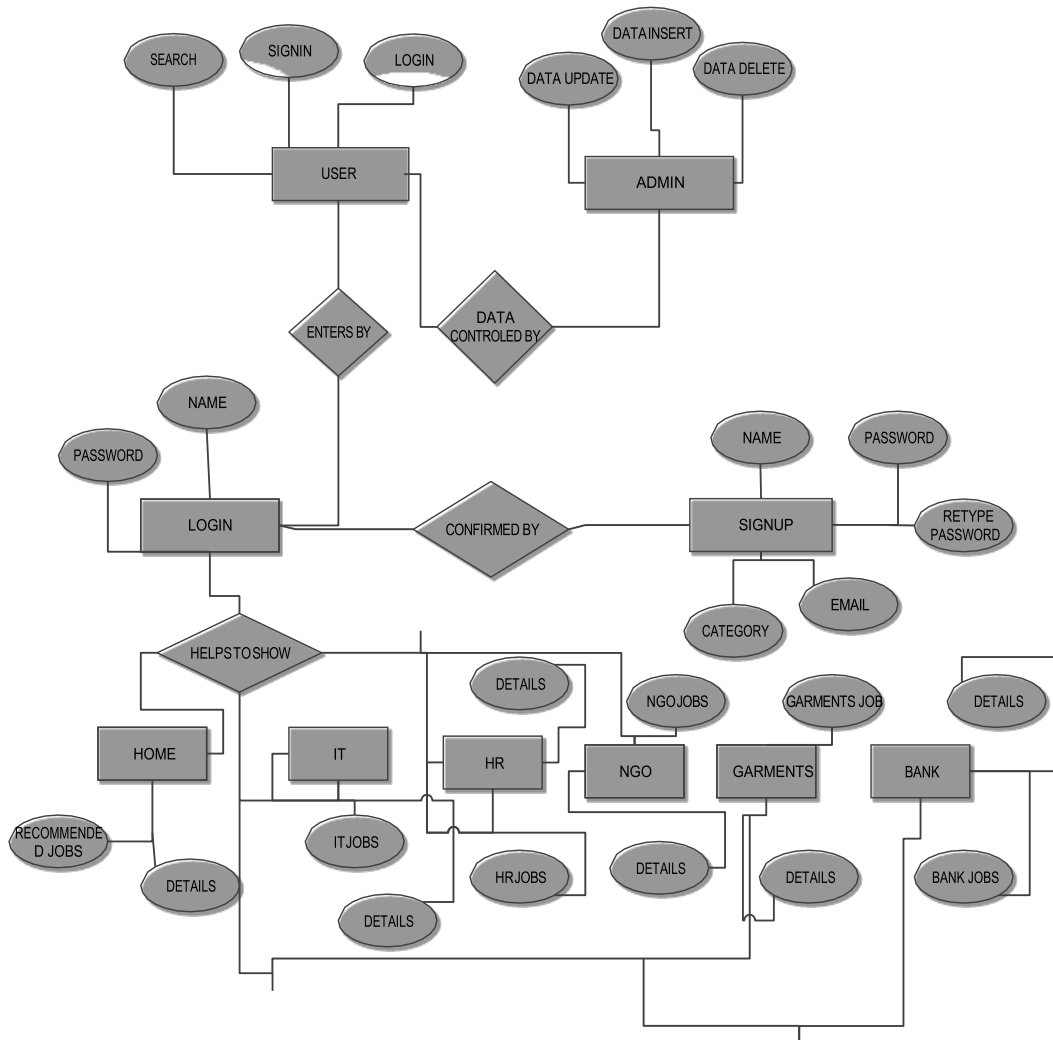


Figure 4: E-R diagram of android app.

4.3 Job Search App Interfaces

After opening the app there will appear a splash screen first.



Figure 5: Splash screen

After the splash screen there will be a login page from where users can log on to the main job search page or new user can create an account by signup page.



Job Search

Name:

Password:

The image shows a login page with a dark blue header containing the text "Job Search". Below the header, there are two input fields: "Name:" followed by a horizontal line, and "Password:" followed by another horizontal line. At the bottom of the form area, there are two light gray buttons with the text "LOGIN" and "SIGNUP" respectively. The background of the page is a vibrant blue with abstract light trails and particles.

Figure 6: login page



Sign Up

Name:

Password:

Confirm Password:

Email:

Job Category:

The image shows a sign-up page with a dark blue header containing the text "Sign Up". Below the header, there are five input fields: "Name:", "Password:", "Confirm Password:", "Email:", and "Job Category:", each followed by a horizontal line. At the bottom of the form area, there is a single light gray button with the text "SIGNUP". The background of the page is a vibrant blue with abstract light trails and particles.

Figure 7: Sign in page

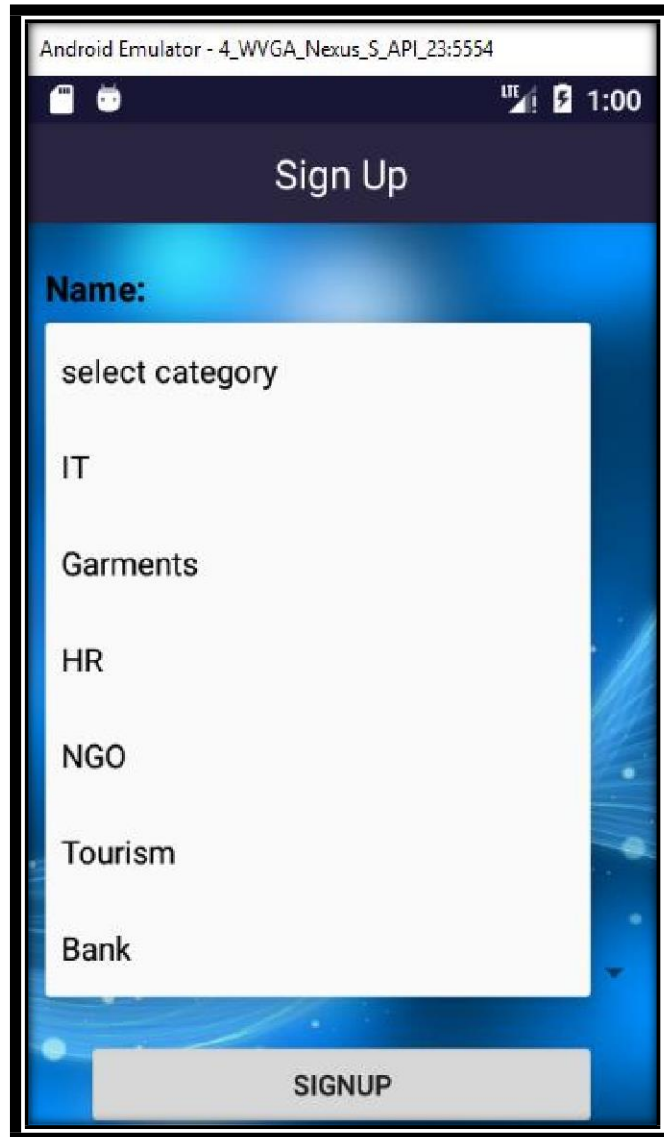


Figure 8: Select category option

This option is very important for us because based on this our recommender system will work.

If the user is totally new for our app then after logging in there will be no job data on the home screen. That means there will be no data to recommend jobs for new user. The home page is mainly used to recommend data based on category ID. This is mainly programmed by search button. If user is not new then the home page will show the job data searched by other same category user, which means if the selected category is same then home page will show their searched job for both users. In our methodology section we will discuss details about this recommendation method.

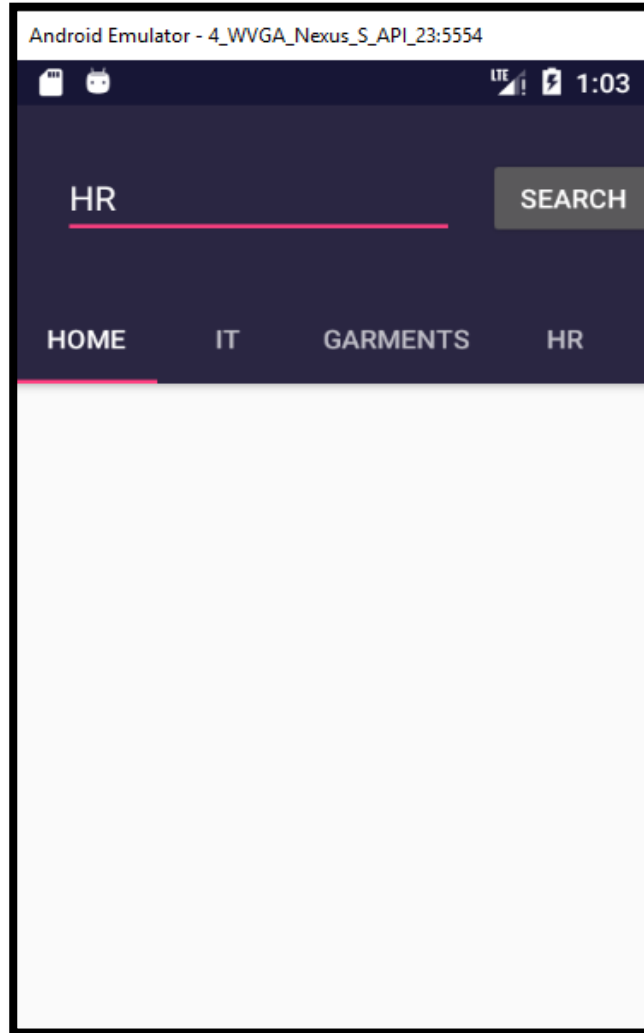


Figure 8: Home page

After searching for jobs by job names when users will go back to the homepage, they can see both searched and recommended jobs based on category.

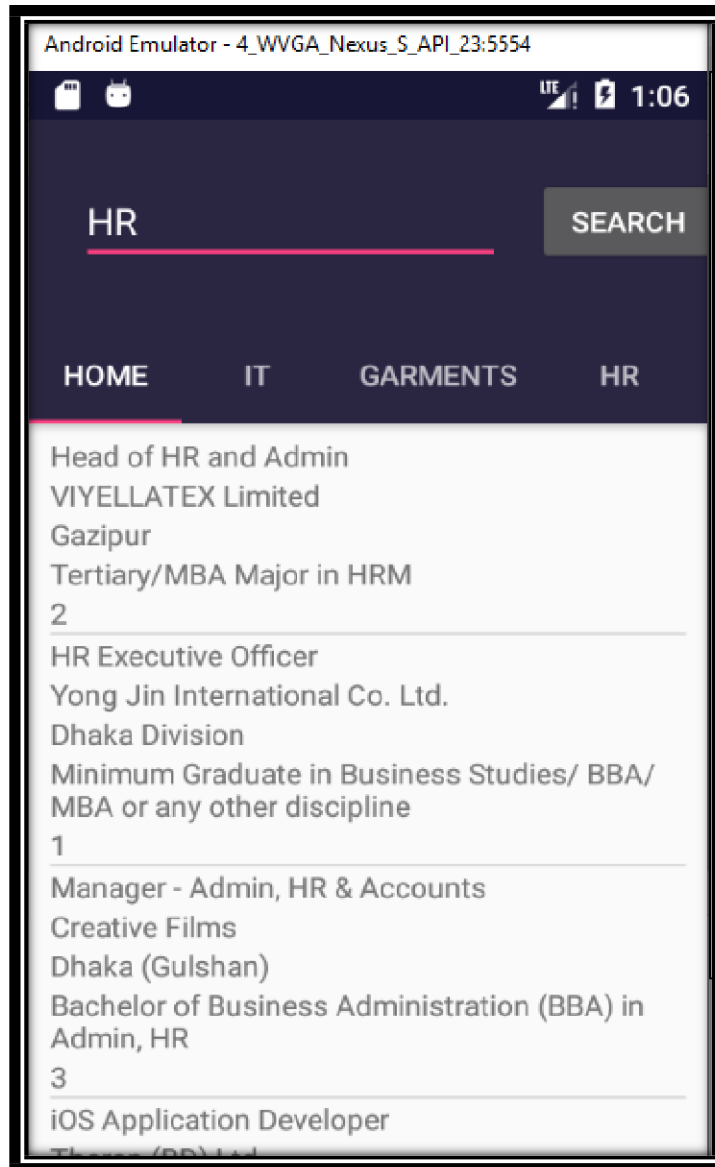


Figure 9: Recommended jobs

There are also fragments called IT, HR, GARMENTS, BANK, NGO. These fragments contain their related jobs. Which makes easy to see the job data. There is also a search option that will work to store user's clicked data. And show on the home page. There is also an option for a navigation bar. By this, the user can operate any data from any page. As an example,

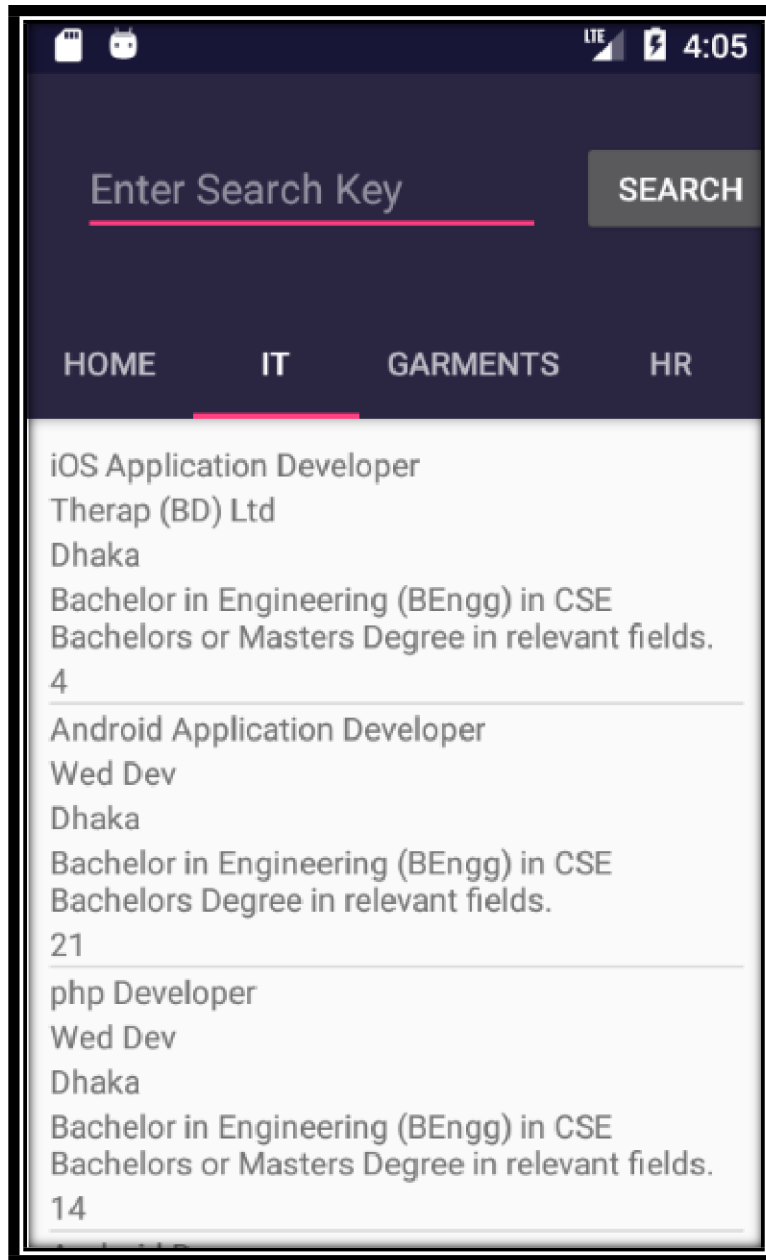


Figure 10: IT related data in fragment

So, these are the interfaces of our android app project.

4.4 Recommendation:

Recommendation Engines are a subclass of information filtering system that seek to predict the 'rating' or 'preference' that user might give to an item.

Three very important types of recommender systems:

1. Collaborative Filtering

2. Content-Based Filtering
3. Hybrid Recommendation Systems

Collaborative filtering methods are mainly based on collecting and analyzing a large amount of information on users' behaviors, activities or preferences and prediction of users like based on their similarity with other users. Many algorithms (such as the k-nearest neighbor (k-NN) approach and the Pearson Correlation) have been used in measuring user similarity or item similarity in recommender systems.

Content based filtering:

1. It uses product features and recommends products to users that have similar features with those they rated highly during the past
2. An approach that recommends items based on the descriptions of that item matched against the description of the user profile.
3. Organizes information based on properties of the object of preference and/or the carrier of information
4. The method of making recommendations to a user by matching user profile entries to content attributes.
5. It is a recommendation strategy that estimates the relevance of an item to a user by matching its content descriptions against the attributes in the user's profile.
6. A technique is done by making a comparison between the content or attributes of a user's profile and the document to make recommendations.
7. This includes techniques to estimate the relevance of a given service or piece of content for a target user, considering that user's previous ratings for resources consumed in the past.
8. In **content-based filtering**, recommendations are calculated based on the description of products.

Hybrid recommender systems combine two or more recommendation systems in different ways and get benefit from their advantages.

Research Methodology

5.1 Overview of the app:

Our system has client side, server and database

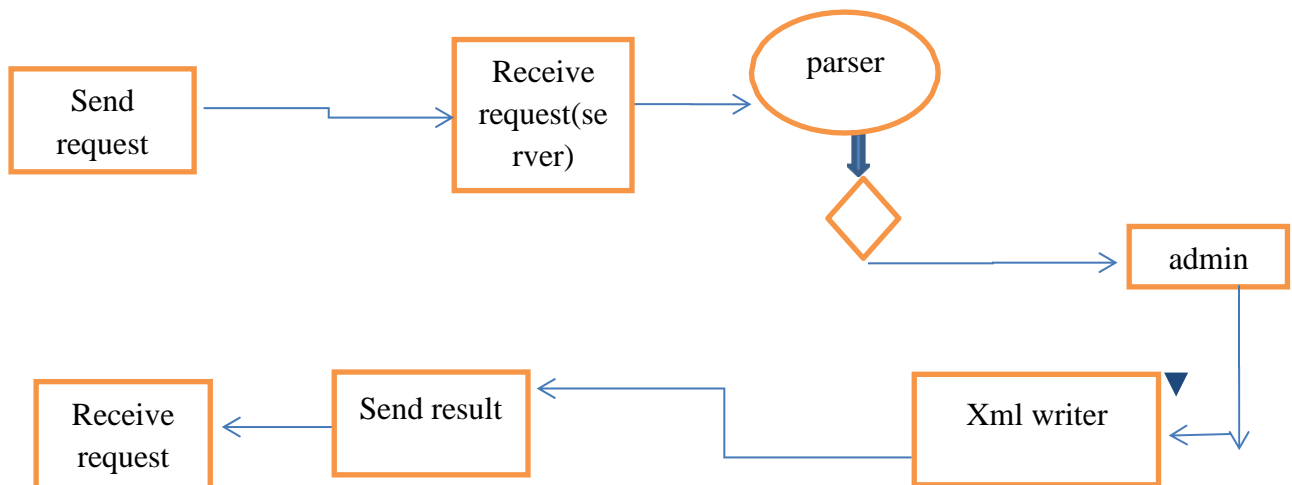


Figure11: System activity diagram

Client side:

Here in the client-side job-seekers, employee and user interface are available

Server-side: Here the API servers to connect the database application are found.

We have used an API server to connect the database with the XML. A server-side web API is a programmatic interface with one or more endpoints to a defined request-response message system, expressed in JSON or XML, which is exposed via the web—most commonly using an HTTP-based web server. We have expressed in JSON format. We have used CodeIgniter framework.

Model: Model represents the shape of the data. It maintains the application data. Model objects retrieve and store model data in a database.

View: A view is a user interface used to display objects within an application and also enables viewers to modify the data. It includes anything that the user can see.

Controller: The controller handles the user request. Typically, a user interacts with View, which in-turn raises appropriate URL request, this request will be handled by a controller. The controller renders the appropriate view with the model data as a response.

Database: Here is the databases that store the information are found. Here database name is job search database.



Figure 12: Job seekers system overview

Database

Table name:

job-name

job-customer-info

job-details

job-search

Admin:

This section explores in detail about admin system architecture design. Admin can view, create, update, delete a job.

The basic features which entered by the job applicant describe his/her personal information and job intention. What is searched by an applicant is his/her preference? It will be saved and will recommend him/her job from his/her previous search history. If someone clicks the same category then the previous viewer's search history will also be recommended to him/her.

Recommender systems function with two kinds of information:

Characteristic information: This is information about items (keywords, categories, etc.) and users (preferences, profiles, etc.).

User-item interactions. This is information about ratings, number of purchases, likes, etc.

We have used characteristic information.

5.2 Recommendation Procedure

- Sign up for the application.
- Get the user session id
- Find similar job related to the user's previous seen job list.
- Make a list of recommendation using Jaccard similarity
- Show recommendation to the user
- Save the user click for future recommendation.

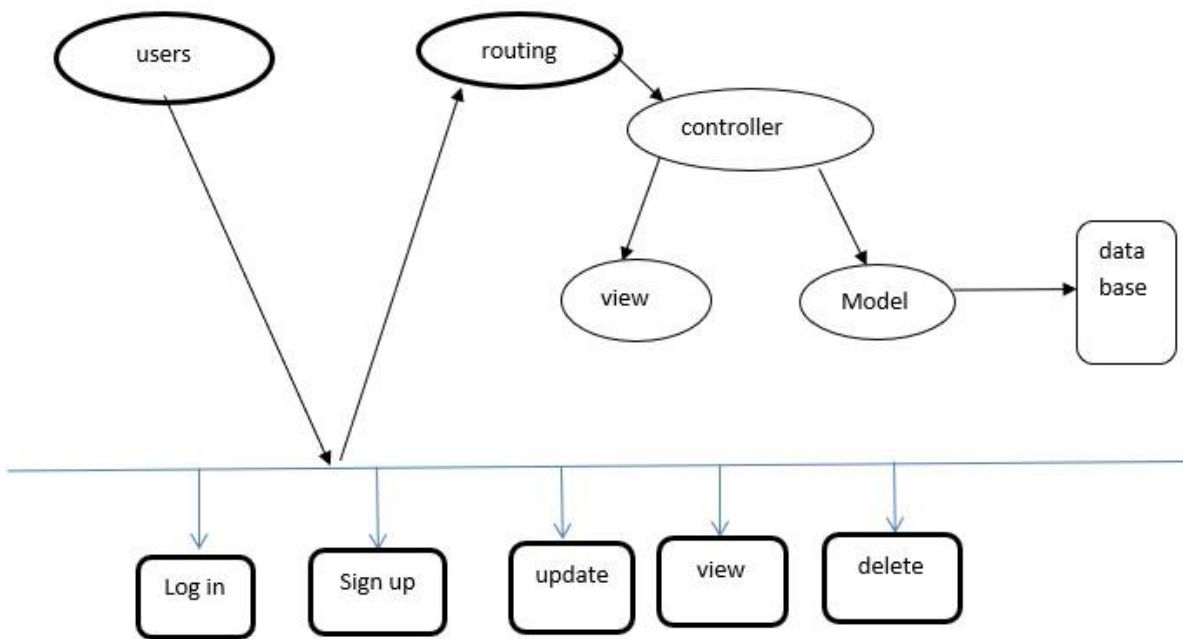


Figure 13: MVC

6.1 Advantages of Our Project:

1. The first advantage of our project is it's based on job search project. Any kind of user can search their content.
2. This whole project is mainly built on android phone. Whoever have mobile phone can easily search for job from anywhere.
3. The interfaces of our app are so easy to operate which encourage users to use this job search app.
4. The main advantage of our project is it has recommendation option for users, which helps more the user.
5. It has also admin panel that helps admin to edit, enter or delete job data very easily.

6.2 Future work

1. The first modified work in our project will be, there can be add some recommendation algorithm like, frequent pattern, collaborative filtering, Jaccard algorithm etc.
2. The interface can be more standardized.
3. Here we have to add new job news by admin, but in future we will use a system where data will be stored automatically and deleted automatically.
4. We will also increase our job sectors and data.
5. There also will be option to apply, for job candidates.
6. There will be options to download images or files from our job search app.

So, these are our future work to update our job search app

6.3 Conclusion:

We have tried to make an application considering some issues people face nowadays while searching for jobs through the phone. The ultimate goal of this project work is to create an application that can recommend jobs. It can be a great medium for posting and getting information about the newest jobs, locations, and vacancies. Though there are any similar applications this method is somehow different from them.

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