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by
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AnveShA:
Automatic Search and Monitoring Agent for Craigslist

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**AnveShA:
Automatic Search and Monitoring Agent for Craigslist**

by

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REPORT

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Dedicated to my husband and my parents.

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AnveShA:
Automatic Search and Monitoring Agent for Craigslist

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The University of Texas at Austin, 2014

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The popularity of Craigslist has enabled users worldwide to find almost any product at prices significantly less than retail prices or market-prices. Craigslist has thus enabled lot of resellers to enter the market and has created a huge market for used/pre-owned products. The key to find products at prices less than their market-prices is to find the right classified and act immediately before other users. Craigslist search agents, with ability to search classifieds, that run on mobile/handheld devices are increasing in popularity with ubiquitous internet connectivity, convenience and speed.

AnveShA is an automatic search and monitoring agent for craigslist that has been developed for Android platforms. AnveShA provides easy access and a rich feature-set that is not available in the state-of-the-art craigslist search applications available on the Android market. AnveShA has been developed to provide the user a rapid and intelligent search agent that can proactively search and monitor classifieds for desired products, contact sellers and increase the chances of obtaining the desired product at the best possible price.

To achieve this, AnveShA has many unique features like the ability to schedule and execute automatic searches, search classifieds based on geographical location, automatically respond to classifieds, store price history for classifieds, get comparative prices from other retail/shopping websites, store favorite classifieds/reminder lists and predict the offer price based on a number of parameters. With such unique features, AnveSha assists users or resellers to find desired products at the best possible prices on Craigslist and hence have a significant advantage over the competition.

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Chapter 1

Introduction

1.1 Motivation

The market share of Android based hand held devices is and has been steadily increasing. Android based hand held device users use readily available android applications to conveniently access the internet. Craigslist.com is a website that allows posting classifieds for various products and services. It was estimated that Craigslist.com is the 11th most visited website in the USA.[74] A large number of sellers and buyers use classifieds in Craigslist.com to sell/buy new/used products.[56, 53]. The popularity of Android and the popularity of Craigslist.com for buying/selling new/used products are the main motivators to develop an android application that will provide an efficient way to access Craigslist.com using the features provided by the Android platform.

There are a number of available applications on the Android market that provide access to Craigslist.com but they lack important features to make them a power search/monitoring agent. The absence of such an application is another motivating factor to a powerful search/monitoring agent called AnveSha. AnveShA in Sanskrit means "to search thoroughly".

1.1.1 User Stories

AnveSha was developed keeping in mind users who use Craigslist.com classifieds to buy products at low prices. Examples of such users are presented in the form of "user stories". User stories describe the way how AnveSha can meet the needs of such users.

- **User Story 1: Professional photography equipment search**

Ray is a businessman who buys and sells used pro Canon photography equipment like cameras, lenses, flashes, light meters, tripods etc. He usually purchases products listed in the local city classifieds craigslist and resells them using popular internet market places like amazon, ebay etc. To achieve this, he has to continuously monitor the craigslist to buy products which he thinks will generate profit. He is also a frequent traveler within the US and would like to expand his business across the cities for better revenue. AnveShA offers him a powerful search and monitoring agent that will enable him to automatically find products that he can buy in a city where he is travelling. Using the application, he can set up multiple queries for various items that he wants to buy. Additionally, he can customize the searches by providing price ranges as offered in craigslist. The application will automatically detect the city/region in which he is currently located and fetches the result from the corresponding craigslist website of the city. In case, the corresponding craigslist website is not found for the current city, the application fetches the results from the nearby city that has a corresponding craigslist website.

It will also perform searches at regular intervals on the craigslist corresponding to his current geographical location and provide notifications at user-configured intervals. AnveSha will also perform searches and displays classifieds that are within a 5km radius of his current location so that he can minimize his travel. Ray can use bulk emailing and auto response features of AnveSha to respond to the buyers quickly. If Ray finds a classified he want to pursue, AnveSha will let him look up the market prices quickly and conveniently before he decides to buy the product. This application enables to buy items at prices that are significantly less than asking prices by acting quickly. These items can be sold at regular market price incurring a profit.

- **User Story 2: Best deal for buying Ipad**

Erin is going on a business trip and visiting a set of places like Washington, New York and Los Angeles. She was thinking of buying an Ipad but want to wait until she finds the best deal in her budget in terms of ipad memory capacity, features, condition of the ipad and ipad accessories. AnveShA will allow her to set a search query for Ipad and customize it with her price preferences. The application will automatically detect Erin's current location and search the local or nearby Craigslist classifieds for Ipad at regular intervals. The application will provide a list of available classifieds from which she could potentially buy the Ipad. AnveShA will provide Erin with the following advantages:

- Erin need not manually search the local Craigslist website every

time she travels. Erin need not be aware of the existence of a Craigslist website for her current or nearby location. The application will automatically find the local Craigslist website.

- Classifieds on Craigslist.com can come up at any time. It is important to act fast to buy items that have low asking prices. Erin need not check Craigslist repeatedly to find such ads. The application is capable of doing this for her by running search queries at regular intervals chosen by Erin and provides notifications.
- Erin’s search is made easy as she receives instant alerts based on matching posts within a radius of 5 km.
- Once Erin has shortlisted few posts, she can compare similar products on market to make a price comparison.
- In order to provide the least possible offer, she can use the price prediction feature of AnveSha that use multiple parameters like supply, price history, market price etc.
- Once she has made decisions on buying a product, she can contact the seller directly using AnveSha via email/call/text. Composing and sending emails are simplified in AnveSha that will aid Erin to send emails quickly. Alternatively, Erin can contact the seller by making a direct call or a text messaging client.

1.2 Vision

AnveShA will automate Craigslist website access by providing most accurate results based upon the current geographical location of the user. It will serve a wide variety of users.

- Small Business Owners who wish to obtain various products at prices less than market prices and resell them at market prices. This class of users can exploit the various features of AnveShA like offer price prediction for obtaining an offer price, Google shopping results for comparison with similar products sold in the market, convenient and quick emailing options etc.
- Frequently travelling users who wish to look for a certain type of product at various locations and obtain the product at the lowest price. This class of users can exploit the notification service features that provide updated results at the current location and also any Craigslist classified matching the search criteria near the current location.
- Lastly, any generic user looking to purchase an item at the best possible price will benefit greatly from this application because of the searches that are automatically run and will provide the quickest response time.

1.3 Scope

The scope of the report is to address five main aspects viz., a survey of available applications for Craigslist, the design and architecture of AnveShA,

results obtained after implementation, the learning experience and limitations of the application.

First, the report will focus on surveying the Android market for applications that provide access to Craigslist and comparing the features of these available applications to the features that are proposed by AnveSha.

Next, the report will focus on the discussion of architecture used and the algorithms designed before implementing the project. This provides an insight on the workflow of the application.

Finally, the report will give the details of various technologies used while implementing and the results obtained. It will highlight the learning experience while implementing the project and the limitations to address the scope of the application.

1.4 Organization of the Report

The remaining part of the report is organized as follows:

Chapter 2 discusses literature survey of similar existing applications and highlights the unique features of AnveShA.

Chapter 3 introduces the architecture and design specifications used for developing the application.

Chapter 4 will provide details about the technologies used for implementing AnveShA on Android and introduce the development environment used.

Chapter 5 will provide the results recorded when testing AnveShA along with detailed information about the user interface. It also provides details on the

learning experience obtained during the design and development of the application.

Finally, Chapter 6 ends the report with conclusion that provides details of several limitations of AnveSha and a summary of possible future work to address the limitations and enhance the features offered in AnveShA.

Chapter 2

State of the Art: Survey of Android applications for Craigslist

There are several applications available on Android market that allows accessing Craigslist on Android platform. This section provides a literature survey of existing applications and illustrates how AnveShA stands out by building a rich feature set that enhances the user experience.

- **cPro Craigslist Client**

cPro Craigslist Client is an Android mobile application that provides an intuitive user interface and provides search results to the user with several capabilities and features to enhance the user experience. cPro Craigslist Client has a wide variety of features and has good user reviews in the market and is a highly recommended application.[54] It is considered the best Android application for Craigslist till date and has good reviews in the New York Times and Forbes. The number of downloads at the time of publication of this report for this application is 84,707.[49] The pros and cons of cPro Craigslist Client is shown in Table 2.1

- **Craigslist Mobile Pro (City Shop-App for Craigslist)**

Pros	Cons
Provides multiple city search results	AnveShA notifies the user with "nearby" search results matching the user's search criteria depending on the current location of the user. The automatic location detection and notification feature is lacking in cPro Craigslist Client.
Performs automatic search and notifies the user with updates.	AnveShA provides users with a feature to create email templates and store beforehand in order for the user to be able to quickly respond to the seller via email with auto-populated subject, body, from and to addresses. This helps many users to be able to obtain best prices by acting instantly. This feature is not provided in cPro Craigslist Client. cPro Craigslist Client lacks bulk email response to multiple sellers. There is no reminder list for contacting the seller at a later stage.
Provides locations nearby on a map and the user has to select the location for search results corresponding to preferred location.	AnveShA offers a feature of predicting the offer price to be made for a particular product sold in Craigslist considering various parameters. This feature is not provided in cPro Craigslist Client.
Bookmarking favorite post, viewing the images posted by seller.	AnveShA provides search results from Google Shopping website for a particular product selected by the user in order for the user to be able to compare the price of the product on street with the asking price of the seller. This feature is not provided in cPro Craigslist Client.
Email, call and text seller of Craigslist ad.	

Table 2.1: Pros and Cons of cPro Craigslist Client

Craigslist Mobile Pro provides a simple and easy to use user interface with extensive features for Craigslist access on Android.

Pros	Cons
Allows viewing the search results just as in Craigslist website with images displayed.	Lacks automatic location detection. The user has to manually enter the location to search the results from the corresponding Craigslist website.
Allows contacting the seller directly via call, email.	Doesn't provide support for email template creation and a bulk email response to multiple sellers.
	Doesn't have a reminder list with option to contact the seller at a later stage.
	Lacks features like offer price prediction, viewing external search results of the product on the market.
	Lacks notification results for updates and matching search results near the current location of the user.

Table 2.2: Pros and Cons of cPro Craigslist Mobile Pro

Craigslist mobile pro has fairly moderate reviews on the Android market. It has a simple user interface covering the basic features to access Craigslist on Android phones. The number of downloads is 107, 298 at the time of publication of this report and came first on the market before cPro Craigslist Client[46, 47, 48] The pros and cons of Craigslist Mobile Pro are shown in Table 2.2

- **Craigslist minimalist browser**

Craigslist minimalist browser, as the name suggests, is an Android application

that provides access to Craigslist website on Android phone with minimum and basic feature set.

Pros: Reflects search agent similar to Craigslist website.

Cons: Lacks several major features that AnveShA offers like automatic search agent, email client, notification results and offer price prediction, Google shopping results.

Craigslist minimalist browser is not suitable for users who want to enjoy a rich and easy to use user interface with a convenient feature set to save time and money. The reviews for this application is just about average and the number of downloads is just 41 at the time of publication of this report.[68, 69, 70]

- **Craigslist for Android(Clapp)**

Craigslist for Android(Clapp) has a visually appealing user interface and provides a variety of feature set. The pros and cons of Craigslist For Android(Clapp) are shown in Table 2.3 Craigslist for Android(Clapp) has a very good user rating and also good reviews in Android market with number of downloads 57, 464 at the time of publication of the report but is not a well- tested application. [75, 76]

- **Craigslist by ClasPics**

Craigslist by ClasPics is an Android application that allows access to Craigslist website on Android phone and tablets. The pros and cons of Craigslist by ClasPics are shown in Table 2.4

Pros	Cons
Search results with images displayed.	Lacks automatic location detection. The users can view results from multiple locations but have to manually enter the locations.
Bookmarking favorite posts.	Receiving notifications for updates requires installing an add on application.
Provides search results from multiple locations.	Lacks several other features that enhances user experience like the email client with template creation, reminder list, offer price prediction, Google shopping results and notifications based on matching search criteria nearby current location of the user.

Table 2.3: Pros and Cons of Craigslist for Android(Clapp)

Pros	Cons
Search results are displayed with minimum response time and image displays for Craigslist ads containing images.	No support for automatic location detection.
Notifications for updated search results.	Notifications not provided for matching search results near the current location of the user
Contacting the seller directly via email, call, text.	Lacks email template creation and other useful features present in Anve-ShA.

Table 2.4: Pros and Cons of Craigslist by ClasPics

Craigslist by ClasPics has a good user rating but has continuous bug fixes that reduce the appeal for this application. [44, 71]

- **SmartClient for Craigslist**

SmartClient for Craislist has a decent feature set that provides an easy to use user interface to access Craigslist on Android phone.

Pros:

- Search results with images.
- Craigslist ads matching search criteria near user's current location is displayed.
- Contact sellers directly via email, call and text.

Cons:

- Has several flaws in the application when the user installs a free version of the application according to user reviews.
- The search results are not accurately displayed and not a well-tested application.

SmartClient for Craigslist has an average user rating with number of downloads 152 but in addition to the flaws in the application, it lacks several useful features present in AnveShA. [42, 41, 43]

- **The Craigslist Checker**

The Craigslist Checker is an automatic search agent that provides a convenient access to Craigslist website on Android phone.

Pros:

- Automated search results when there are updates.
- Bookmarking favorite posts.
- Image display for search results.

Cons:

- Lacks several major features present in AnveShA.
- Not well-tested application for location-based search results.

The Craigslist Checker has an average user rating with number of downloads 198. [33]

• **Craigster**

Craigster is an Android application allowing access of Craigslist website on Android phone similar to search on Craigslist website.

Pros: Search results from Craigslist website.

Cons: Lacks several major features and as per user reviews, the application has failed to successfully provide access.

Craigster has negative reviews in the Android market and major reviews mention that it cannot be downloaded and fails to provide search results. [61]

Although, the number of downloads is 203 at the time of publication of this report, the user rating indicates that the application is not worth using.[62]

• **Classic Auto Finder Craigslist**

Classic Auto Finder Craigslist is an Android application that is tailored to

searching cars on Craigslist.

Pros: Has a good user interface with images displayed for the search results.

Cons: It is not a free android application, has a limited capability of search based on locations and also limited to only one search item.

Classic Auto FinderCraigslist has mostly negative reviews because of it's limited capability and functionality.[39] The number of downloads at the time of publication of this report is 3 and this indicates that the application lacks feature set and usefulness. [38]

- **Craigslist for particular locations**

Craigslist for particular locations emulates Craigslist website on android phone with manual entry for current location of the user.

Pros: Provides search results as displayed on Craigslist website.

Cons: Lacks several useful features and user obtains only current location results. Craigslist for particular locations has about 1000-5000 downloads at the time of publication of this report but has a poor user interface based on the screenshots and lacks user reviews.[34]

2.1 Summary of Comparison with existing systems

No	Feature list	AnveShA	cPro Craigslist Client	Craigslist Mobile Pro (City Shop- App for Craigslist)	Craigslist mini- malist browser	Craigslist for An- droid(Clapp)	Craigslist by ClasPics	SmartClient for Craigslist	The Craigslist Checker	Craigster	Classic Auto Finder Craigslist	Craigslist for par- par- ticular locations
1	Automatic Search Agent	Yes	Yes	No	No	No	Yes	No	Yes	No	No	No
2	Automatic location detection	Yes	No	No	No	No	No	No	No	No	No	No
3	Nearby city search results	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No
4	Email templates	Yes	No	No	No	No	No	No	No	No	No	No
5	Auto-Response	Yes	No	No	No	No	No	No	No	No	No	No
6	Reminder List	Yes	No	No	No	No	No	No	No	No	No	No
7	Email client	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No
8	Search other shopping websites	Yes	No	No	No	No	No	No	No	No	No	No
9	Offer Price Prediction	Yes	No	No	No	No	No	No	No	No	No	No

Table 2.5: Summary of Comparison of AnveShA with existing applications in Android Market [49, 46, 68, 75, 71, 43, 33, 61, 39, 34, 35]

Chapter 3

AnveShA Architecture and Design

3.1 AnveShA Architecture Overview

AnveShA application is built based on the 3-tier architecture model shown in Figure 3.1. The purpose of using 3-tier architecture is to isolate the presentation, business and data logic to make the application modular. The presentation tier provides the user interaction that involves collection of data from the user and display of results in a user-friendly manner. The logic tier encapsulates the business and data access logic for processing the user information. The logic tier can be further broken to several layers containing business logic. This division is based on various sets of business rules. The data access logic controls the access to data by performing user and data validation.[80] The data tier stores and retrieves the data to/from the database and acts as a persistent storage for data. [80, 63, 73, 81]

The major benefit of using this architecture model in the application is modularity. This in turn makes the application modules reusable, maintainable, extensible. It also ensures quick development of the overall application and aids in easy testing and bug fixing.[63, 72, 80, 73]

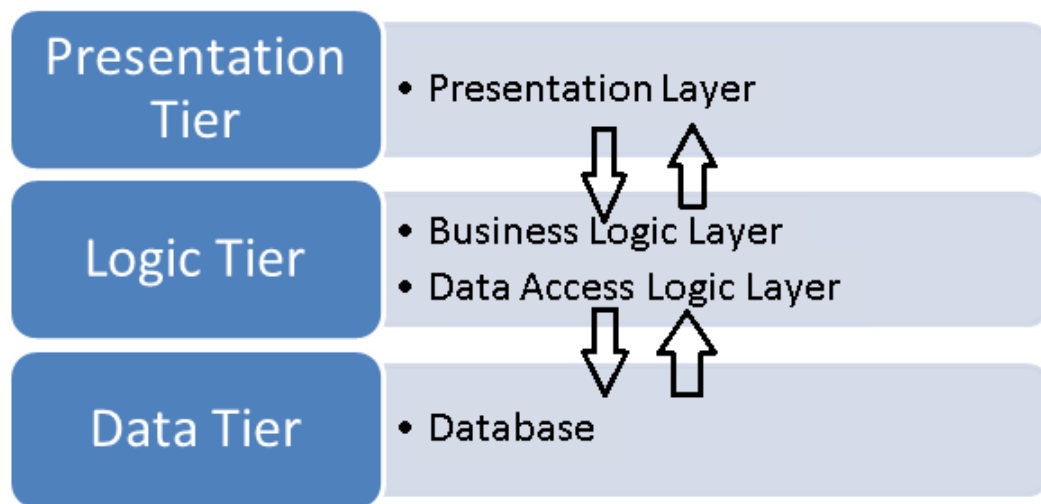


Figure 3.1: Three tier architecture model [63, 73]

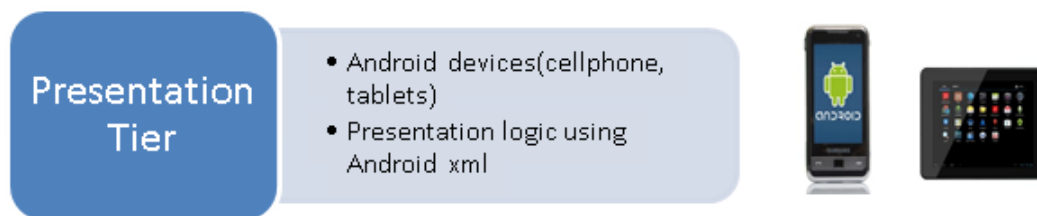


Figure 3.2: Presentation Tier in AnveShA

3.2 Presentation Tier

The presentation tier allows the user to interact with the application by entering the required fields and viewing the results. The presentation layer is separated from rest of the layers in order to allow the user to access information with little or no delay. Figure 3.2 illustrates the components of presentation tier.

The Android platform is chosen for AnveShA because of the immense

popularity that it holds in the world market.[60, 40]. The other popular alternative in mobile application development is iOS(iPhone Apple’s mobile operating system) platform but choosing Android over iOS has several advantages like the open development platform, accommodation of diversity of devices like touch screen, device keypad, ease of development in creating applications that alerts the user of any data via notification service, and GPS access to detect current location. [51, 65]

Android XML is used for developing the Graphical User Interface. It offers different layouts and several useful widgets that make the development of user interface easy and rich. The use of android XML offers adaptation to different screen sizes, language and density by allowing instantiation of layouts at and thus increases flexibility. [15]

3.3 Logic Tier

The logic tier is considered to be the core of AnveShA that implements the major functionality of the application. It is subdivided into two logical layers viz, Business Logic Layer and the Data Access Logic Layer. Figure 3.3 depicts the components of the logic tier.

The summary of description of various components in the Logic Tier is depicted in Table 3.1.

Component	Description
Location Service	Location Service component determines the current city of the user or a nearby city within a radius of 30 km of the user's current location by obtaining the exact address from GPS and the network provider. This aids in providing the results from the corresponding Craigslist website relevant to the current or nearby location. This component also uses the exact address obtained from GPS and the network to provide matching posts in the current location or within a radius of 5km to the current location.
Notification Service	Notification Service component runs in the background based on the time interval set by the user repeatedly and alerts the user to view updated results for matching search criteria. It also runs another thread in the background to alert the user about post matching the search criteria and the current location.
Web Scraper	Web Scraper component is used to fetch the posts and the relevant details matching the search criteria from the Craigslist website.
Email, Call and Text client Service	Email, Call and Text Client Service Component is used to contact the seller of the Craigslist ad directly from AnveShA by integrating the email, call and text client into the application. Email Service Component is used to email multiple sellers who are selling similar product at once.
Offer Price Prediction Service	Offer Price Prediction Service Component is used to calculate a good asking price for the sellers product based on several parameters in order for the user to obtain good deals. The flowchart for the offer Price Prediction Service is depicted in the section 3.5.2.5.
Data Service	Data Service component is used to handle the calls to the database in order to store and retrieve the data.

Table 3.1: Components of Logic Tier in AnveShA



Figure 3.3: Logic Tier in AnveShA



Figure 3.4: Data Tier in AnveShA

3.4 Data Tier

SQLite is the most widely used and a default database engine for Android mobile application development.[15, 67] AnveShA requires a local data-store that stores the data pertaining to the user preferences. SQLite database is already embedded in every Android device that makes it the most suitable database for AnveShA.[79] Besides, SQLite database is light-weight and reduces disk space and memory consumption that makes it suitable for Android mobile operating system.[67] Figure 3.4 depicts the data tier.

3.4.1 Discussion on alternatives to SQLite Database

Android offers other alternative data storage options. SharedPreferences is one of the alternatives but has the disadvantage of storing only primitive data whereas AnveShA requires storing data other than primitive types like 'Date'. The other alternatives are to use internal and external memory storage that saves files but AnveShA requires storing structured data. The use of Network Server to store data is unnecessary and involves usage of battery and the network provider.[16] Android also has a remote "cloud" storage backup service but again not relevant to the requirements of AnveShA that requires a datastore local to the application. So the use of "cloud" service becomes futile as interfacing with the remote backup agent is needed.[6]

3.5 AnveShA Design Specifications

The design specifications serve as guideline and assist in the implementation of AnveShA. The design details specify how each requirement of AnveShA is achieved. This section is broadly classified into User Interface Design that describes the details of user interactions with the application and System Design that describes the work flow of the application.

3.5.1 User Interface Design

This section presents the high level use case that acts as a prototype for developing the application and a set of mock ups that act as blueprint for depicting the user interface and overall flow of the application.

The mock ups are designed using Wireframe Sketcher.[64] It is the most popular tool for designing mock ups and can be tailored to use gallery and frameworks for android mobile application. The mock ups helped to visualize the application look and feel during the design stage.

3.5.1.1 "User Settings" Screen Mock up

The users are presented with the "User Settings" screen on launch of the application. The mock up of the "User Settings" screen is shown in Figure 3.5. The users select the time interval from a set of options between 1 hour to 24 hours. This provides user control over the time interval after which the notifications are to be received on updated results for the search criteria set up. The other options in the settings screen is that the user can create custom email templates and store for sending emails to the seller of a product. The user is prompted to enter the suitable title and body for email template. Also, the user can view the contacts of the sellers that were added to the reminder list. When the users views the remainder list, the following is displayed title of the classified, contact information of the seller and the HTML link to the classified on the craigslist website.

3.5.1.2 "Create and Manage Search Criteria" screen Mock up

The users can create search criteria by entering the relevant details on the "Create Search Criteria" screen. They can opt to view the search results immediately or view them later. The users can view the results for search

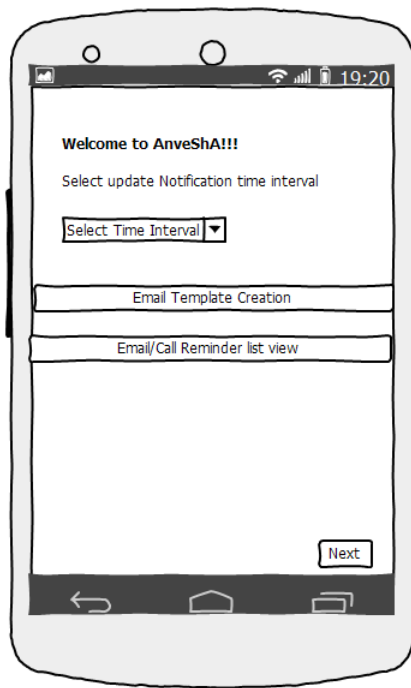


Figure 3.5: "User Settings" Screen Mock up

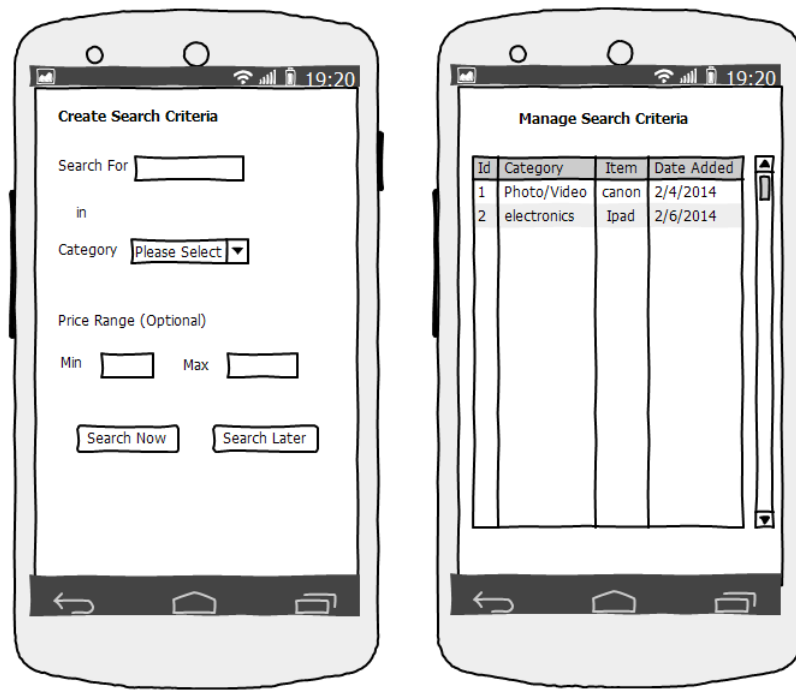


Figure 3.6: "Create Search Criteria" and "Manage Search Criteria" Screen Mock up

criteria or delete search criteria at any time in the "Manage Search Criteria" screen. The mock up screens for creating and managing search criteria are shown in Figure 3.6

3.5.1.3 "View search results" screen Mock up

The user is displayed with the search results that match the search criteria. The results are displayed as a scroll able list view containing the title and the price of each post. The users can sort the posts based on price. Additionally, they can view bookmarked posts, most recent posts and send a

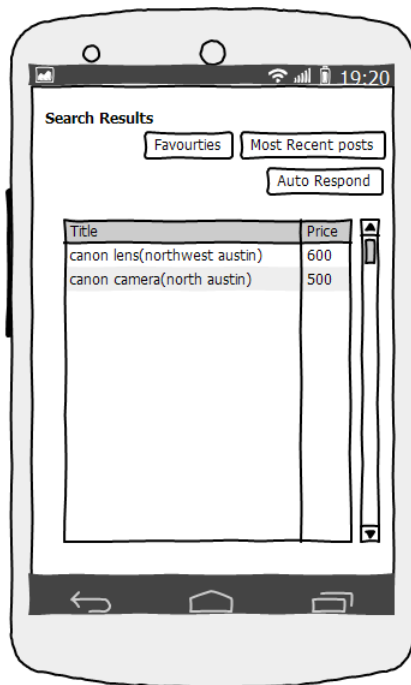


Figure 3.7: "View Search Results" Screen Mock up

bulk email response to the sellers of all the posts in the list. The mock up screen for viewing the search results is shown in Figure 3.7

3.5.1.4 "View Description of Craigslist classifieds" screen Mock up

The "View Description" screen shows the title, link to original craigslist post, description and a list of images posted by the seller. The user can bookmark the post as favorite. The user can enlarge each of the images for a zoomed in view. The user can add the seller contact to a reminder list. The user can contact the seller directly if the seller has provided a phone number. These features are highlighted in the mock up screen shown in Figure 3.8

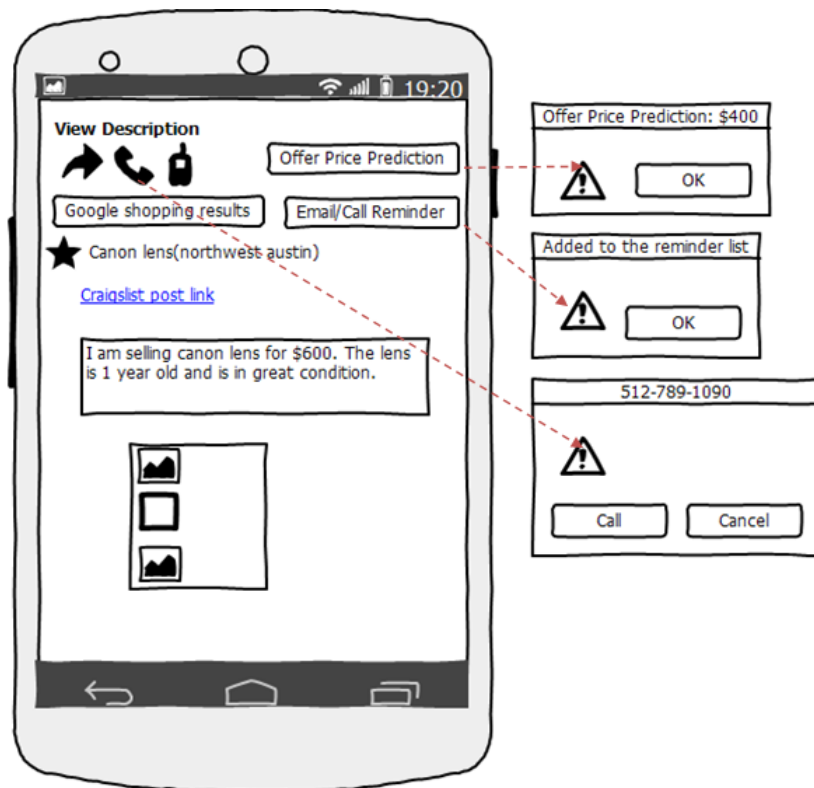


Figure 3.8: "View Description details of Craigslist classifieds" Screen Mock up

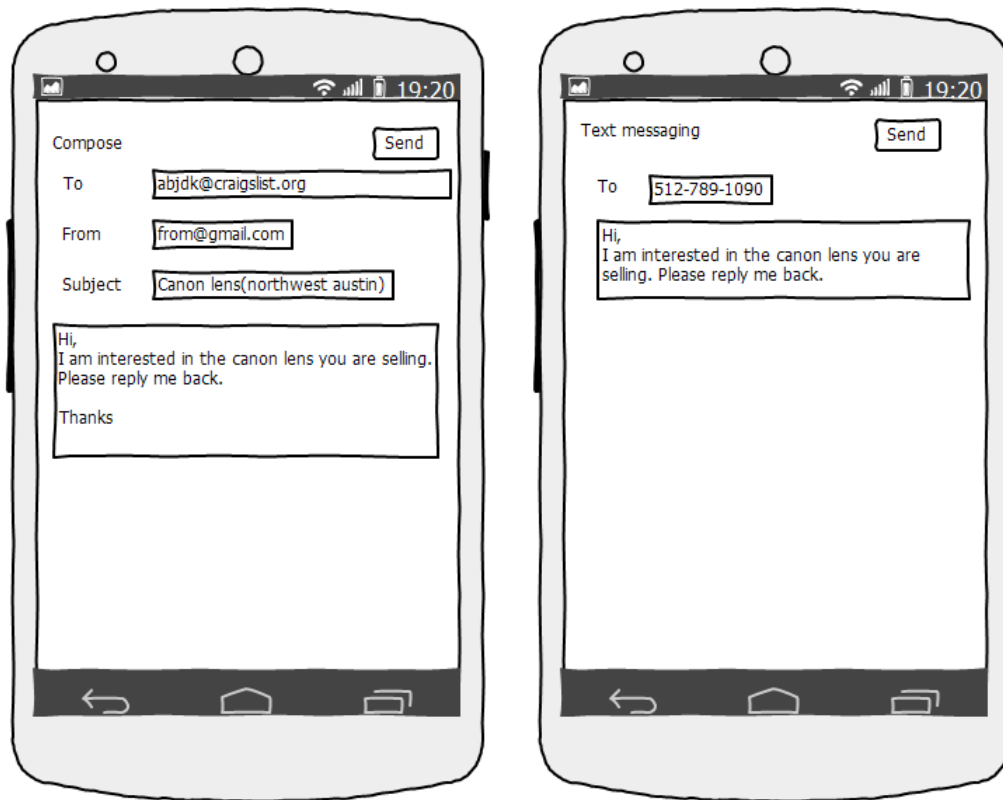


Figure 3.9: "Email and Text Messaging" screen Mock up

The user can contact the seller via email and text messaging. Figure 3.9 shows the mock up screen of display of email and text messaging client with seller contact details being auto-populated. The email client further reduces the user's job of composing the email by populating from email templates created in the user setting screen in Figure 3.5.

The user can highlight part or whole title and view the Google shopping results for a particular product. The results are loaded from Google shopping website and displayed to the user in the browser within the application. Figure

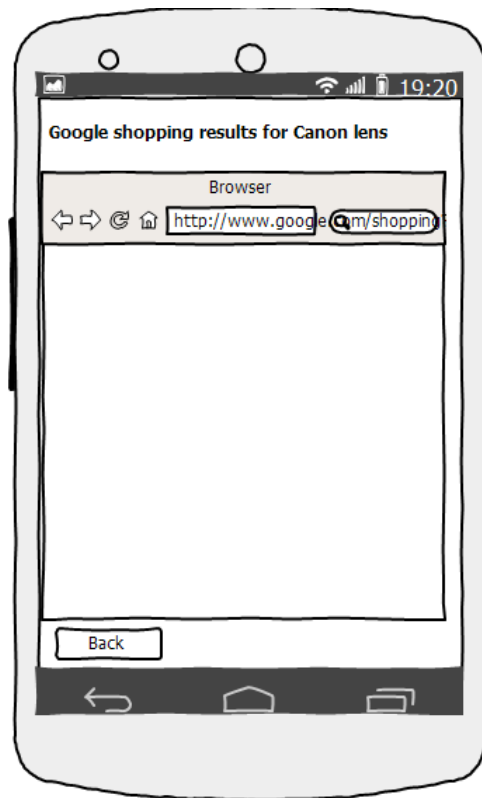


Figure 3.10: "View Google Shopping Results" Screen Mock up

3.10 shows the mock up screen of displaying Google shopping results in a browser.

3.5.1.5 "View Notifications" Screen Mock up

The notifications for updated results based on user-defined time interval are shown to the user. The user can view the updated results for any search criteria set up. The notification is also thrown to the user whenever there is a post matching the search criteria near the current location of the user. The

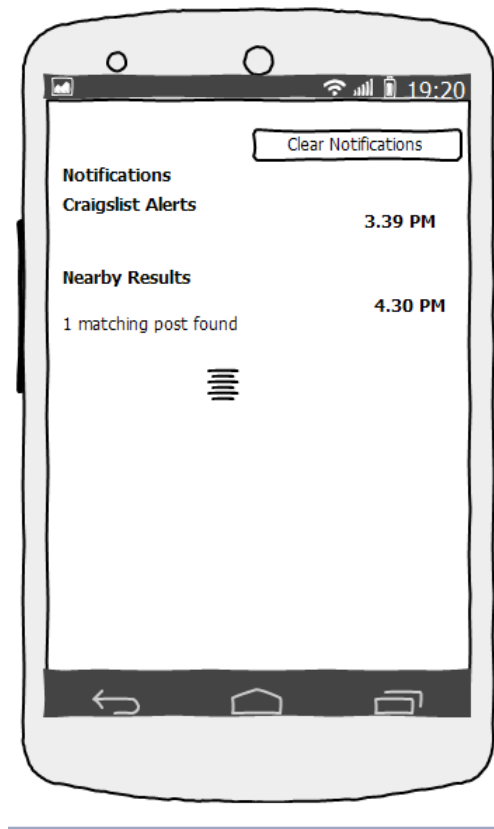


Figure 3.11: "View Notifications" Screen Mock up

number of matching posts is displayed at the time of displaying the notification. The user can view the results by clicking on the notification. The mock up screen for viewing Notifications is shown in Figure 3.11

3.5.2 Application Design

This section describes the design details of major components of AnveShA. It presents the algorithm designed for all the components identified in the section 3.3

3.5.2.1 GPS Data Collection algorithm

GPS data is required to determine the current or nearby city for fetching the search results from the corresponding Craigslist website matching search criteria. The algorithm determines current or nearby city by checking the GPS and network service provider and obtains the current location results. If the current city has a corresponding Craigslist website, the application uses the location to obtain the search results matching the user input criteria. If the current city doesn't have a corresponding Craigslist website, then the algorithm searches the nearby city that has a corresponding Craigslist website within a radius of 30km and uses the location to obtain search results. If neither search determines a suitable location, the algorithm throws an error message "Location not found".

GPS data is also required to obtain any posts matching the search criteria near the user's current location. The algorithm determines the minimum and maximum latitude and longitude of the current location and compares the calculated latitude and longitude with the Craigslist ads latitude and longitude (if posted by the seller). If there are any posts matching the search criteria within the radius of 5 km, then the algorithm collects all such Craigslist ads to display to the user. The flowchart for the GPS data collection is shown in Figure 3.12.

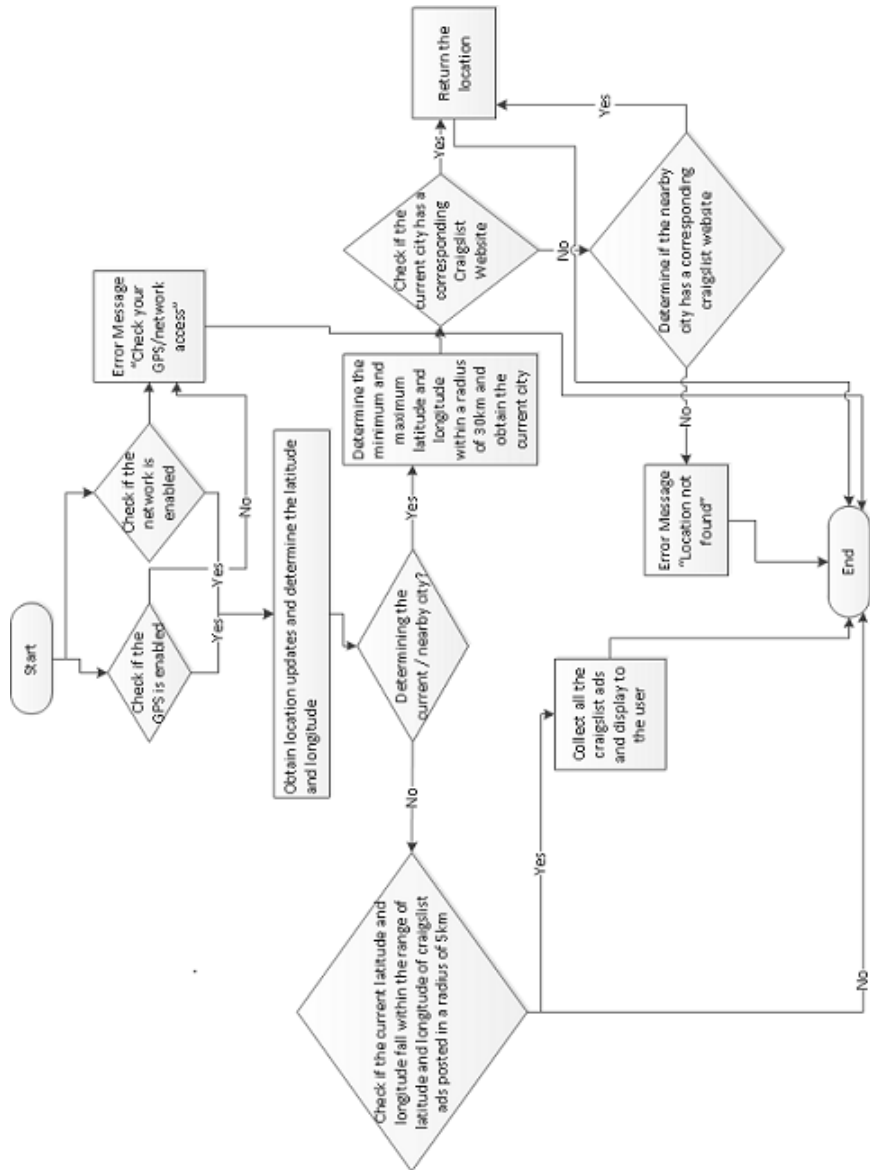


Figure 3.12: GPS Data Collection Algorithm

3.5.2.2 Notification Service Algorithm

The notification service is required for user to receive alerts for viewing updated results and results matching the search criteria set up by the user. The Notification Service Algorithm schedules a timer that is run repeatedly based on user defined time interval in background after which it performs the operations and alerts the user with results. It also schedules another timer that runs in the background for every 15 minutes and compares the current location with the locations of all the Craigslist classifieds matching the search criteria and alerts the user with those posts whose locations match within the radius of 5 km using GPS data collection algorithm in Figure 3.12. The flowchart of Notification Service Algorithm is shown in Figure 3.13

3.5.2.3 Web Scraping Algorithm

The Web Scraping Algorithm is used to obtain the search results from the Craigslist website for the search query input by the user. It processes the Craigslist feed URL based on the search query and parses it. Then the algorithm runs recursively to process each node of the Craigslist feed website and obtain the required elements. It collects all the relevant search results in order to display to the user. The flowchart of Web Scraping Algorithm is shown in Figure 3.14

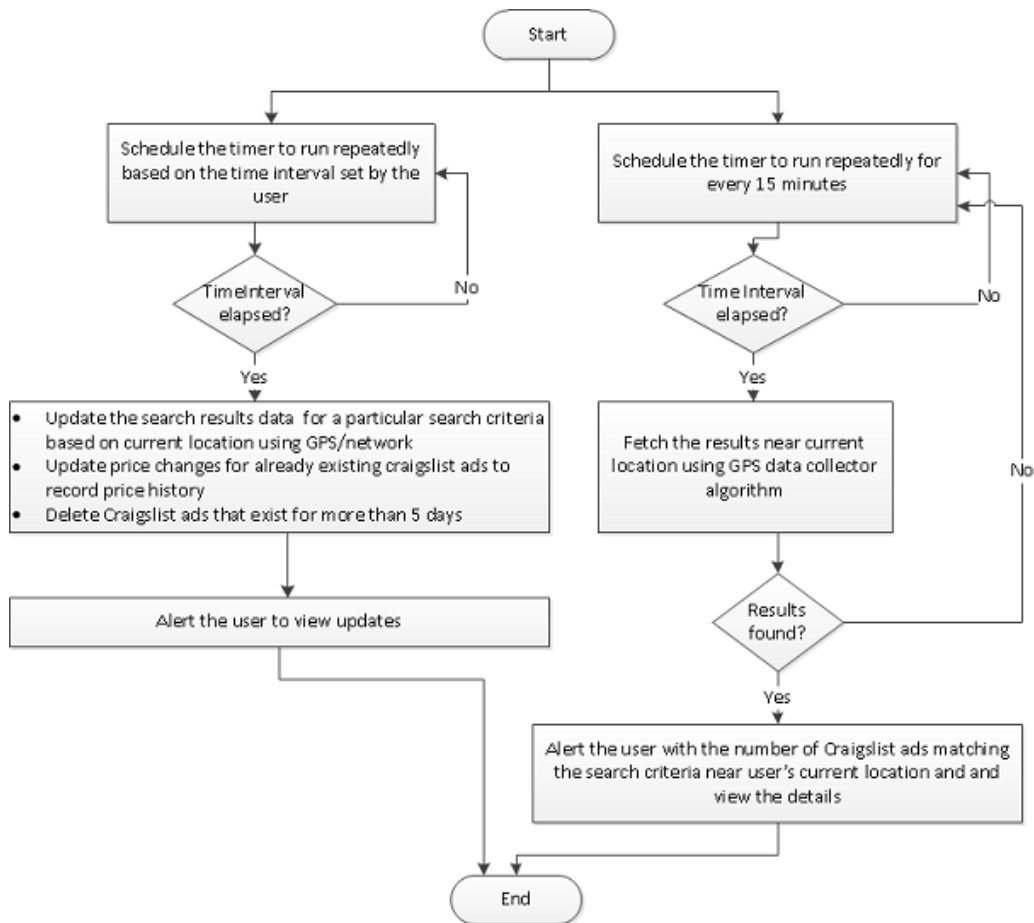


Figure 3.13: Notification Service Algorithm

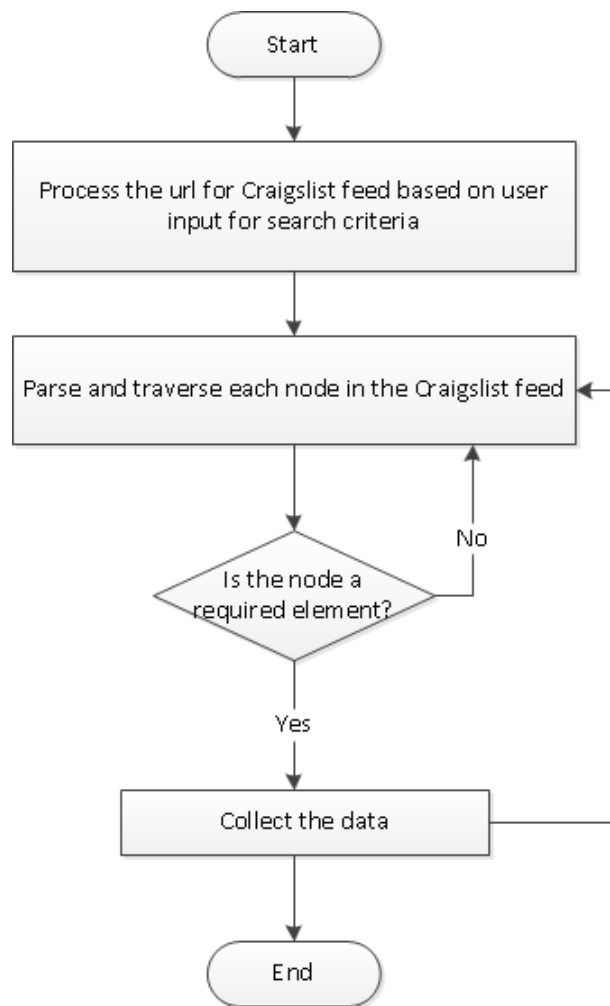


Figure 3.14: Web Scraping Algorithm

3.5.2.4 Seller Contact Algorithm

Seller Contact Algorithm is an algorithm developed for the users of the application to contact the sellers easily and conveniently. The algorithm contacts the seller based on the various options that the user selects.

- **Selection of Bulk Email Response by the user**

The algorithm performs a bulk email response in case the user wishes to send emails to all the sellers who have posted Craigslist classifieds matching the user's search criteria. In order to perform this operation, the algorithm obtains the email addresses of the sellers. As a prerequisite, the user is asked to provide the login credentials in order to determine the email address through which the email has to be sent. The algorithm then checks for authentication of email address and password entered by the user. Upon successful authentication, it sends an email to all the sellers with pre-populated subject and body. The application alerts the user after the emails have been successfully sent.

- **Selection of email response to a particular seller using email client by the user**

In case the user wished to contact a particular seller via email, the algorithm obtains the seller's email Id and the various templates created and stored by the user. The user will choose the template and email client. After receiving the user choice of template and email client, the algorithm displays the email client with auto-populated subject, body, to and from address for the email to be sent.

- **Selection of call option by the user to contact the seller**

If the user selected the option of calling the seller on his phone number, the algorithm checks to see if the seller has provided a phone number to contact. If it is present, then the algorithm starts the calling service by auto-dialing the provided phone number.

- **Selection of text messaging by the user to contact the seller**

If the user selected the option of sending a text message to the seller on his phone number, the algorithm checks to see if the seller provided a phone number and, if present, it displays the text messaging client with auto-populated phone number in the to field. The flowchart for the Seller Contact Algorithm is shown in Figure 3.15

3.5.2.5 Offer price prediction algorithm

The offer price prediction algorithm is a unique algorithm developed to recommend the best offer price that a user can provide to the seller for the product sold on Craigslist. The algorithm takes into account multiple parameters when calculating the offer price.

- One of the parameters is a user can discount an asking price by some percentage because most of the sellers will be willing to give a discount. So, the user can input a certain percentage off of the asking price for the product.
- The second parameter that the algorithm considers is the number of classifieds posted in the Craigslist for a particular product. If the number of classifieds is more, then the prediction is that the demand for that product

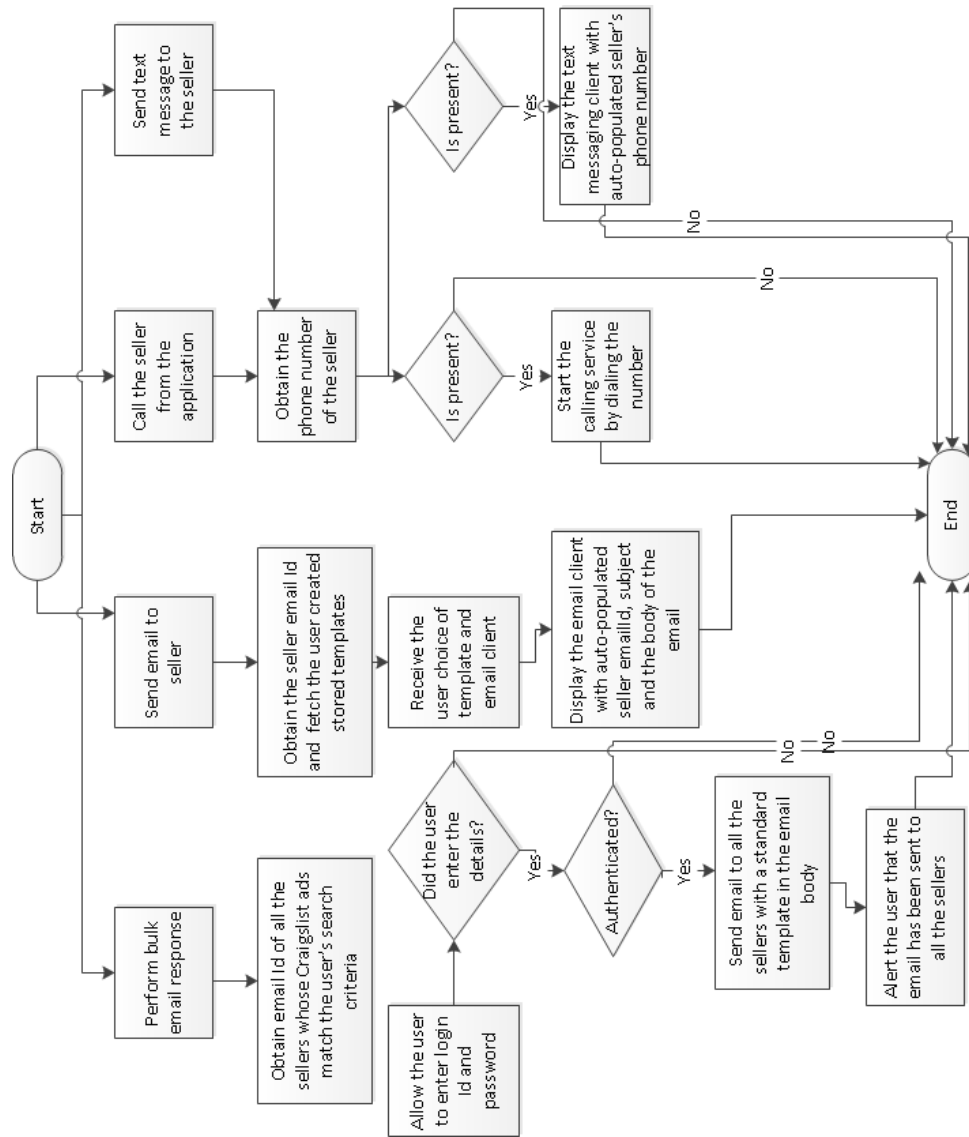


Figure 3.15: Seller Contact Algorithm

is less and the supply is more. Thus, the algorithm calculates an offer price by determining the price by which the asking price has to be reduced. It will calculate a higher discount if the number of classifieds are more and calculate a lesser discount if the number of classifieds is less.

- The third parameter that the algorithm considers is the market price of the product. The algorithm checks the 'Amazon' website result in order to determine the market price for the product. This provides a comparison between the asking price of the seller and the market price and ensures that the user is going to pay less than the market price.

- The final parameter that the algorithm considers is based on how old the Craigslist classified is. If the seller is trying to sell the product since a long time, then the algorithm predicts that the seller will be open to selling the product for lesser price. So, a higher discount is determined if the Craigslist classified is old and a lesser discount if the Craigslist classified is recently posted.

The exact percentage off calculations and determination of offer prices based on various parameters is shown in Figure 3.16. After the algorithm has determined several offer prices, it takes the minimum of the offer price calculated and suggests the best offer price to the user. The flowchart of this algorithm is shown in Figure 3.16.

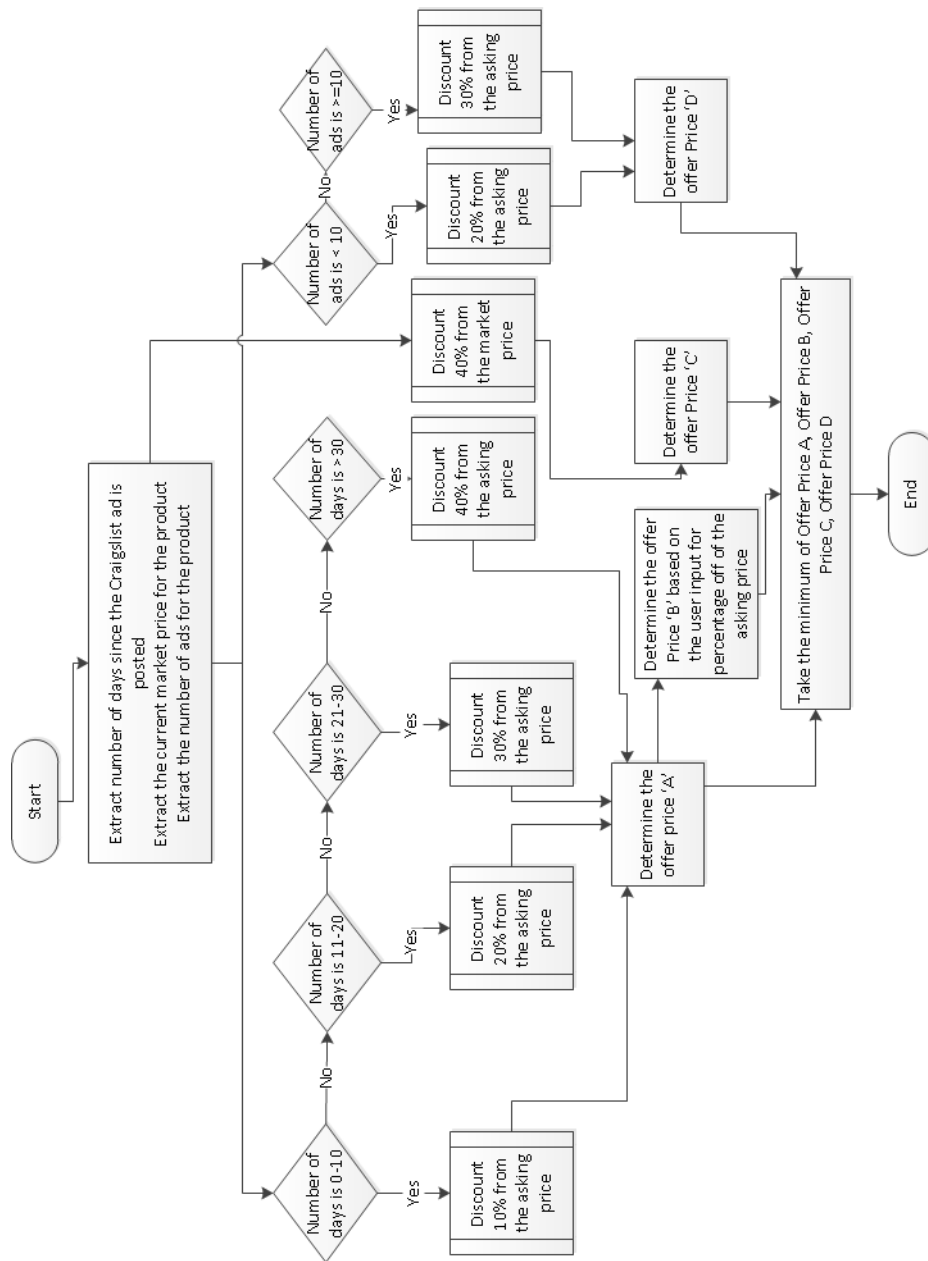


Figure 3.16: Offer Price Prediction Algorithm

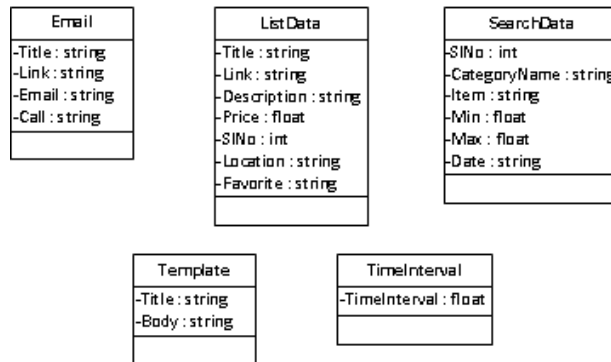


Figure 3.17: Database Schema

3.5.2.6 Database Schema

The database schema contains several tables to store and retrieve the data and perform create, read, update and delete (CRUD) operations. The database design developed for this application is shown in Figure 3.17

◇ Description of database tables

- **Email Table:** This is used to store the reminder list with the contact details of the seller for a particular Craigslist ad that the user is interested in.
- **ListData Table:** This is used to store the Craigslist posts when the search results are updated along with the user bookmarked posts.
- **SearchData Table:** This is used to manage the search criteria set by the user.
- **Template Table:** This is used to store and retrieve the templates created by the user for sending an email to the seller.

- **TimeInterval Table:** This is used to store the time interval selected by the user in the user settings for which the notification about the updated results are shown to the user.

Chapter 4

Implementation

4.1 Development Environment

The following hardware and software configuration was used for the development of AnveShA.

- **Android SDK:** Android SDK provides developer tools that aids in development, debug and test android applications. It provides the API libraries that AnveShA leverages for the implementation.[8] AnveShA is built on Android platform 3.0 and API level 11 because this versions supports display of web pages within the application and is one of the features implemented in AnveShA.[4]

- **Eclipse Integrated Development Environment(IDE) and plugins:** Eclipse IDE is an open-source tool set for the development of Java-based applications and comes with several plugins that are easily installable to start the development. The version used is the Indigo release. Eclipse is chosen because it has Android Development tool (ADT) plugin that makes the development of Android application easy. ADT has several capabilities that let the developer set up Android projects quickly and also other tools to design and build the user interface and debug the application. [21, 1]

- **Java Programming Language:** The programming language used is Java

as building Android application using Java is quicker and easy as several tools and tutorials are available instantly. The other programming language that can be used for building Android applications is Python but development in Python for Android application is difficult as it doesn't include native User Interface elements like list view. The users who download the application must also get the Python interpreter and thus packaging the application is not user-friendly.[20]

- **Desktop:** Windows 7 Professional, Intel Core i5-2520M CPU @2.5GHz , 64-bit Operating System, 6GB RAM

4.2 Technology Stack

4.2.1 JSoup

Jsoup is an open-source Java library that facilitates parsing the HTML content from URL and extracting the relevant data.[52] The jar file used is jsoup-1.7.3.jar. Jsoup is used in AnveShA because it requires a lot of HTML data to be scraped and extracted in order to display the entire data set for each Craigslist ad to the user. Jsoup is well-suited for the purposes of AnveShA's development and has several advantages. It is open-source with libraries that makes the developers job easy. It also works with HTML that are not well-formed and no dependencies on external libraries.[36] Jsoup has support for identifying various parts of web page and obtains required elements. [37]

There are other libraries for performing web scraping like Groovy, XPath, WebHarvest, Jaunt API. Table 4.1 discusses the pros and cons of each library

and lack of suitability to AnveShA.

4.2.2 Google Gson

The offer price prediction requires searching a particular product and obtaining the market price of it. In order to obtain the best available market price, it requires fetching all the website URLs that sell the product and obtain the market price. For convenience and simplicity, AnveShA extracts "Amazon" website URL and determines the market price by scraping the website data. In order to do this, AnveShA reads JSON objects. JSON presents an ordered list of values with name/value pairs and gives a structured list of URLs.[10] Google-Gson is then used to deserialize the JSON object and presents the data in a readable format. Google-Gson is a java library that provides an easy way to deserialize JSON objects.[50] The jar file used is gson-2.2.4.jar.

4.2.3 Java Mail API

Java Mail API is a standard used for sending email from Java application. [58, 57, 30]

AnveShA requires sending email programmatically in order for the user to be able to respond to multiple sellers automatically via email. Java Mail API is used to send email via Simple Mail Transfer Protocol(SMTP).[27] It uses JavaBeans Activation Framework (JAF)[59] to support abstraction of different file types like Multipurpose Internet Mail Extensions(MIME) types. [31] Java Mail API is used in AnveShA because of its flexibility to add the email

WebScraping Libraries	Pros	Cons	Lack of Suitability to AnveShA
Groovy	Provides an easy way of fetching URL and has a simplified parsing tool	Not suitable for filtering elements based on id, class and other attributes	AnveShA requires element filtering based on various parameters and thus Groovy is not suitable
XPath	Powerful tool to perform element filtering	Not suitable for HTML parsing	AnveShA requires a webscraping tool that supports extracting HTML content and hence XPath is not suitable
WebHarvest	Open source and supports HTML content extraction	Every data extraction requires a separate user-defined configuration file	AnveShA extracts several elements in a webpage and writing a separate configuration file for every extraction is burdensome
Jaunt API	Open source and parses and extracts HTML data	Jaunt has focused on automating the scraping and provides higher level of abstraction than just focusing on parsing and extracting the data.	AnveShA requires a simple tool for parsing HTML data and extracting the contents

Table 4.1: Summary of WebScraping Libraries in Java [37, 77, 78, 26]

service to any application. It is platform independent and aids in creating simple mailing lists that best suits for AnveShA.[66] While Java Mail API is the standard, there are several alternatives to sending email. Spring Framework has a package that supports sending email but is not suitable for the development environment chosen for AnveShA.[23] Apache Commons is another framework that is useful to implement email applications but is built on top of Java Mail API and requires all the jar files related to Java Mail API.[45] Columba is another java-based alternative that provides a user interface but for the purposes of AnveShA, it is unnecessary. Mime4J is another alternative for building email application but requires the knowledge of XML parser.[23] Hence Java Mail API suits best with the needs of AnveShA.

4.2.4 Android Framework

AnveShA uses the Application Framework layer of Android to leverage the use of tools and API's provided by it for developing the application. The main components of the Application Framework that are used in AnveShA are discussed below.

- **Location Manager API** Location Manager provides access to system location services. Its main functionality is to determine the Android device's current location and the application uses this class to obtain the user's current geographical location and pick the city or latitude and longitude.[11, 12, 13]
- **GeoCoder API** GeoCoder API for Android is used to transform the user's current geographical location obtained using Location Manager API into a

latitude and longitude or determines the current city. [7]

- **AlarmManager API** Alarm Manager API is used to schedule an activity or a service to be completed sometime in the future. The API provides access to the Android Alarm Service. AlarmManager provides methods to set the alarms. Alarm can be one time or repeating. When the alarm goes off (alarm time occurs) a pending intent will be broadcasted that can invoke a BroadcastReceiver (intent receiver) or Service or Activity. [3, 2]

- **NotificationManager API** Notification Manager API allows adding an icon to the system's status bar and an expanded message in the "Notifications" window. When the user selects the expanded message, Android fires an Intent launching an Activity that is defined by the notification.[14]

- **Android Plot** AndroidPlot is a pure Java API for creating dynamic and static charts within an Android application. Unlike multi-platform plotting libraries that must cater to the lowest common denominator, AndroidPlot is designed from the ground up exclusively for the Android platform. If there is a price history available for a Craigslist ad, then a simple XY graph is displayed to show the change in price against date. In order to implement a graph in Android application, the Android Plot graphing package is used. The Android Plot library can be utilized using the following jar: Androidplot-core-0.4.4-release.jar The application makes use of XYPlot class available in the Android Plot library and a number of specifications are provided including the series and graph display.[32]

- **Android Intents** Android provides Intents that facilitate several operations

to be performed. It has standard Activity Actions to send email, call or text.

ACTION_SEND

Activity Action is used to send email to the seller and also provides options for the user to choose specific email client.

ACTION_SENDTO

Activity Action is used to text the seller that opens up the text messaging client.

ACTION_CALL

Activity Action is used to call the seller that dials a specific phone number.[9]

4.2.5 Bitmap

Bitmap API is used to decode the images for a particular Craigslist ad scraped from the Craigslist website and render the images to the user in a presentable format.[5]

4.2.6 WebView

WebView API is used to display web pages within the Android Activity. [19] Google Shopping results for the user created search keyword is presented to the user in a web browser within the activity. Web Settings API is used to manage the settings of the WebView.[18] AnveShA sets the WebView with a built in zoom control.

4.3 Deliverable Schedule and Code Size

Table 4.2 depicts the feature set and the actual development time taken for each features and the code size for each feature. The code size is measured using LocMetrics tool.[22] The lines of code include the Java source code development and exclude the Android XML and resource files generated. The Actual Development time indicates the time actually taken to complete each deliverable and is measured in weeks.

No	Description of Deliverable	Java Classes	Actual Development Time(in Weeks)	Code Size
1	User settings for notification, viewing reminder list and email template creation	CraigslistActivity.java, Places.java	1 week	710
2	Creating a search criteria and manage several search criteria set up by the user	CreateNotificationActivity.java, CategoryList.java, ManageNotificationActivity.java	1.5 weeks	1315
3	Search results from current or nearby locations using GPS and network Bookmarking the Craigslist ads and sorting them based on price Bulk email Response to the sellers of the Craigslist ad that matches search criteria provided by the user	Craigslist.java, DisplaySearchResultsActivity.java, MapComparator.java, GmailSender.java, JSSE-Provider.java	1.5 weeks	781
4	Description details of Craigslist ad with images, viewing google shopping results, offer Price Prediction and contacting the seller.	DisplayDescription.java, CustomListViewAdapter.java, RowItem.java, DisplayGoogleShoppingResult.java, GoogleResult.java	2.5 weeks	924
5	Notification based on matching search criteria and user's current location and notification for updated results based on user's current city or nearby city.	AlarmService.java, AlarmReceiver.java, FAQCalendar.java, ClickNotificationActivity.java, DisplayItemClickActivity.java, DisplayItemRowClickActivity.java, DisplayHistory.java, AlarmReceiverForNearbyMatch.java, ClickforNearbyResult.java	2.5 weeks	1886
6	Creation of database helper classes	TimeIntervalDbAdapter.java, EmailCallReminderDbAdapter.java, TemplateDbAdapter.java, ListDataDbAdapter.java, SearchDataDbAdapter.java	1 week	1139

Table 4.2: Deliverable Schedule and Code Size

Chapter 5

Results

5.1 Testing Environment

The configuration and the tools used while testing AnveShA is listed below:

- **Android Device:** Motorola MB865
- **Android version:** 4.0.4
- **Network Connection:** Wifi
- **GPSVisualizer tool:** Calculates the distance between two GPS coordinates. [25]
- **GMapToGPX tool:** Converts GoogleMaps Data to GPS coordinates.[28]

5.2 Application Usage with Screenshots

5.2.1 "User Settings" Screen

Figure 5.1 shows the "Welcome screen" of AnveShA. The user has to select the time interval from the dropdown that specifies the duration after which the user receive notifications with updated results. The user can create

email templates by clicking on "View/Add email templates" button. The functionality and the usage of "View Email/Call Reminder list" button present in the "User Settings" screen is detailed in section 5.2.10. Figure 5.2 shows the templates already available and an option to provide title and body as inputs to create a custom template. These templates are displayed in the "Description View" screen in Figure 5.19 for sending an email to the seller. The user can also view the body of the template by clicking on title for already created templates. Figure 5.3 shows the body of the template displayed to the user on selection of template with the title "polk".

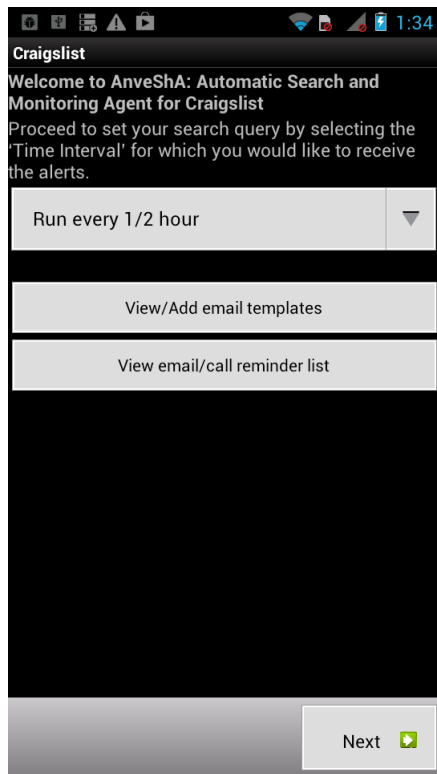


Figure 5.1: "User Settings" screen

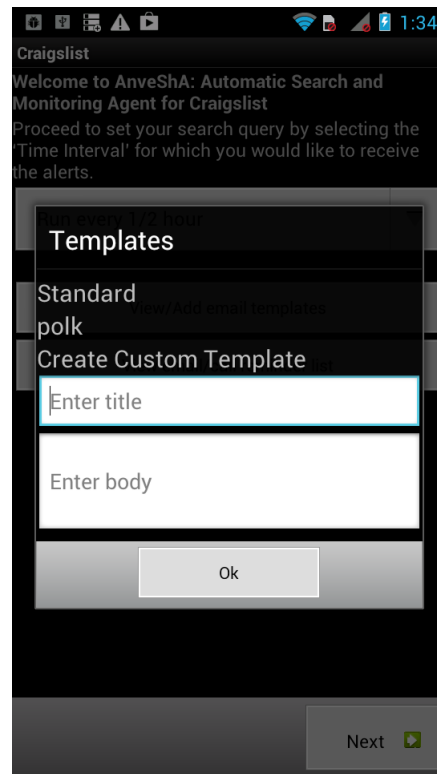


Figure 5.2: Template View

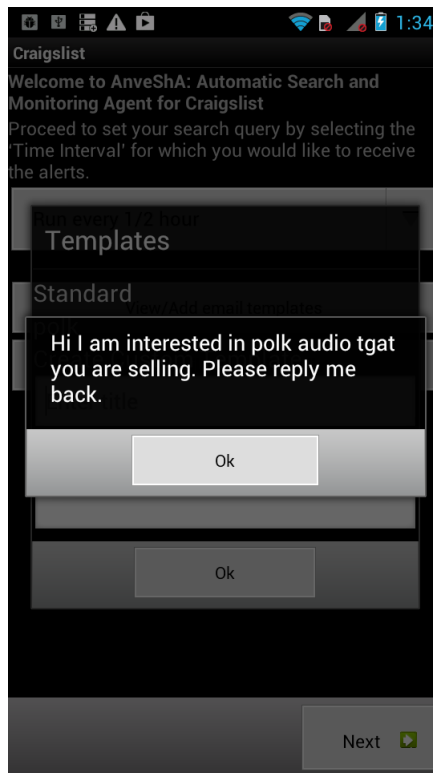


Figure 5.3: Viewing body of the template

5.2.2 "Create Search Criteria" Screen

Figure 5.4 displays the "Create Search Criteria" screen where the user can input the item to search in a particular category selected from the drop-down. Optionally, the user can provide a minimum and maximum price range to narrow down the search results. Figure 5.5 displays a search criteria entered by the user without providing optional input parameters and Figure 5.6 with optional parameters. The user have an option to view the search results immediately by clicking on "Search Now" button. The user can simply create

search criteria for later viewing or receiving notifications by click on "Search Later" button.

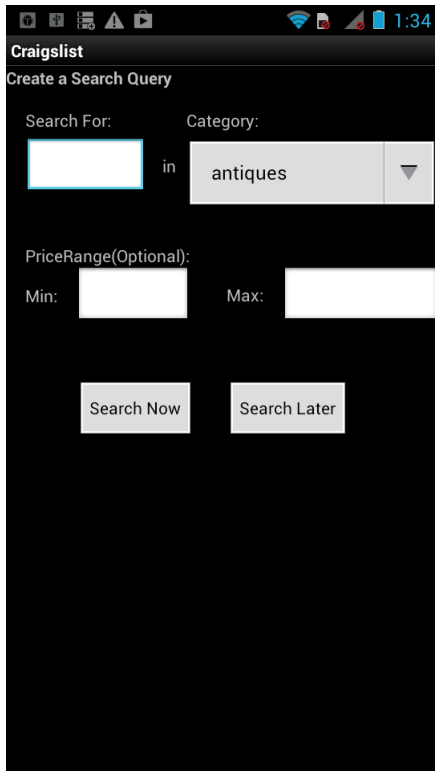


Figure 5.4: "Create Search Criteria" screen

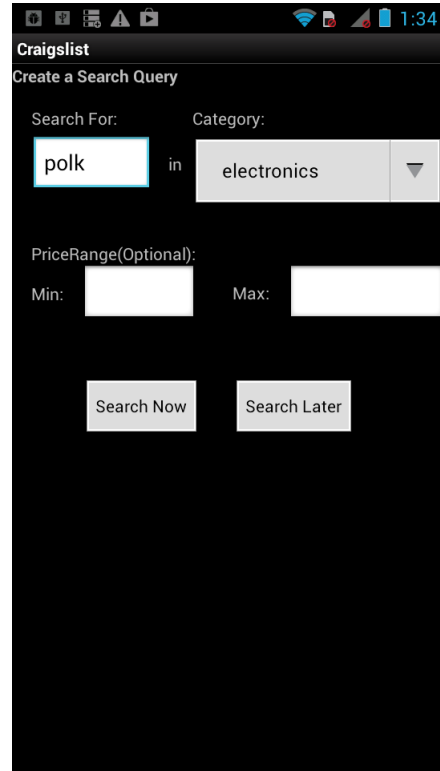


Figure 5.5: Creating Search Criteria without optional parameters

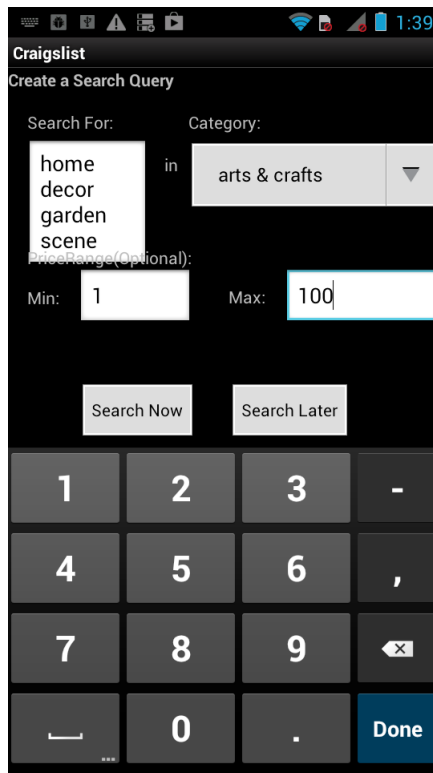


Figure 5.6: Creating Search Criteria with optional parameters

5.2.3 "Manage Search Criteria" Screen

Figure 5.7 displays the "Manage Search Criteria" screen where the user can view the details of the search criteria set up previously. The user can click on any of the search criteria to get the updated results. Figure 5.8 displays the search results for the user action of clicking on the search criteria for "polk" item. The user can delete any search criteria by long clicking on the search criteria. Figure 5.9 displays the user action for long clicking on "polk" item where the user can confirm delete for the search criteria.

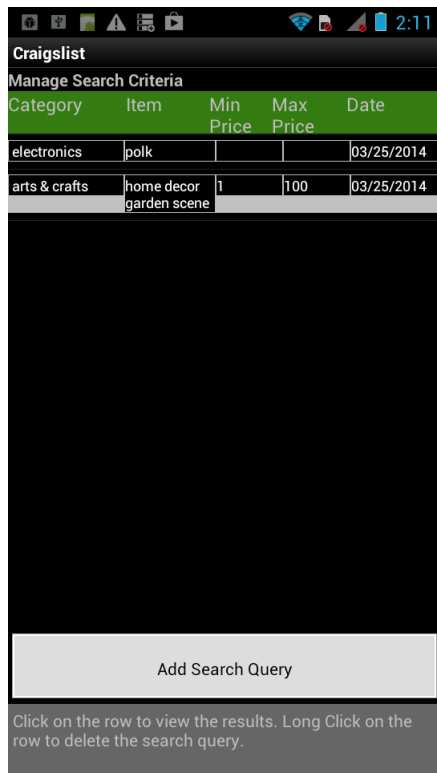


Figure 5.7: "Manage Search Criteria" screen

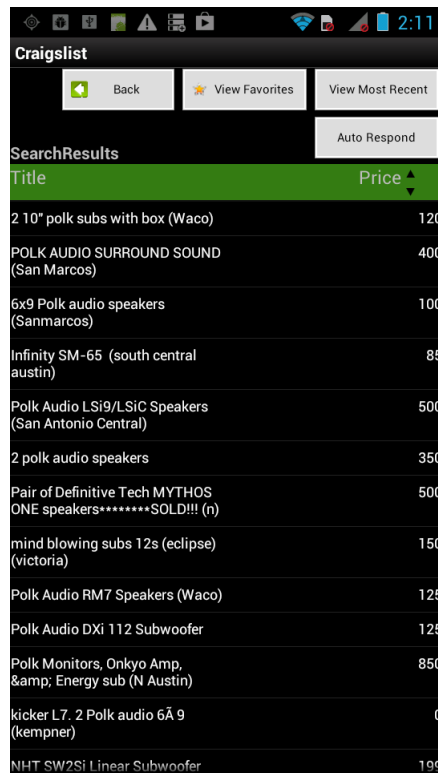


Figure 5.8: Display of Search Results

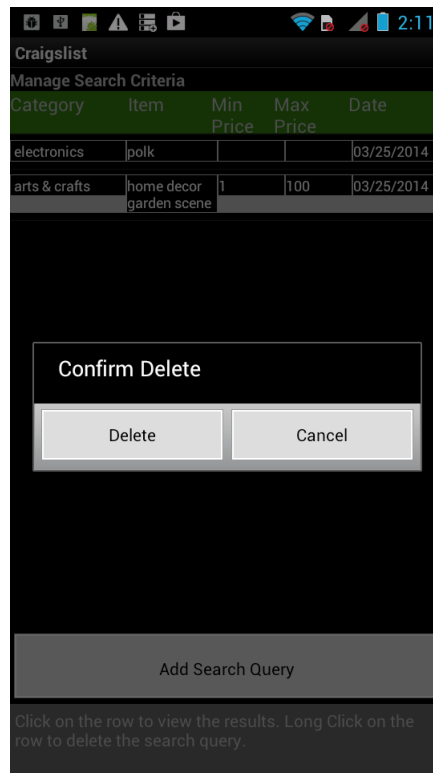


Figure 5.9: Deleting a search criteria

5.2.4 Displaying search results and viewing the description

The user can view the search results for a particular search criterion. Figure 5.10 shows the user view for search results. On clicking of any Craigslist classified, the user is taken to another screen that displays the details of a particular Craigslist ad. The user has an option to view bookmarked Craigslist classified, view Most Recent Craigslist ad or sort them based on price and send a bulk email response to all the sellers. The usage of these options can be seen in the below sections. Figure 5.11 displays the description screen. The user

is provided with a variety of features in this screen for a convenient access to Craigslist website deals. The user can contact the sellers directly from AnveShA via email, call and text buttons on the top left corner. The user can view the title, price, description and the images posted by the seller. The user can click on the link to view the Craigslist ad in the original Craigslist website. In addition, it also offers Offer Price Prediction, viewing Google shopping results and adding a Craigslist ad to the reminder list. The usage of these options can be seen in the below sections.

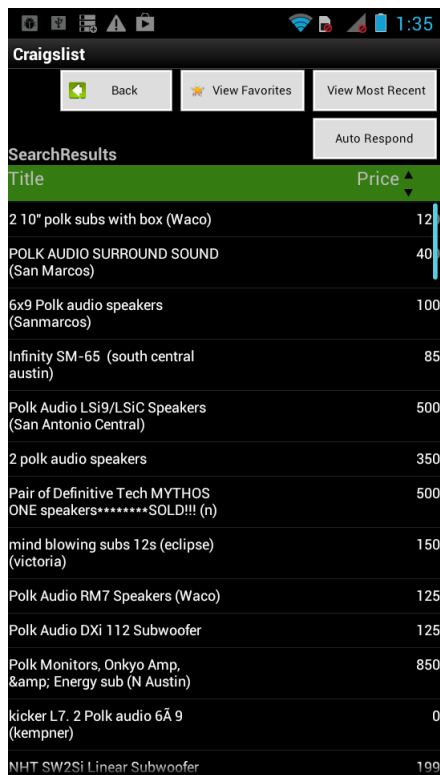


Figure 5.10: "Display Search Results" screen

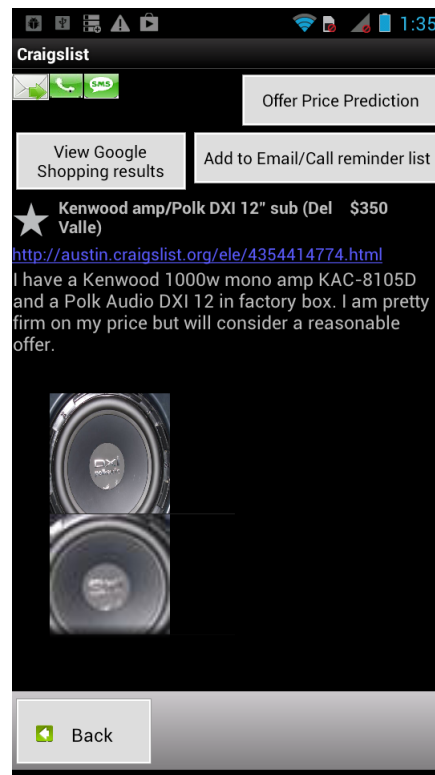


Figure 5.11: "Description View" screen

5.2.5 Bookmarking the Craigslist classifieds

The user can bookmark the Craigslist classifieds as favorites. Figure 5.12 shows the screen where the user bookmarks the Craigslist ad by clicking on "star" image to the left of the title. Figure 5.13 displays the user action of clicking on "View favorites" button that displays the bookmarked Craigslist classified.

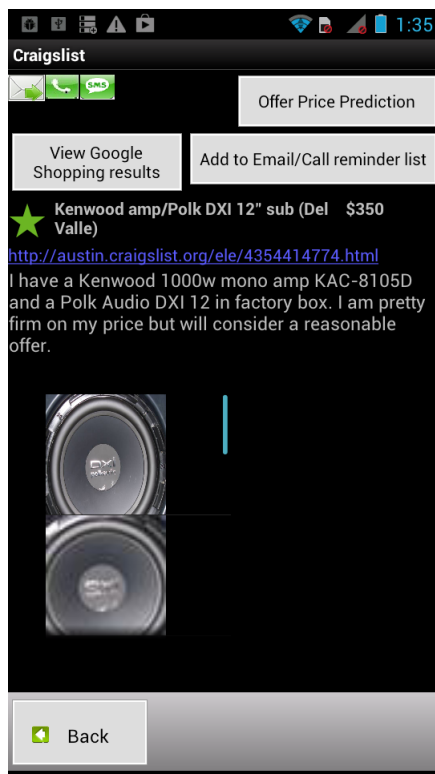


Figure 5.12: "Bookmarking Craigslist classified" screen

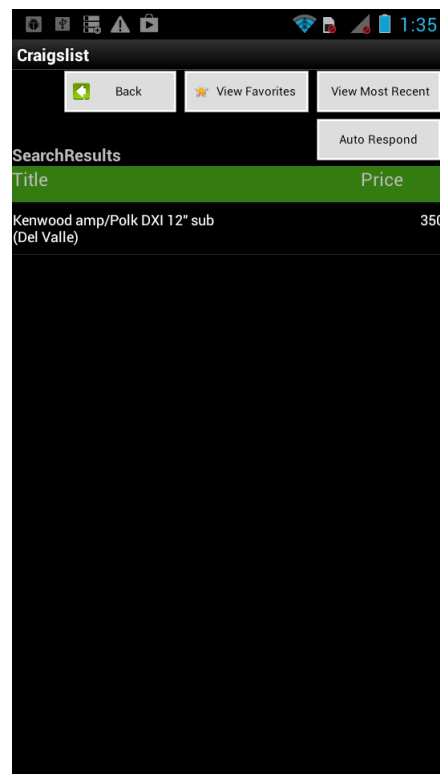


Figure 5.13: "Viewing favorites classifieds"

5.2.6 Sorting Craigslist classifieds based on price

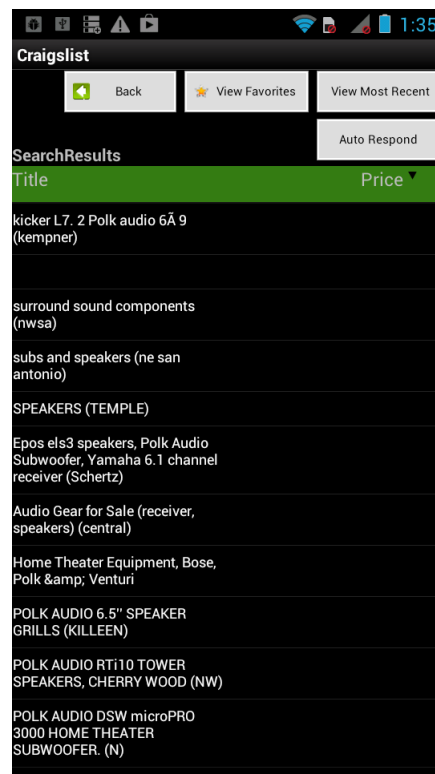
The user can sort the Craigslist ads based on ascending and descending order of the price shown in the Figure 5.14 and Figure 5.15 respectively. By click on "View Most Recent" button, the user views the list with most recently added Craigslist ads on top. Figure 5.16 displays the results of the user action of clicking on "Most Recent" button.



The screenshot shows the Craigslist mobile app interface with search results sorted by price in ascending order. The 'Price' column is sorted from lowest to highest.

Title	Price
Rare Polk Audio SRT (Signature Reference Theater) Speakers (78748)	3000
Home entertainment system (New Braunfeld)	2000
STEREO SYSTEM VINTAGE (SAN ANTONIO)	1500
Rythmik FV15HP Subwoofer (Westlake)	1100
Sony Bravia 55 inch LED 3d Smart Tv + Electronics (West Hwy 90)	1100
Polk Audio: RT110 towers, RT16 bookshelves & CSI5 center channel (central)	850
Polk Monitors, Onkyo Amp, & Energy sub (N Austin)	850
Artistic Audio Mobius Home Audio Speakers	800
Vintage Polk Audio speakers and Insignia sound receiver (Northeast San Antonio)	600
Polk Audio LSi9 Stereo Bookshelf Speakers Pair Ebony LSi (Waco)	595

Figure 5.14: Low to High Price Craigslist classifieds



The screenshot shows the Craigslist mobile app interface with search results sorted by price in descending order. The 'Price' column is sorted from highest to lowest.

Title	Price
kicker L7. 2 Polk audio 6.5 (kempner)	0
surround sound components (nwsa)	0
subs and speakers (ne san antonio)	0
SPEAKERS (TEMPLE)	0
Epos els3 speakers, Polk Audio Subwoofer, Yamaha 6.1 channel receiver (Schertz)	1
Audio Gear for Sale (receiver, speakers) (central)	1
Home Theater Equipment, Bose, Polk & Venturi	1
POLK AUDIO 6.5" SPEAKER GRILLS (KILLEEN)	2
POLK AUDIO RT110 TOWER SPEAKERS, CHERRY WOOD (NW)	5
POLK AUDIO DSW microPRO 3000 HOME THEATER SUBWOOFER. (N)	5

Figure 5.15: High to Low Price Craigslist classifieds

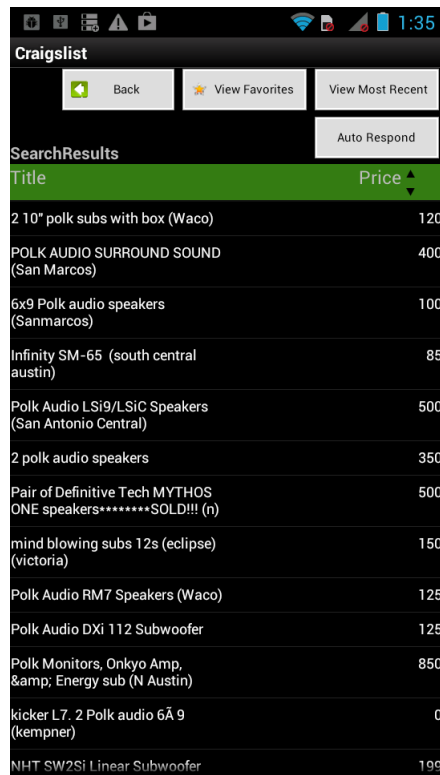


Figure 5.16: Viewing Most Recent Craigslist classifieds

5.2.7 Sending bulk email response to the sellers

The user clicks on "Auto Respond" button in order to send a bulk email response to all the sellers of the Craigslist ads displayed on the screen. The user has to enter a Gmail login id and password that is a one-time entry. The application doesn't store any details of login credentials. The application performs the operations and alerts the user that email has been sent to all the classifieds. Figure shows the option for the user to enter login details and Figure shows the alert. The actual sending of email runs in background.

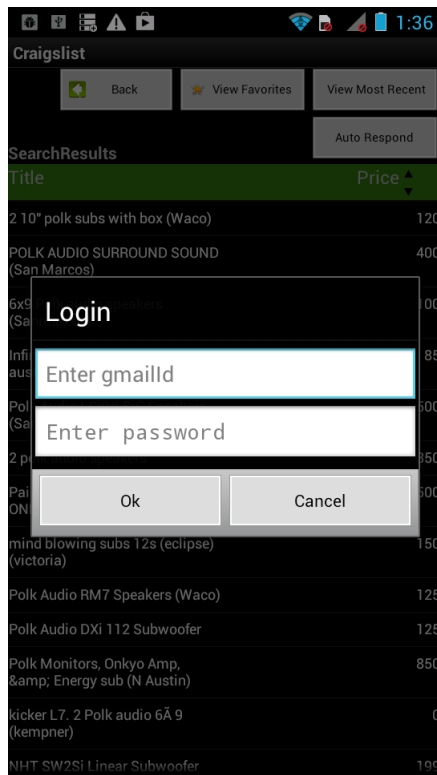


Figure 5.17: Enter login details to send bulk email

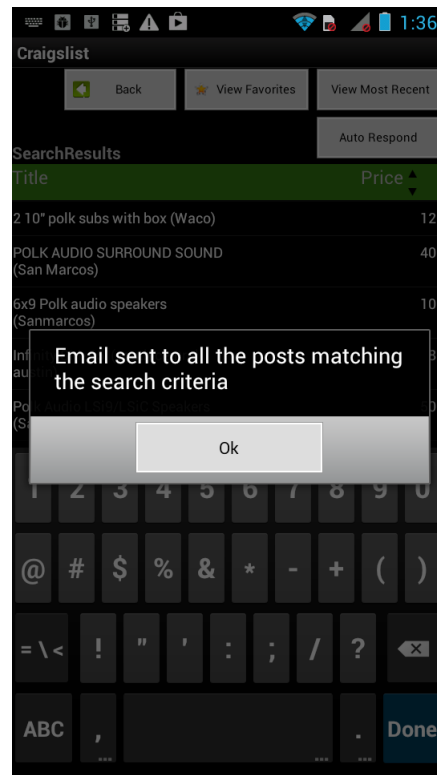


Figure 5.18: Alert the user about bulk email sent

5.2.8 Email, Call and Text Client

The user can contact the sellers directly by using email, call and text client. Figure 5.19, Figure 5.20 and Figure 5.21 shows the usage of email client after the user clicks on "reply" button in the top left corner of the screen. The user is given with a choice of templates that are created in the "User settings" screen. After the user selects the choice of template, the email client selection can be made that takes to the respective email client with auto populated from, to address, subject and body. The user clicks on "Send" button

to send an email.

The user can click on the "call" button next to "reply" button in the description screen in Figure 5.11 for calling the seller directly.

The third button in the row is used to open the text messaging client that is auto populated with seller's phone number and the user can type in a text message to send it to the seller. The screenshot displays the text messaging client with seller's phone number in to field for user action of clicking on "sms" button in the description screen in Figure 5.11.

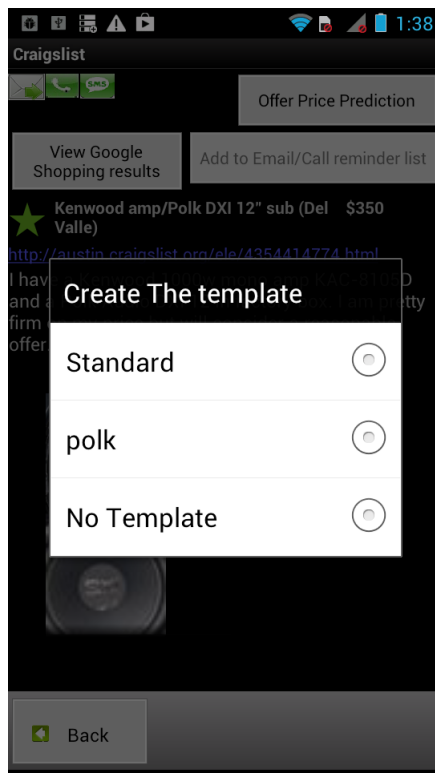


Figure 5.19: User selects from a list of templates

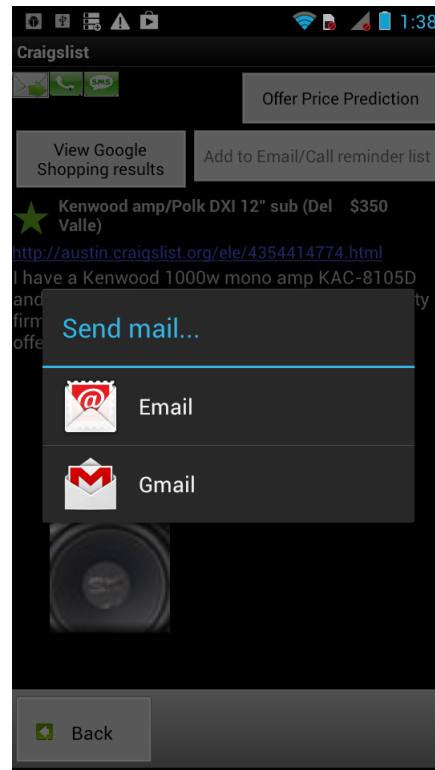


Figure 5.20: User selects from a list of email clients

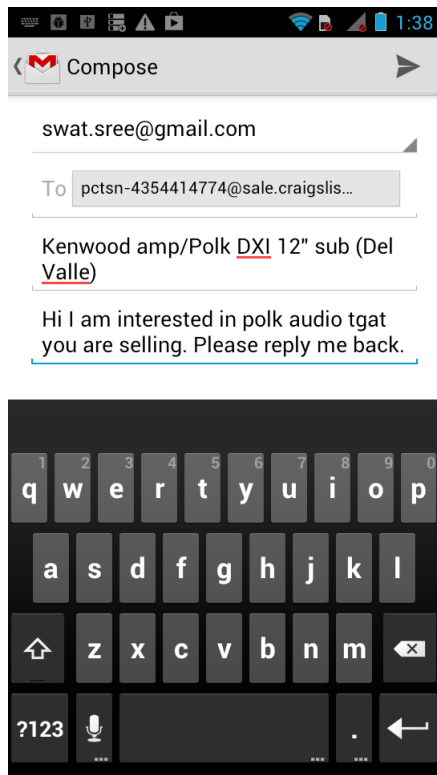


Figure 5.21: Display of Gmail Client selection

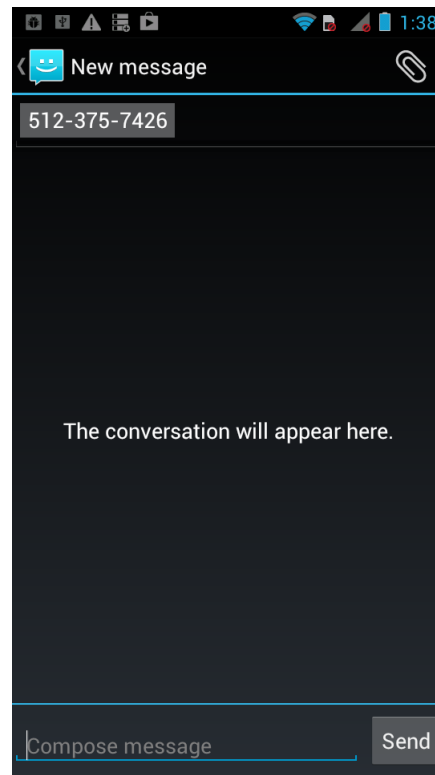


Figure 5.22: Display of text messaging client

5.2.9 Image display and viewing Craigslist classified in the Original Craigslist website

The user can view the enlarged images by clicking on any of the images and click back for a default size. Figure 5.23 displays the enlarged view of one of the images. Figure 5.24 displays the Craigslist classified in the original Craigslist website after the user action for clicking on link in the description screen in Figure 5.11.

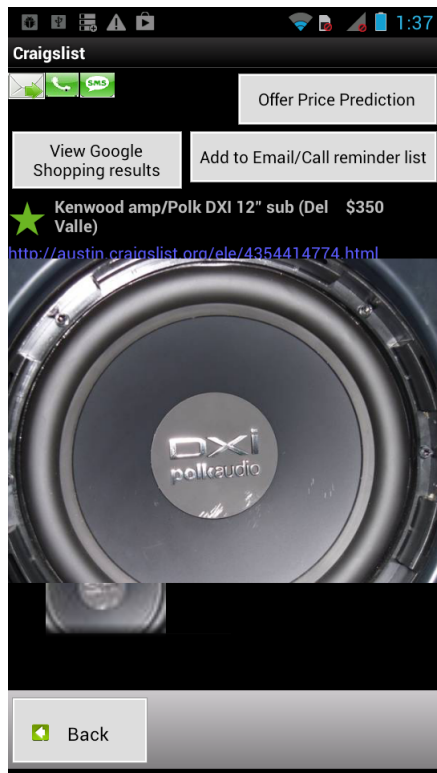


Figure 5.23: Enlarged image view of image in a Craigslist classified

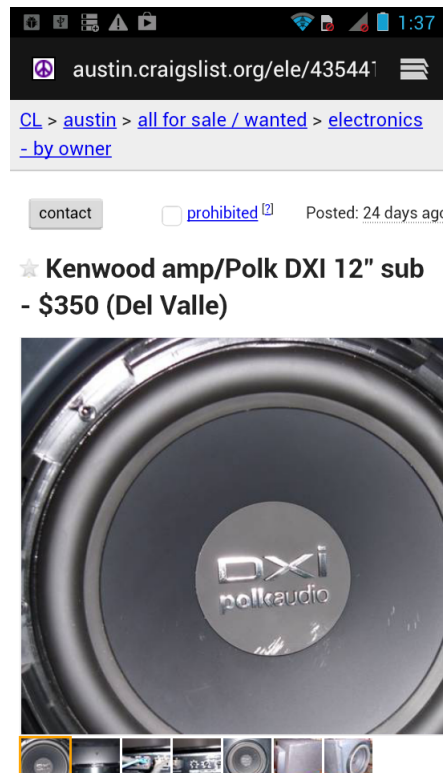


Figure 5.24: Classified view in Original Craigslist website

5.2.10 Email/Call Reminder list

The user can add the seller’s contact information into a reminder list to contact the seller at a later time. The application alerts the user of adding the seller contact to the reminder list when the user clicks on ”Add to Email/Call Reminder list” button as shown in Figure 5.25. The reminder list can be viewed in the ”User settings” screen in Figure 5.1 . Figure 5.26 and Figure 5.27 displays the reminder list with the entry that was added. The entry displays the title, an option to send email, call the seller as shown in Figure

5.26 . The user can also view the Craigslist classified in the original Craigslist website by clicking on the link displayed as shown in Figure 5.27

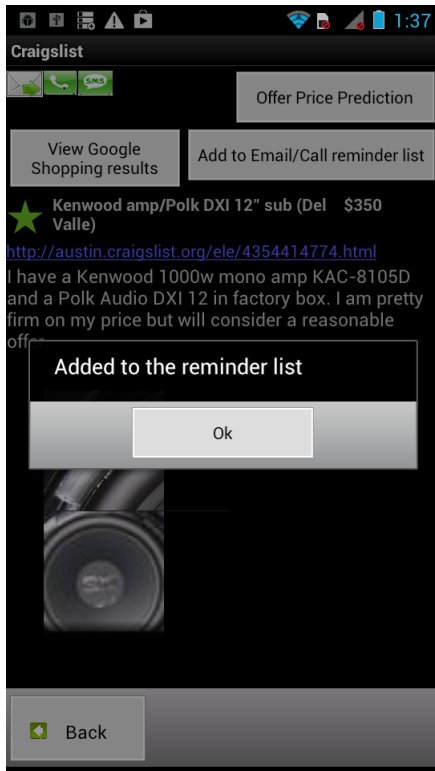


Figure 5.25: Adding the seller contact to reminder list

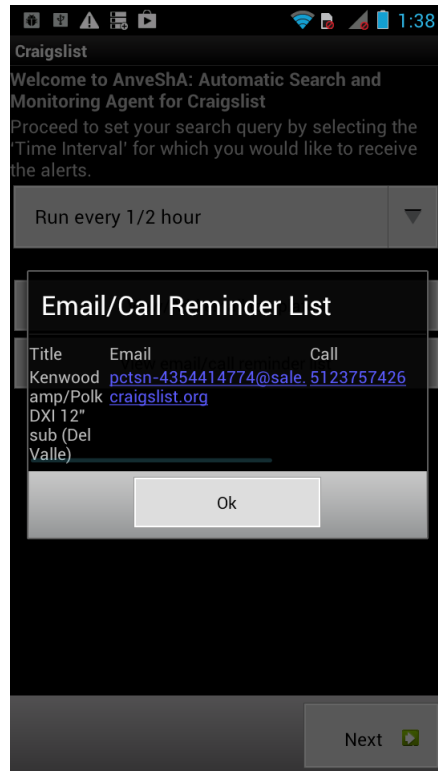


Figure 5.26: Viewing Email/Call Reminder list

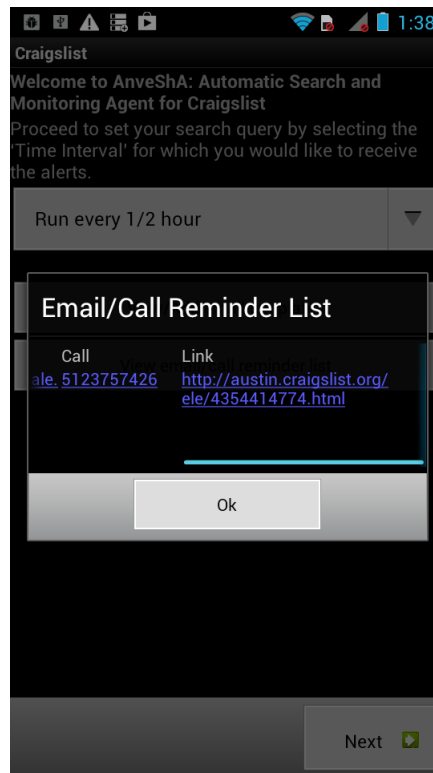


Figure 5.27: Viewing Email/Call Reminder list with link to Original Craigslist website

5.2.11 Offer Price Prediction

Offer Price Prediction was explained in 3.5.2.5. It provides the user with a recommended offer price based on various parameters. To access this feature, the user has to click on "Offer Price Prediction" button in the description screen in Figure 5.11 . A dialog box asking for the "percentage off" will be displayed where the user can input the choice of a "percentage off" of the asking price as shown in Figure 5.28 and Figure 5.29. After the user enters the choice for percentage off, the application calculates and provides the best

offer price. The best offer price prediction is displayed to the user as shown in Figure 5.30.

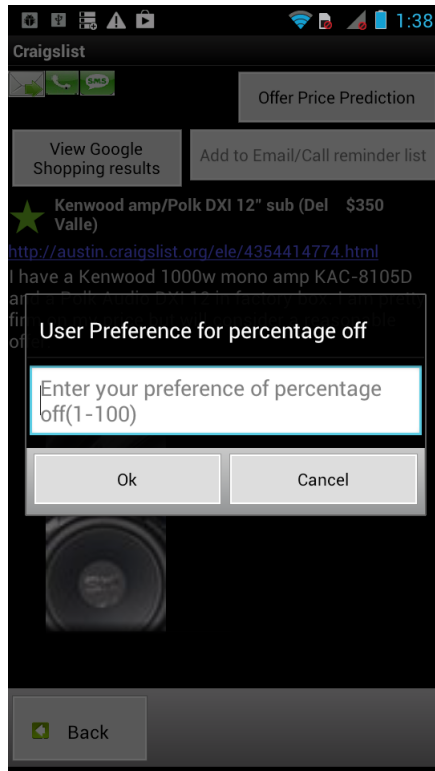


Figure 5.28: Choice for the user to enter percentage off

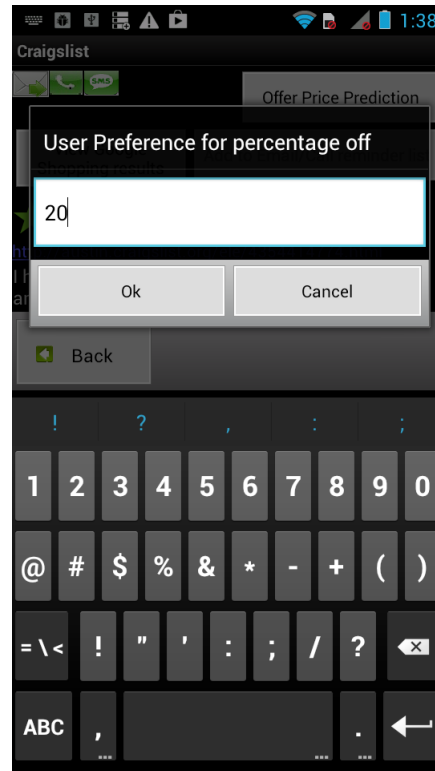


Figure 5.29: User choice of percentage off

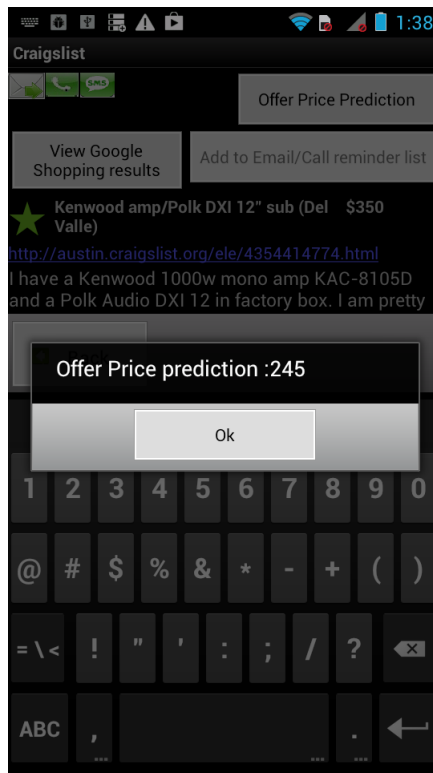


Figure 5.30: Display Offer Price Prediction

5.2.12 Viewing Google Shopping Results

The user has an option to select a particular keyword from the title to view the market prices of the products via Google Shopping Results. It is because Craigslist users post the classifieds with a suitable title in different ways and is not consistent. So if the user can select the keyword, the application can use it directly instead of trying to parse the title to figure out what the keywords are. Thus, the user selects the keyword and clicks on "View Google Shopping Results" button in the description screen in Figure 5.11. Figure

5.31 displays the user action of selection of keyword and Figure 5.32 displays the results from Google shopping website from within the application.

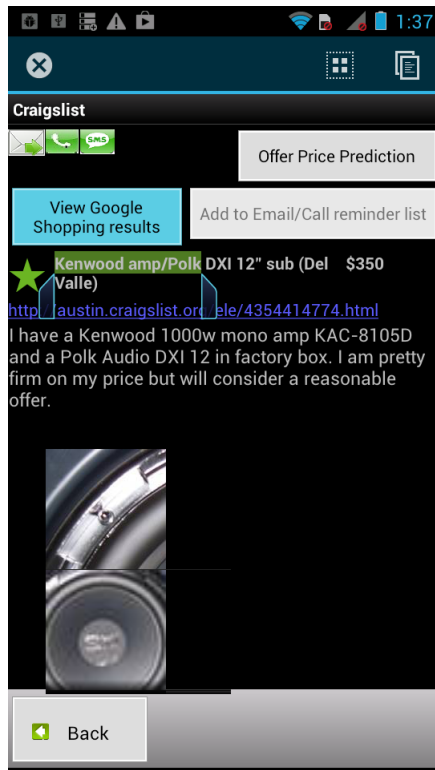


Figure 5.31: Keyword selection for viewing Google Shopping Results

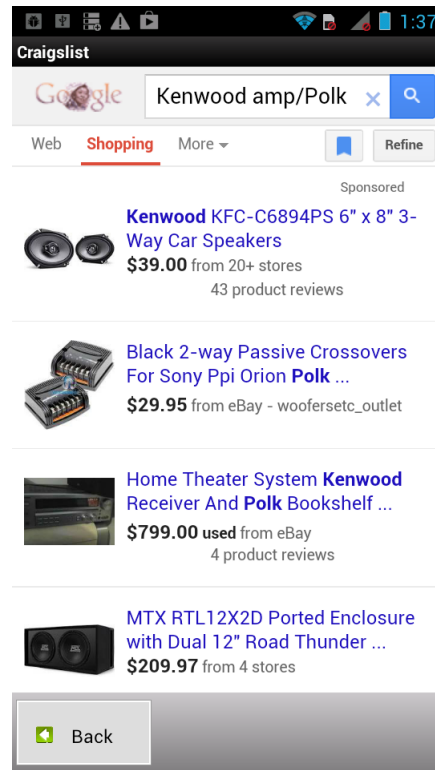


Figure 5.32: Viewing Google Shopping Results

5.2.13 Notification for viewing updated results

After the user created time interval has elapsed, the user is presented with the notification to view updated results for the search criteria. Figure 5.33 the notification view and on click of it, the user is displayed a screen as shown in Figure 5.34 where a list of search criteria gets displayed for the user to select and view the updated results for. The selection of an item is shown

in Figure 5.35 and the updated results for selected item is shown in Figure 5.36.

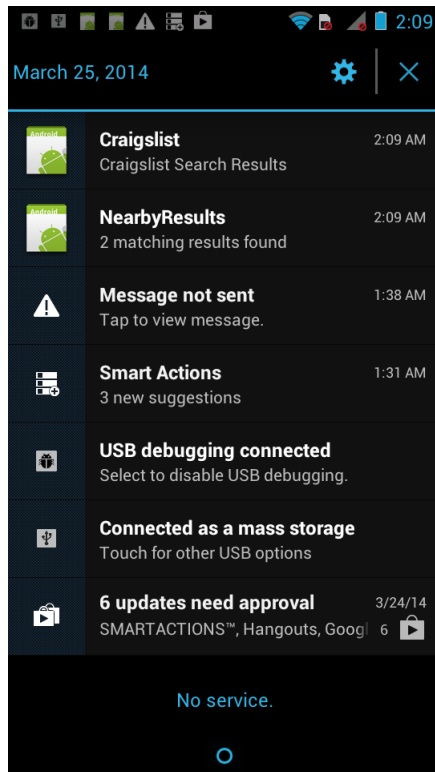


Figure 5.33: Notification view for updated results

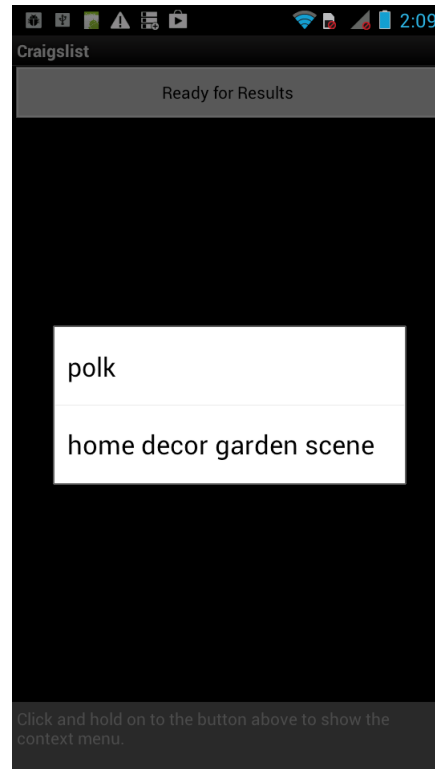


Figure 5.34: List of items in the search criteria

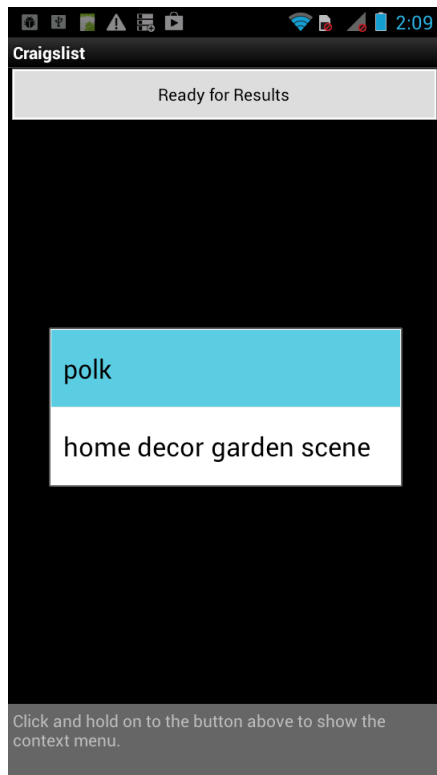


Figure 5.35: User selection of item for updated results

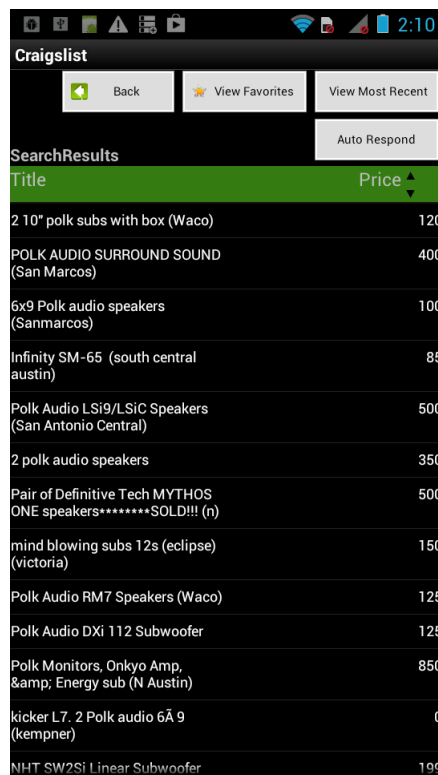


Figure 5.36: Displaying updated results for selected search criteria

5.2.14 Viewing price history and description

The user can click on any Craigslist classified displayed with the updated results as shown in Figure 5.37. On click of any Craigslist classified from the list, the user is displayed with a screen to select the option to view the description or a price history as shown in Figure 5.38. On clicking "View description" button, it displays the Description screen as shown in Figure 5.39 and on click of "View pricehistory" button, it displays the price history graphically as shown in Figure 5.40(if any) or the recently added price. For the

selected Craigslist classified, it shows that the price has been reduced from 30 dollars to 20 dollars.

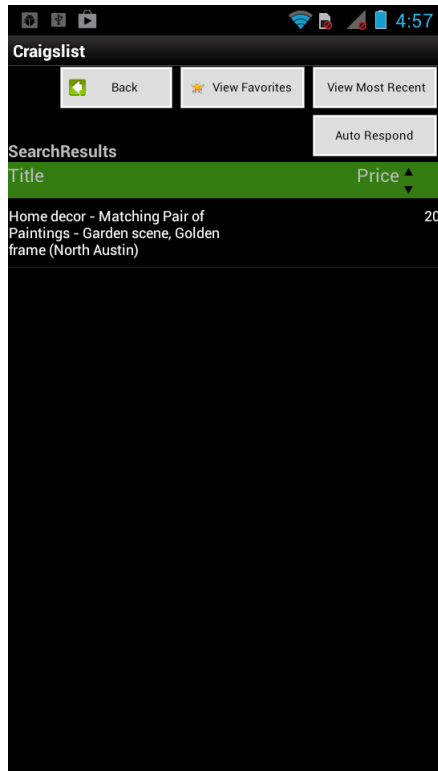


Figure 5.37: Classified selection from the list

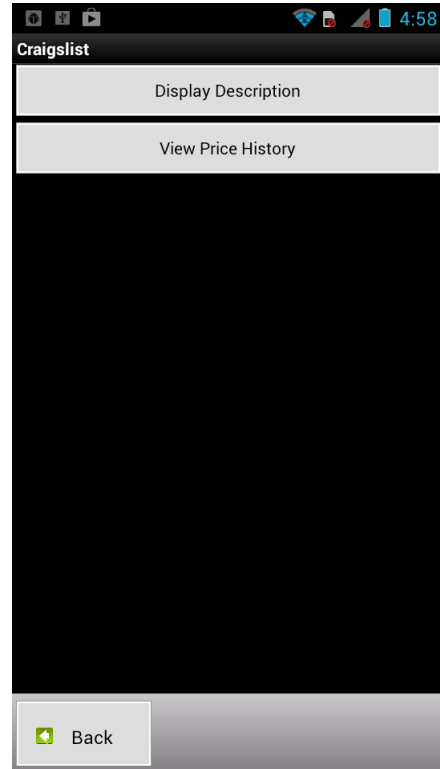


Figure 5.38: List of options to view the details of Craigslist classified

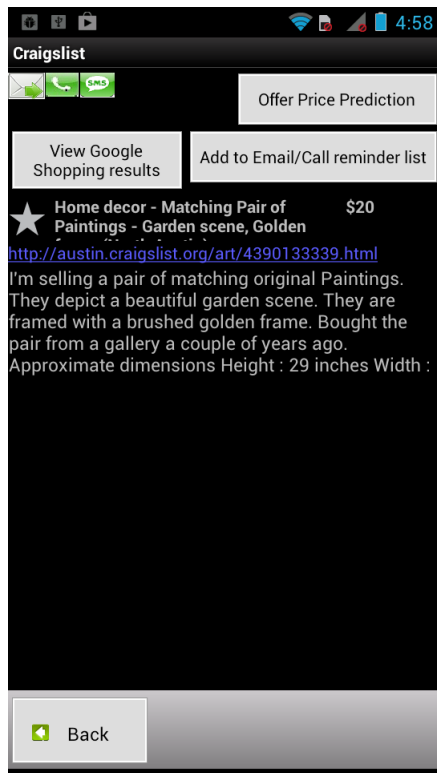


Figure 5.39: Viewing description of Craigslist classified

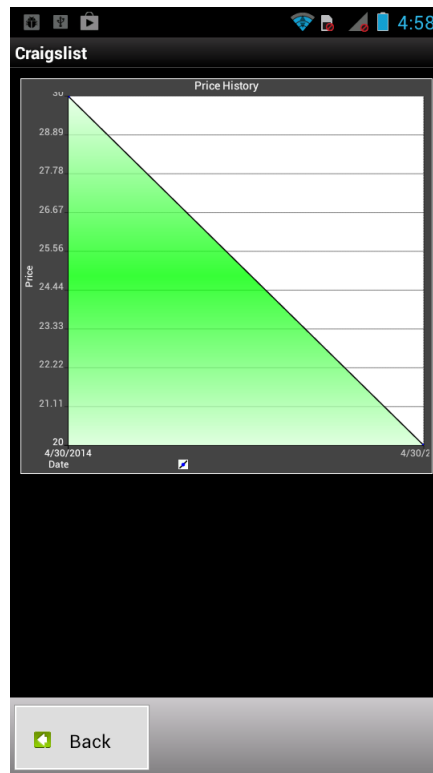


Figure 5.40: Viewing price history of Craigslist classified

5.2.15 Notification for viewing nearby results

The user is given a notification to view results matching search criteria and the current location of the user every 15 minutes. The user can view the number of matching results and click on the notification to view the details of Craigslist classifieds. The details display the title and a link to original Craigslist website for each classified. Figure 5.41 shows that there were 2 matching results for the search criteria set up by the user and Figure 5.42 shows the details of the Craigslist classifieds.

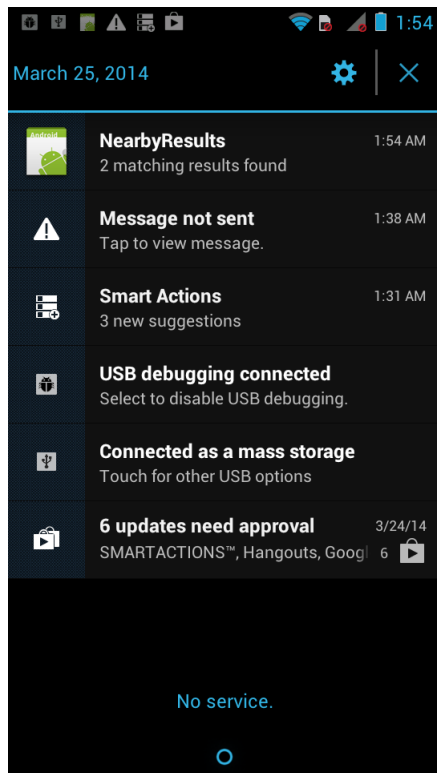


Figure 5.41: Notification view for nearby results

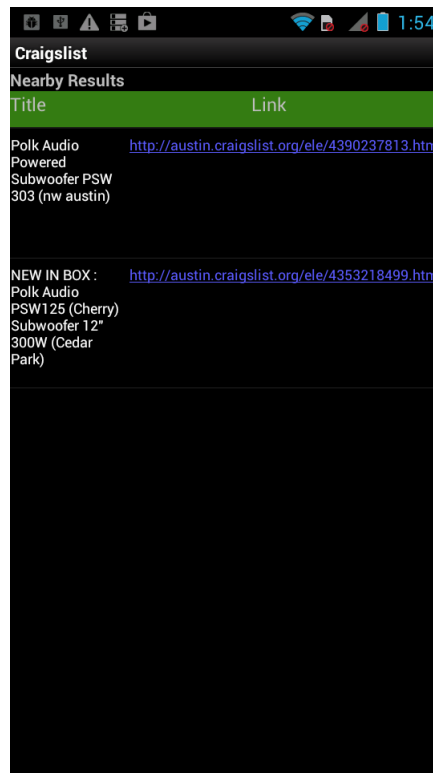


Figure 5.42: Details of "nearby" Craigslist classifieds

5.3 GPS data accuracy

In order to understand AnveShas performance, the accuracy of the geographical results provided by AnveSha are measured. For this, AnveSha was instrumented with some debug and test functionality. In order to measure the accuracy, the test first obtains the GPS coordinates from AnveShA. This is then compared with the GPS coordinates obtained by the reference GMapToGPX tool.[28] GMapToGPX tool converts google maps data to GPS

coordinates and is reported to be very accurate.

The accuracy is measured with the following steps:

- GPS coordinates for the current location are obtained by AnveShA.
- GPS coordinates for the current location are obtained by the GMap-ToGPX tool.
- The difference between the coordinates are computed by the GPSVisualizer tool.[25] The calculation is based on Vincenty Formula and is considered to be accurate(upto 0.5mm accuracy)[17]

The above measurement process is performed for multiple locations around Austin-Cedar Park-Round Rock and Leander area. The results are reported in Table 5.1. It shows that the accuracy of the GPS location detection was high and was in the range 0.087km-0.301km. Ultimately the accuracy does depend on the GPS device on the phone/tablet.

5.4 Accuracy of distance computation for nearby results

In order to obtain "nearby" results, AnveShA first fetches all craigslist classifieds matching the search criteria. Next, AnveShA measures the Great Circle Distance (GCD) between the users current location and the location of the classified.[29] If the distance is less than 5km, that classified is qualified as "nearby". In this section, we describe how the accuracy of the GCD computation is measured.

No.	Address	GPS coordinates obtained by AnveShA	GPS coordinates obtained by GMapToGPX tool	Difference in distance(km)
1	1700 W Parmer Ln No.260, Austin, TX	30.445389747618744, -97.74396657943441	30.448066, -97.744465	0.301
2	201 N Frontier Ln, Cedar Park, TX	30.5169396 - 97.7632709	30.517408, -97.762546	0.087
3	N Interstate Highway 35 Round Rock, TX 78681	30.517176389693326 -97.68929243087484	30.519911, -97.689136	0.304
4	1805 U.S. 183 Leander, TX 78641	30.557141304015225, -97.8421682357504	30.556397, -97.843862	0.182
5	2247 Guadalupe St, Austin, TX	30.2860694,- 97.7402482	30.286604,- 97.741150	0.105

Table 5.1: GPS Data Accuracy

The GCD is calculated in km for a range comparison and is determined by the formula that is based on spherical Earth model:

$$GCD = \arccos(\sin(lat1) \sin(lat2) + \cos(lat1) \cos(lat2) \cos(lon1 - lon2))R \text{ [55]}$$

where R=6371 km, lat1 , lon1 are latitude and longitude of matching Craigslist classified's location and lat2, lon2 are latitude and longitude of current location.

In order to analyze the accuracy of GCD calculation, the calculated GCD for several GPS coordinates by AnveShA is compared with the calculated GCD based on Vincenty Formula using GPSVisualizer tool that accounts for flattened shape of the earth.[25]. The GPSVisualizer tool is considered to be accurate (upto 0.5mm accuracy).[17] The GPS coordinates were extracted from various Craigslist classifieds posted in the Craigslist Website. The results from both the formulae are shown in Table 5.2.

Figure 5.43 indicates that the GCD computed by AnveShA and GPSVisualizer have high correlation. The maximum difference is less than a km. For distances less than 5km, the difference in GCD is negligible.

No.	Latitude, Longitude of a matching classified	Latitude, Longitude of the current location of the user	GCD calculated in AnveShA (in km)	GCD calculated in GPS Visualizer tool (in km)
1	30.506000, -97.747200	30.5172241, -97.7625657	1.9298	1.93
2	30.478181, -97.810196	30.5172241, -97.7625657	6.2986	6.296
3	30.518498, -97.765875	30.5172241, -97.7625657	0.3472	0.348
4	30.477200, -97.817600	30.5172241, -97.7625657	6.9000	6.899
5	30.496977, -97.730679	30.5172241, -97.7625657	3.7948	3.796
6	29.875400, -97.940400	30.5172241, -97.7625657	73.3854	73.182
7	29.482100, -98.455400	30.5172241, -97.7625657	133.0385	132.798
8	29.875400, -97.940400	30.5172241, -97.7625657	73.3854	73.182
9	28.809000, -96.999300	30.5172241, -97.7625657	203.7584	203.256
10	31.037600, -97.680900	30.5172241, -97.7625657	58.38676	58.219

Table 5.2: Comparison of GCD calculated in AnveShA and GPSVisualizer tool

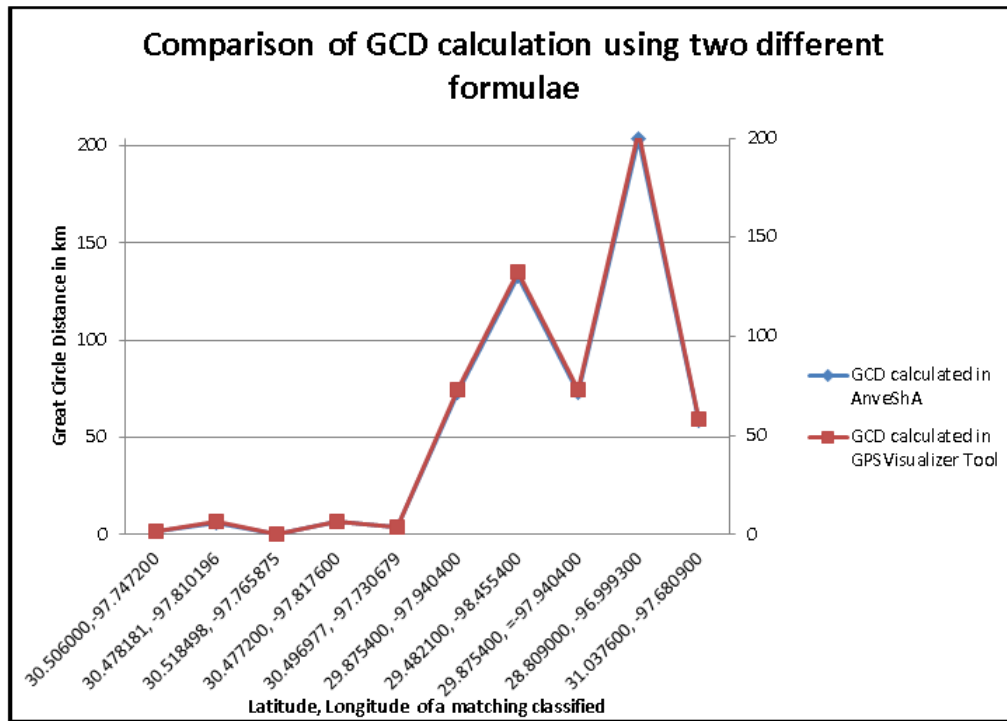


Figure 5.43: Graphical display of comparison of GCD calculated in AnveShA and GPSVisualizer tool

5.5 Performance Evaluation of AnveShA

The overall performance of the application is assessed by measuring the average response time for performing major operations. The response time was calculated by placing java hooks and recording the system timer provided by OS. The code was instrumented with minimal overhead by using the timer. The response time for each operation was measured for 10 different Craigslist Classifieds or search queries depending on the operation and the average of 10 response times was taken. Figure 5.44 indicates the response time measured

for several operations.

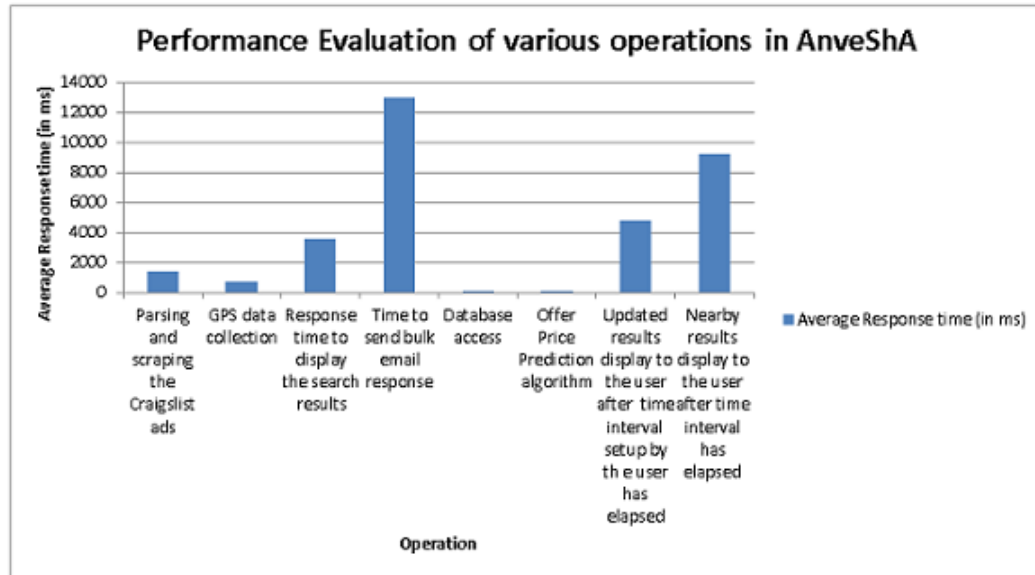


Figure 5.44: Performance Evaluation of AnveShA

The time required to send bulk email response is recorded to be the highest and the most time consuming operation compared to other operations. This is because it involves calling the Mail API for responding to each individual seller. The time recorded increases as the number of Craigslist classifieds matching a search criteria increases. Nevertheless, the time measured shows that the user experience and response time will not be compromised because the time required for most operations is less than 5-10 secs.

5.6 Learning Experience

Architecting AnveShA posed significant challenges at various stages of development. This resulted in expanding of the knowledge base and gain immense experience in all stages of application development. Some of the main aspects of the experience gained are -

- How to build intelligent, automatically reconfigurable (based on geographic location) search agents for handheld devices?
- How to interface the application with multiple devices like GPS, network adapters and timers?
- How to use services provided by Android like Alarm/Notification Services, Calling/SMS services etc?
- How to interface with other applications like email client, text messaging client?
- How to use various web scraping tools to obtain market price and search results from other websites like Google, amazon?

Chapter 6

Conclusion

6.1 Summary

AnveShA has been developed to serve a wide variety of users who use Android handheld devices. It can be used by ordinary individuals and resellers trying to find products to buy at the best possible prices. AnveShA has incorporated a unique set of features that are not present in other available applications. As part of the development, AnveShA was conceptualized, architected, designed and tested. Along the process, various technologies were explored like Android framework, GSON/Jsoup web scraping libraries, web page loading within the application, Mail API and integrating external clients like Gmail, Android Email and Text messaging. The advantages of these technologies were leveraged to enhance the user experience and build a sophisticated and intelligent application. AnveShA provides a significant advantage to the user compared to the competition.

6.2 Limitations and Future Work

AnveShA is a fully functional application and a powerful search engine but the performance of AnveShA can be non-optimal under certain circum-

stances. Also, in order to reach the Android market, future work will be necessary. Over the course of this semester, most of the effort has been spent on making the application work as specified. Apart from the obvious processes like code optimization, performance enhancement, formal verification, directed and random testing, AnveShA will greatly benefit from the additional development tasks. The current limitations of AnveShA and possible future work for certain tasks are noted below-

- When AnveShA is used on a device that is not connected to a mobile network or a device that does not have a GPS, geographical location-based features do not work. With lack of geographical location-based features, AnveShA will prove to be less attractive to the users.
- Selecting the keyword for Google shopping results is not automatic because of the way Craigslist sellers post titles (titles and names are not consistent).
- AnveShA provides a fully functional user interface but it is still basic compared to the state of the art applications. The user interface can be improved further to provide the user a better experience.

– ***Future Work: Migrating to Android User Interface Patterns***

AnveShA provides a fully functional user interface but it is still basic compared to the state of the art applications. The user interface can

be improved further to provide the user a better experience. The use of Android UI Pattern tool will enable us to design a more advanced user interface.[24] Additionally, custom styling components can be used to improve the user interface.

- Offer price prediction is a unique feature that was implemented to incorporate the way potential buyers of products on Craigslist think. Only a prototype of the algorithm has been implemented based on some assumptions.

- ***Future Work: Building a more sophisticated Offer Price Prediction***

Offer price prediction is a unique feature that was implemented to incorporate the way potential buyers of products on Craigslist think. Only a prototype of the algorithm has been implemented based on some assumptions. Offer price prediction takes into several parameters but it can be more effective if more parameters can be considered like -

- * The algorithm can potentially determine the willingness of a seller's on negotiating the price. This can be determined by the algorithm by searching for common keywords like "non-negotiable", "Or Best Offer (OBO)", "negotiable", "firm", etc.
- * A large number of users sell items that are non-used or are brand new. Generally, these sellers are less willing to accept

lower offers. The algorithm can potentially identify such classifieds by looking for keywords like "Brand new in box (BNIB/NIB)" in order to predict a more accurate offer price.

- * The offer price prediction algorithm currently discounts the asking price based on certain parameters. The percentage of the discount can be heuristically fine-tuned.
 - * The willingness to accept lower prices for a product are also highly dependent on the categories of products. For example, Sellers are more willing to accept lower prices for used furniture but are usually unwilling to accept lower prices for used Apple products. The algorithm can take this into account when predicting the offer price for classifieds.
 - * Lastly, literature survey of bidding algorithms was out of the scope of the current application development. However, the offer price prediction algorithm, and eventually AnveShA, will greatly benefit from such a literature survey.
- The search for "nearby" locations runs and fetches data every 15 mins. The cellular data usage will increase if the user is frequently travelling and the user has to take a note of this.
 - *Future Work: Notification Service based on user control for results matching search criteria and current location of the user*

Notifications for "nearby" results are provided every 15 minutes for all the criteria. This is not ideal because the number of new classifieds posted per hour is different for different types of products. For example, the rate at which new classifieds are posted are more for "electronics" and less for "furniture". Additionally, the user may not be interested to receive "nearby" results for all the criteria.

- The search for updated results runs and fetches data based on user-defined time interval for every search criteria set by the user. The user may not require updated results for all the search criteria with the same time interval.

- ***Future Work: User-configurable notification interval for every criteria***

AnveShA allows the user to provide a time interval at the start of the application, instead an option can be provided to the user to select different time intervals for each query sets up. This will aid the user to receive alerts to particular items at a specified time interval for updates and allows the application users to be more organized about the search. This can be achieved by storing the time interval selected for each query and upon reaching the time interval, the display includes only the relevant items. This involves a simple fetch from the database as the search queries are already stored and only an extra field is to be added to the corresponding table. The results can be correspondingly cached using SQLite Database.

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