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The Best Preferred Product Location Recommendation According to User Context and the Preferences

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Abstract— **Currently the Smartphones are more popular among the community with the available technologies such as sensorbased interactions and smart apps. The other kinds of trends in such apps lead on context awareness and the personalization for recommending the services for the users based on their context and the preferences.**

Further, the researches are going on tracking the location of a person and guiding them to the nearby places where the products and the services are available according to their preferences. To accomplish such tasks, tracking and analyzing of the user preferences on different categories of products is required. This paper describes a mobile-based solution; NavToPref where the user preferences and the contextual information are gathered from their mobile phones and recommend and guide them to the nearby locations where the most preferred products are available. Analyzing the metadata of the sites of the frequently and mostly searched products, their top preferred categories of products are identified. This is done by the analysis of the browsing history. Further from their mobile devices, their own contextual information such as whether, location, identified special events from the Google calendar are collected to achieve more personalization on product recommendation. By analyzing the identified preferred products and the user context at the moment, the best preferred product/service locations are notified in the Google map with the shortest path for each product location from the users current location and allows the user to navigate to such locations. If someone is looking for a best promotional deal for shopping, that information is notified along with the recommendation.

Keywords— **User Preferences, Contextual Information, Context-awareness, Navigation**

I. INTRODUCTION

Today the smartphones are pervasive, personal and customizing. With the advanced technologies of such devices, many user navigation systems are available by integrating user context such as weather, time, traffic, location etc. Contextawareness is already utilized in several types of applications [1][6]. With the recent progress in smartphone technology, several route guidance applications for mobile shopping have become available [6]. These existing systems either ask desired locations of the user directly or ask a preferred product from the customer and then navigate them to the desired location where the preferred products are available. When collecting the user preferences for shopping items, such systems use the sample survey methods to determine the customer's products of interest in general [12]. Most Application systems widely use a group of app users or a community to get samples and test their interests and choices to build algorithms [6]. Mostly, they use the same method to identify the most popular items on stores or in sale [3]. However, to make it unique and precise from the rest of apps on the market, our approach was to consider individual app user's search results on browsing history and filtering out the metadata and developing an algorithm to find out the bestpreferred items on the considering categories of products.

The main objective of NavToPreff is dynamically navigating the user to the places of desired items precisely. The system, on the other hand, incorporates context awareness to determine the best product at the moment and propose the navigation paths for the locations.

II. RELATED WORKS

This research focuses on the user context and the preferences to propose the best-preferred products and the locations to the user at the right moment. Location information is a necessary fact to be considered in the design of contextaware information systems [3]. Context-aware navigation systems require the use and integration of an appropriate spatial model that satisfies application and structural constraints, and takes into consideration the dynamic properties and interactions of moving objects with their physical surroundings [1]. Context-aware recommender systems integrate user context into the recommendation process [3][6]. If the context of an entity shall be defended, it is necessary to ask which information is relevant to the situation. To obtain better context data for navigation purpose, several types of researches have considered on the use of Google APIs[15].

Many research projects and companies are exploring the use of personalized applications that

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manage this deluge by tailoring the information presented to individual users. These applications all need to gather, and exploit, some information about individuals in order to be effective. This area is broadly called user profiling.

Here we study some of the most popular techniques for collecting information about users, representing, and building user profiles. In particular, explicit information techniques are contrasted with implicitly collected user information using browser caches, proxy servers, browser agents, desktop agents, and search logs [2]. There the user profiles are represented as weighted keywords, semantic networks, and weighted concepts [3]. User profiles are constructed from information sources using a variety of construction techniques based on machine learning or information retrieval. Depending on the desired user profile representation, different techniques may be appropriate. Techniques which are commonly used to construct are keyword profiles, construction techniques, appropriate for semantic network profiles and concept profiles respectively [9].

Here the Techniques which automatically construct the profiles from user feedback are much more popular. Some approaches use genetic algorithms or neural networks to learn the profiles. In every of these methods, the profile must be updated to reflect the user's preferences accurately; this has been proven to be a very challenging task. Profile updating can be done automatically or manually. Automatic methods are preferred because it is less intrusive to the end user [9]. Some authors warn against fully automatic profile updates, advising that user feedback, which requires minimal effort, should be used [10] [11] [12] [13].

In most of the personalized systems in different contexts such as education and marketing, they have focused on Building Keyword Profiles [12]. In web based systems, keyword-based profiles are initially created by extracting keywords from metadata from Web pages where the users are visited on searching products. In e-learning systems, for personalizing the activities, user behaviour profiles are analysed. Some form of keyword weighting is done to identify the most important keywords from a given Web page to determine the best preference of the user.

III. CONCEPTUAL MODEL ON PERSONALIZATION

Based on the literature, finally we came up with the model which is shown under the Fig. 1 for implementing the product locations recommendation system according to user context and preferences. It has 3 libraries and 4 models for user profiling, context modelling, navigation and advertisements of products which are manipulated by the algorithms developed for the personalisation mentioned in the middle part of the model.

A. A. *Identifying user context and preferences for product location recommendation*

Here we propose a model (Fig. 1) on a personalized recommendation for navigation through product locations by gathering user context and preferences. The shops, by registering with the website should have to update their promotional and location information along with their products and the services. By extracting the metadata from the visited sites, the user has been modeled by finding the bestpreferred items searched. From the contextual model, the user context has been obtained.

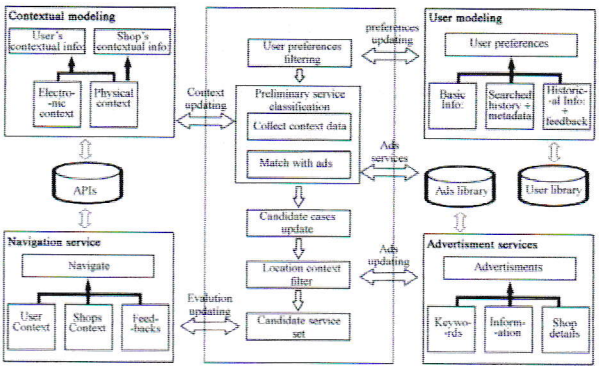

Fig. 1 User context and preference filtering for the recommendation of best product and navigation paths for the product locations.

First, the search results along with the metadata are uploaded to the server through the terminal in the service user modeling and the user context from the contextual model. Second, the server filters the achieved services according to the results from advertisement service. To filter advertisements, need quick physical context information such as user location. According to the user location and preferences, the server will suggest the advertisement that needs to be displayed. If the user has searched for similar products in many days, the model will identify such products and suggest best searches and propose the locations of them. Thus, the efficiency and accuracy of preferred location will be improved. When a user buys some product by navigating using this app they should have to give feedbacks. If it's provided by the user, it will affect to predict best locations for the user.

B. B. *The functions of each part can be described as follows*

1) *User modeling*: Under user modeling component we consider about basic information, browsing history, and historical information and feedbacks of users. From these main three areas, we are mostly focused on browsing history. Algorithms are implemented to extract selected URLs and read metadata of the pages which are relevant to the URLs. To extract selected URLs, the algorithm uses predefined keywords that contain in the database. The system will consider about user's basic information also. That basic

information is age, gender, interest, hobbies so on. When the user has been registered through the mobile app we can collect that information by giving to fill up form. With the combination of all of these components the system that has the functionality of selecting highly preferred product category above a given threshold value among the extensive amounts, prioritize the preferences to select the best preference.

2) *Advertisement Service*: Member shops are responsible for interacting with a web server and upload the advertisements which contain the information about promotional deals, discount, and offers. And also, when publishing the advertisement, they should give their shop details and keywords that are relevant to each advertisement. Always the system maps the keywords that are relevant to the advertisement with user's top preferred products similar to predefine keywords.

3) *Context Modeling*: This is also the main component of the system that has the functionality of identifying the contextual information of user and shop. Under user context information we consider the user location context, whether context and activity context taken from calendar events. Also, it should understand external environment context as well. As shop context information, we get the information that the shops are given at their registration. If there are immediate changes happen in shops it is also can be updated.

5) *Navigation Service*: Navigation is the field of study that focuses on the process of monitoring and controlling the moment of craft or vehicle from one place to another. Under this process, component considers comparatively supervision of received contextual information, user preferences and user's feedbacks[15]. An application shows where you are right now. When the system gets user preferred products, it provides shops location if the product is available in such shops. These locations provided are shown according to user current location. User location and shops locations are directly sent to the Google Map APIs and get the navigation service.

How the combination is working in each part can be described as follows.

6) *User preferences filtering*: Through the data collected to calculate the historic and real-time user information, the user preferences model determines the user's preference to different categories of service. With the help of user preference, it is able to get more reliable and match keyword that needs to continue the process.

7) *Preliminary services classification*: The result from the above process will be used in the service classification. There are two main processes included in this process. The result of the preferences filtering will extract each keyword and optimize the user preferences. To match with the advertisements, need some context data of user and shop. In here we use dynamic context attributes to make quick reaction under the mobile environment.

8) *Candidate cases update*: Checking whether there exists the same instance in the historical recording according to the recent preference that has been requested. If there any similar records in the database, the server will check user's feedback and compare the user's profile and the query efficiency will be improved according to the candidate cases.

9) *Location context filter*: For the mobile users with uncertainty position, each of them has various context-aware attributes under mobile Internet environment, such as weather, time, season, location, traffic and so on. We set up a context library and save the historical context for service recommendation.

10) *Candidate service set*: At the end of preferences and advertisement matching process, the most suitable results of service discovery will be returned. The returned service is shown in google map and can navigate on a given route or we can select routes manually. As discussed in Fig. 1, the model collects the evaluation of user satisfaction rating and store it to the database.

IV. METHODOLOGY

As stated in the above, our evaluation task is to predict user preferences by counting preferred product items from the abstracted URLs which are obtained from user browsing history. Our application views metadata across multiple sites and pages. According to the algorithm mentioned below, top five preferred items are apparently identified.

The collection of user preference function is mentioned below. As mention above our application displays the advertisements which are evidently related to the user preferences. To accomplish this task, we use the browsing history of particular user.

Through this abundant historical data, our application accepts only the URLs which are coincided with the predefined keywords [12]. Therefore, we read meta data to obtain the most suitable URLs for the eventual process.

```
extractURL(keyword, url){
        if(keyword exist in URL)
        // process of extracting metadata

                getMetadata(selectedURL, user);
                return metadata;

         else
                /* if there isn't keyword in URL skip to
                    next URL
                  */
                gotoNextURL();
}
```

These perceived meta data are sent to the user profile table in the database. Constantly application obtains the excessive user preferences. The application is smart enough to retain only four preferences which are nominated as most preferred one. Algorithm below mention is use to select 4 top most preferences. Therefore, we consider four factors which are Date, last 6 hours, last 3 days and last seven days of users browsing history to select the 4 top most preferences. Here the strong preferences and soft preferences are obtained respectively. The most preferred product in the preffered product list and second most recent product in the preferred product list are obtained.

```
setTopPreferences(user, keyword, context){
      preferencesLast6Hours(user, keyword, metadata)
                setStrongPreference1;
       setSoftPreference1;
      preferenceThisDay(user, keyword, metadata)
                setStrongPreference2;
       setSoftPreference2;
       preferenceLast3Days(user, keyword, metadata)
                setStrongPreference3;
                setSoftPreference3;
      preference7Days(user, keyword, metadata)
                setStrongPreference4;
                setSoftPreference4;

}
```

In here we rank the best 4 preferences among above top 8 preferences. In this case we compare Strong and soft preferences according to following algorithm.

```
rankingTopPreferences(user, preferences){

        /*
          Firstly, compare only with strong preferences
that getting from every method
         */
       matchStrongPreferences();
                setTempRankStrongPreferences;

        /*
          Secondly, compare only with soft
preferences that getting from every method
         */
       matchSoftPreferences();
                setTempRankStrongPreferences;

        /*
          Finally, compare only with strong and soft
preferences that getting from every method
         */
       matchSoftStrongPreferences();
                setTempRankSoftStrongPreferences;

        /*
          Then we set preference ranking by getting
each
          top preference using above methods
         */
       while(end soft and strong preference)
                setRanking(user, rank1, rank2, rank3,
                    rank4);
}
```

If we want to navigate user to the suitable location, we need to match preferences and other contextual data (current location, weather, date and time, Shops' feedbacks etc.) with the shops.

```
if isInScenario(environment) is true, then
while true, do

/*
Get the current context and the user preferences from the
database that ranked.
*/          getNextPercept();
getContext(environment,
user);
getTopPreferences(user, context);
```

Ultimately NavToPref matchs the preferences with the correlated contextual data and notify what are the best shops to be visited.

Our intention is to make a mobile screen as a showcase to the user with dynamically updating ads related to the top five preferences. To obtain that task we have developed a webbased system using Content Management System (CMS). This system gives good opportunities for store sellers to build and launch brand

advertising products on our website. As CMS, this system used OpenCart which is a free open source ecommerce platform for online merchants. NavToPref uses OpenCart since it provides a professional and reliable foundation to build successful online stores.

In our case, we are highly engaged with the calendar events due to their seamless collaboration. Displaying advertisements are determined by the user preferences [4][12]. Then NavtoPref deals with the calendar events and determine whether the status of the user is suitable or not for displaying the notification and propose the items best for special events [7].

In this case, to take a calendar events, application NavToPref have to interact with calendar provider API [4]. The Calendar Provider is a repository for a user's calendar events and Calendar Provider API can be used by applications and sync adapters. When we develop the application we have set the permissions to access the calendar to read calendar events and filter the events.

when the application displays advertisements, it also includes the status of the particular shop (whether it is opened or closed). Thus, we get current date/time very easily from the date and time picker and then application intimate user, by giving some status about the shops which are already opened.

NavToPref uses google Maps APIs for Android for proposing navigation paths for the desired locations. When we consider the trajectory of a mobile user NavToPref recommends the best path for the user to reach their desired location. Our purpose is to develop user comfortable data-rich map engaging with contextual data. Therefore, our application interacts with OpenWeatherMap API and we access current weather data for any location to consider the best option.

V. EVALUATION RESULTS

Before launching NavToPref, we consummated testing part through thirty of our application user. We compassed our task by asking them to do the set of activities we have mentioned after installing the app. Ultimately, we obtained the results from them by asking them to fill a questionnaire. The questionnaire has designed to evaluate two major areas using six-point scale as follows,

A - Donates strongly disagree
B - Donates disagree
C - Donates disagree to a certain extent
D - Donates agree to a certain extent
E – Donates agree F - Donates strongly agree.

The first part of the questionnaire consists of quality of the application and performance based questions and the second part of the questionnaire evaluates user satisfaction and overall system usability. We analysed those two parts separately with the obtained results.

A. *Evaluate application quality and performance*

We represented obtained results as percentage values to determine how the application supports to approach their requirement.

Using Frist two questions in first part, we evaluate the system's capability to select the most preferred categories. Fig. 2, Fig. 3 shows the overall results. The next questions in the first part evaluate the system's capability to Select the best path for most preferred category. Fig. 4, Fig. 5, Fig. 6, Fig. 7 shows the overall results.

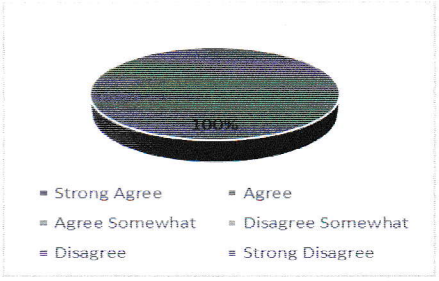

Fig. 2 Are the shown categories match with your searched items?

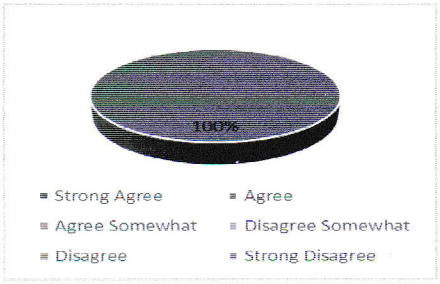

Fig. 3 Shown path have the best weather condition?

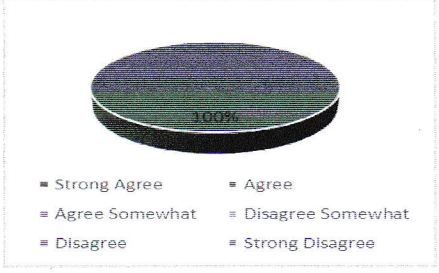

Fig. 4 Is the path the closet path to your location?

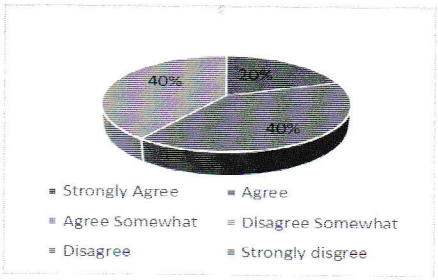

Fig. 5 Is the shown path match with your current schedule?

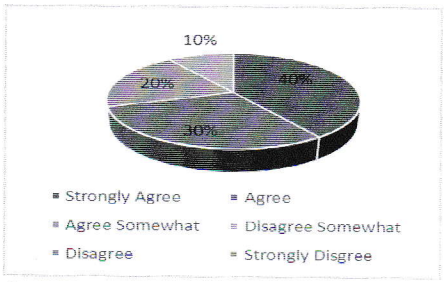

Fig. 6 Is app gives your most recent preferred categories?

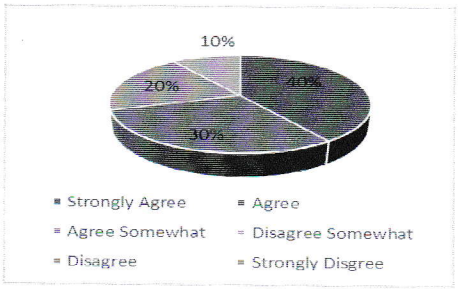

Fig. 7 Is the shown shop has the best promotion details?

B. *Evaluate user satisfaction and overall system usability*

ISO 9241 defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [14].

The second part of the questionnaire assesses user satisfaction and overall system usability. Questions were classified for figuring out the System Usefulness, Information quality of overall system and Interface quality. Fig. 8,9,10 shows the questionnaire results.

1). System Usefulness: The questionnaire contains six major questions to evaluate the system usefulness. When user use the system they can get real experience about the system. Fig. 8 shows how the thirty users experience with the system under the six main areas.

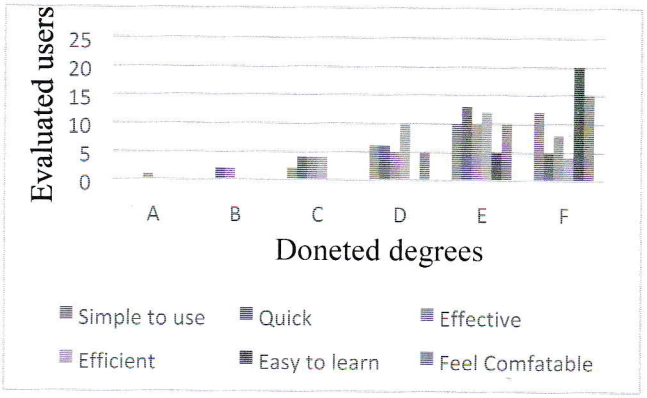

Fig. 8 System Usefulness

2). Information Quality: The next four questions in Questionnaire is based on Information Quality of the system which gives major contribution to consider overall system usability. While most of users are satisfied with updated and relevant information given by system, they recommend the system as a system that can find and understand information easily.

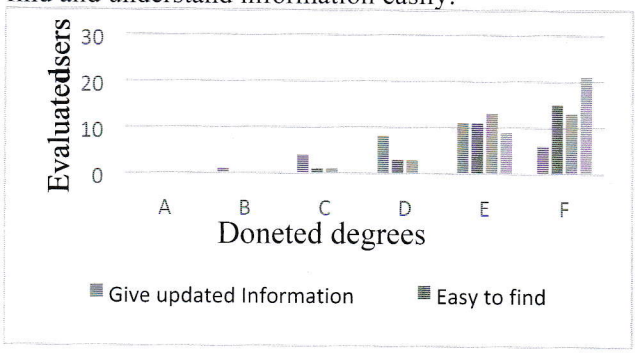

Fig. 9 Information Quality

3). Interface Quality: The last two Questions are organized to evaluate Interface quality. Majority says the interface is clear and pleasant.

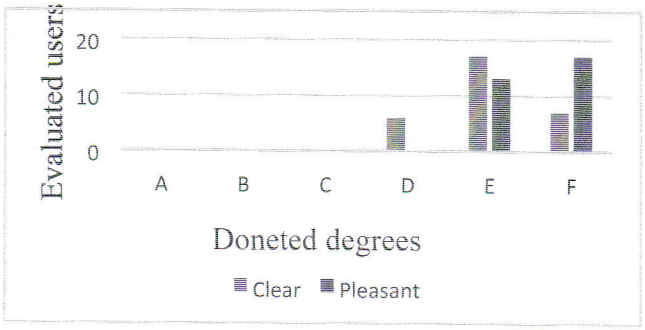

Fig. 10 Interface Quality

VI. DISCUSSION AND CONCLUSION

The main target of the research is to deliver a mobile based personalized product recommendation system. according to the model under Fig. 2, the mentioned objective is achieved by well profiling the context and the preferences of the user. From the evaluation results obtained, through the system more than 50% of the users are satisfied with the accuracy of showing the preferred categories of the products. Further the system capability of finding the nearest path is also satisfiable according to the Fig. 3. According to the user feedbacks on the questionnaire, information and interface quality and system usability are at a plesent level. Although some of the user contexts and the preference factors have been considered here for the product personalizing, the scope is expected to be expanded to consider on more parameters of each to enhance the accuracy of finding the best product [6].

Here the well-known Global Positioning System (GPS) has been used for user navigation in the outdoor.

For the Sri Lankan situation, the more practical application is to use such a system for outdoor navigation rather than indoor. However, our main idea is to modify this app for indoor navigation as well where inside the shopping mall displays indicate the user status, which is also, in turn, individualize for a large number of users simultaneously.

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