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Personalized local search using ontology based user profile category model

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Abstract

The personalized local mobile search aims at finding the right on the spot information that is most relevant to the user's requests. It is implemented as a mobile application where the user can access nearby places based on his/ her current location. In Today's technology driven world user profiles are the virtual representation of each user and they include a variety of user information such as personal, interest and preference data. These profiles are the outcome of the user profiling process and they are essential to service personalization. The user profile based personalization approach can be applied to enhance the power of mobile local search for local spots and contributes to a significant convenience in location-based mobile searching. The system takes the user information such as personal, health, entertainment and choice of preference and these parameters are passed to Google Maps API key for personalized query processing. As a result, the user will get prominent services rather than closing one.

Keywords: Robot collision, Capacitance sensor, Non–Contact Sensor, Human safety.

1. Introduction

Advancements in the mobile networks and wireless communication technologies are increasing the demands for novel mobile local search for POI services such as listing the business and emergency services beyond voice and text-messaging applications. Mobile local search is rapidly becoming the primary mode to LDIS for user, where user is in unknown places and also in mobility. Recently there has been significant industry activity in the mobile local search with Google and Yahoo as major players within the search engines venture into the mobile sector. These major players generating billions of dollars from online advertising, are racing to bring consumer services like local search and SMS based search to the handheld devices.

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2. Related Work

Combining search technologies and knowledge about user query and user context into a single framework in order to provide the most appropriate answer for a user's information needs, has been described by [1, 2, 3, 5, 8, 7, 6, 9, 14] for local POIs content. Effective personalization of local information access involves two important challenges:

- Analyzing the query to accurately identifying the user intends, and
- Describing the structure of the location dependent POI information in such a way that matches the particular user context

Extracting the user interests and preferences are essential elements in identifying the user context to design the most personalized mobile local search systems employing a user profile modeling component [11] and [12].
Recent research shows that users often settle for the results returned by imprecise queries, picking through them for relevant information, rather than expending the cognitive effort required to formulate more accurate queries. Since the users are reluctant to specify their underlying intent and search goals while on the move, personalization must pursue techniques that leverage implicit information about the user's interests and preferences [1, 10, 11, 12, 13].
A LDIS is designed for retrieving relevant POI services from the location content provider to user by integrating user's physical location, service object's distance from user's physical location and user's search intentions (i.e., keywords, preferences). Users' seamless access to location dependent information through wireless communication is a major concern for providing the efficient local information search to improve the business in m-commerce as discussed by [4, 5, 6, 13]. The major issue in LDIS is to identify and understand what POI being queried by the mobile users, and how to find 'right on spot' information that is most relevant to the request. By considering these issues, an efficient local search process is to be designed to provide the relevant search results to the user's need.
The mobile local search results are primarily based on keyword relevance, distance, and prominence. These factors are combined to find the POI objects for mobile local search query. For example, mobile local search technology might decide that POI object that's farther away from user location is more likely to have what the user is exactly looking for than a POI object that's closer to user location.

Definition 2.1. ***Keyword Relevance***
Keyword relevance is how well a local POI listing matches when user is searching for. Adding complete and detailed POI information can help us better understand POI service objects and match to relevant search results.

Definition 2.2. ***Distance***
The distance is measured as the distance from user's query location to location of POI object. The potential POI search results are displayed based on calculating the distance to the location term used in query. If the user doesn't specify a location in search query, LDIS will calculate the distance based on user's current location.

Definition 2.3. ***Prominence***
This describes how well-known or prominent POI can be. This is based on information stored about POI. For example, famous restaurants, hospitals, or well-known malls that are familiar to many people are also likely to be more prominent in search results.

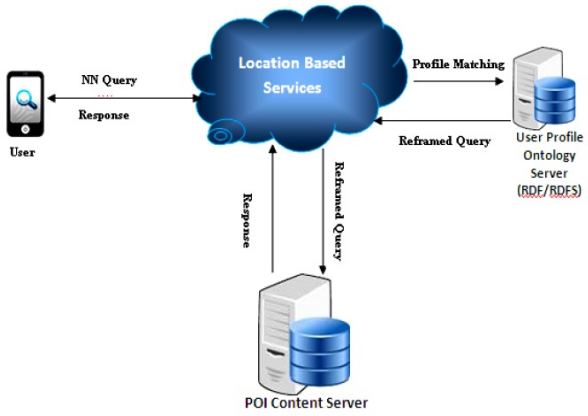

Figure 1: Architecture of User Profile Based Local Search Using Ontology Model

Just using the keyword relevance, distance between POI object and user location and prominence may not provide the most relevant nearest neighbor results based on the user's search query. In order to return the most relevant search results, semantically enriched ontology based user profile category description has been provided and integrated it with the POI content context ontology to perform a variety of tasks: discovery, personalization, adaptation, automatic execution and re-rank the search query results of mobile local search services with maximum degree of user satisfaction.

3. Proposed System

Personalization of mobile local search is a significant area of study in recent years due to the emergence of pervasive computing applications. In this research work, a framework for providing personalized mobile local search services for users in mobile environments has been proposed. The proposed approach uses ontological user profile modeling to capture various characteristics of a user in order to create a unique set of profile category information. In addition, user profiles can adapt to changing user behavior to respond to evolving user needs and preferences.
The proposed personalized search system is collecting preference details from a user/searcher that may make it easier for the personalized search engine to deliver search results to them that more closely match what they may be looking for than from a non-personalized search. Instead of providing details about search query, the proposed system utilizes the kinds of information collected as user preferences and uses it in the system to re-rank search results.

3.1. Architecture of User Profile Based Local Search Using Ontology Model

Figure 1 shows the architecture of user profile based local search using ontology. The mobile user issues a NNQ for local information to the LDIS. LDIS receives the NNQ and sends this to user profile server. A NNQ is matched with the user's profile details available in the server as an ontology representation in the form of RDF/RDFS document and generates a reframed NNQ. The reframed NNQ is sent to the POI content server for retrieving the most relevant POI objects as a response to the NNQ of mobile user.

3.2. Use Case Scenario

The Figure 2 shows the representation of Hospital POI service objects in map. The user issues a NNQ to 'find the nearest hospital' at location U_L, when he has chest pain as shown in Figure 3. The location content server returns the MOSES EYE hospital as point of interest data closest to the

Figure 2: Example Hospital POI objects are listed

user current location U_L. The returned hospital may or may not have treatment facility for a heart problem.

The existing work on the nearest neighbor query returns an irrelevant result which could not be used by the user, when user is in a critical situation to get immediate treatment for heart pain. There is a need for collecting user context to provide most relevant POI from a LDIS server. This implies developing techniques that will integrate detailed knowledge of user profiles, history, needs, and preferences to serve relevant POI data. In this scenario, the irrelevant result was returned due to the lack of information about the user.

User profile is given as an important key to provide intelligent and personalized POI data retrieval by the LDIS. The proposed work focuses on ontology based categorization of user profile into personal, professional, health, entertainment, food and drink, recreation and tourist etc.

If the user information was known, the query for the nearest hospital could have been modified with a few more parameters like "hospitals having cardiac care facilities" depending on the user profile to get relevant search results.

Therefore, the query made by the user can be modified based on his profile. So obtaining user information on his health, entertainment, food, travel etc. preferences, would help us to make a better query to search among the available nearest point of interest.

In this scenario, it is assumed that the user profile has been obtained, which is stored in the User Profile Ontology Server. It is further assumed that the user is a heart patient and he has mentioned his health problem in this profile. Now, when the user issues NNQ to find the "nearest hospital", his profile is matched in the Ontology server and the query is modified as per the user profile to get relevant search results. This modified query is sent to POI content server. By this, user's health profile is matched against these hospitals and the corresponding hospitals are returned as results. This may help people in critical condition for emergency treatment. The resultant procedure would be:

- NNQ by the User – "Nearest Hospitals"
- Modified query (After Obtaining the user profile from the Ontology Server) – "Nearest Hospitals with Cardiac Care"
- POI content server returns the search result, which is more useful to the user than plain NNQ.

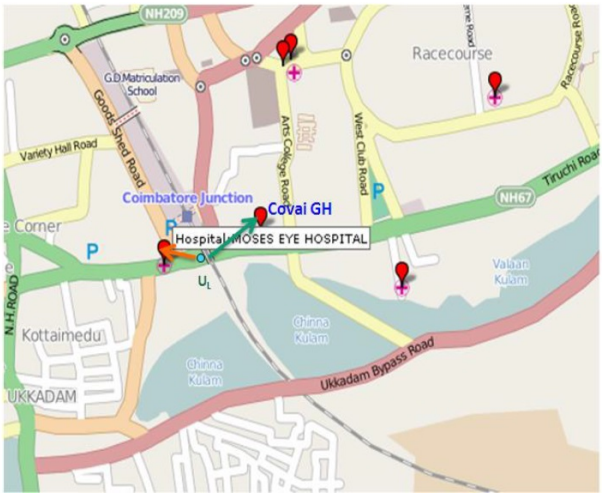

Figure 3: User Query Evaluation using Hospital POI objects

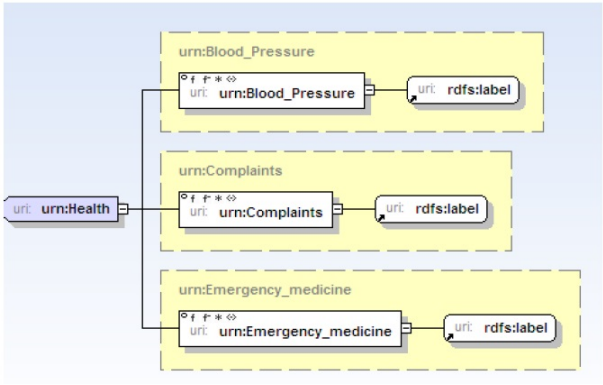

Figure 4: User profile based ontology representation

3.3. Representation of User Profile Ontology

The proposed system is capable of providing two different results to two users asking the same NNQ at the same location and at the same time using ontology based keyword matching and filtering process according to users' profiles categorization. For example, user profile on health category is defined using ontology as follows: Health Profile Category (Health complaints {Heart problem, BP, Ulcer, Sugar}, Emergency medicine {Heart tablet, BP, Sugar, Pain killer}). When a user issues a query for the nearest hospital from the mobile device, the server processes the query by matching the relevant user profile categorization. Depending on the matching keyword in complaints list, LDIS server finds the nearest heart hospital and returns it. User profile based ontology representation is shown as in Figure 4.

The user profile contains all the details that the user would like to share about his preferences. The user profile is represented as a JSON Object having the fields such as names, date of birth, preferences, economic preferences and gender. By having such basic information about the user, the POI results can be filtered. The preferences field comprises of two components, type and a list of subtypes. Suppose the user wants to give his theatre preferences, theatre would be the type and Hollywood; Bollywood etc. would be the sub type.

Economic preference is an extra field which can help us filter the results based on the POI cost; for example, if the user searches for "nearby restaurants", if his economic preference is moderate then we can skip out all the 5 star or costly restaurants from the result set. An example of user

profile is below:

```
{
  "name" : "Jerry",
  "dob" : "Jun26, 19911 : 15 : 16AM",
  "preferences" :
  {
   "health" :
    ["bloodpressure",
    "heartpain",
    "sugar"
    ],
    "food" :
    [
     "vegetarian",
     "southindian"
    ]
     "theatre" :
   [
     "hollywood",
     "bollywood"
   ]
  }
  "economicPreference" : "moderate",
  "gender" : "male"
}
```

By this profile we can tell that Jerry has blood pressure, sugar and his taste of movies is in Hollywood and Bollywood. So when he searches for "nearby theatre" we can modify the query based on his preferences to "nearby theatre, which shows Hollywood and Bollywood movies".

4. Results and Analysis of NNQ Processing in Proposed System

The NNQ processing flow is shown in Figure 5. The proposed framework accepts NNQ and match with user profile based ontology and presents the user with most relevant results which are ranked based on user requirements. Each component involved in the NNQ process flow is described as follows:

A. Query Processor The query processor extracts the keyword from the user query and sends the same to the user profile match processor. For example, 'what is the nearest hospital', the keyword 'Hospital' is extracted from the user query and sent to user profile match processor.

B. User Profile Match Processor The user profile match processor matches the keyword with the user profile categories; for example, the keyword 'Hospital' is matched with the health category. Similarly the keyword 'Restaurant' is matched with the food preference category. Such cases, if the health profile contains 'Heart Complaints', then the query is reframed as 'what is the nearest heart specialty hospital'. Based on the reframed query, POI objects categorized under 'Heart Hospital' are retrieved.

C. Extended Semantic Matching The extended semantic matching is used to retrieve the semantically related POI objects. For example, POI objects with the keywords 'Multispecialty' or 'Poly Clinic' is also retrieved since they are semantically related.

D. POI Objects Similarity Computation The similarity among the retrieved POI objects is computed using ontology matching. For example, POI objects related to the keyword 'Hospital' is mapped with the health ontology. The similarity computation among all POI objects is computed based on reframed query. For example, if the modified query is "heart hospital", then the similarity computation of all POI objects is computed with health ontology.

E. Ranking of POI Objects Based on the similarity computation, the top ranked POI objects will be returned to user. Here the number of results 'k' can also be fixed based on the nature of query. If it is an emergency service the size of 'k' can be small and in case of other services like entertainment the size of 'k' can be large.

F. Personalized Search Results The prototype model of personalized mobile local search based on ontology user profile is developed and model setup is tested with search results.

4.1. Restaurant Search

When a user in a particular location searches for the nearby hotel, the ones which are assumed to be near are displayed. The result is based on the user's search location and the food and cost preference provided by the user. The hotels include all the veg and non-veg restaurants as they are looking for high quality or not, all gets included in it.

The price preference is the major criteria for showing the appropriate hotels and blocking the remaining. The users are even asked about their preferences of food like vegetarian or non–vegetarian or others and their restaurant preferences like cuisine, multi-cuisine, fine or casual dining. The food categories include traditional, chettinadu, chinese and continental. Resulting POIs are populated in the map by providing closest hotels. The google maps are integrated along with the result, so the user can also view the direction, distance, time takes to reach the hotel and so on and it is shown in figure 6.

4.2. Hospitals Search

The user searches for the hospital with the particular keyword, only those intended hospitals will be displayed. The keyword includes cancer, spleen, and dental, eye, and acupuncture and so on. If the user does not need any kind of specialized hospital, and he/she just want to visit the hospital, then all the hospitals around him/her will be displayed. If the user needs to find out only on the preference, then right service is returned as right spot POIs.

The hospitals which matches with the keyword and those are nearby are displayed. Once the hospitals are displayed, if the user wants to find out the direction, time takes to reach the destination or the distance, it can be done since it is integrated with the google maps as shown in figure 7.

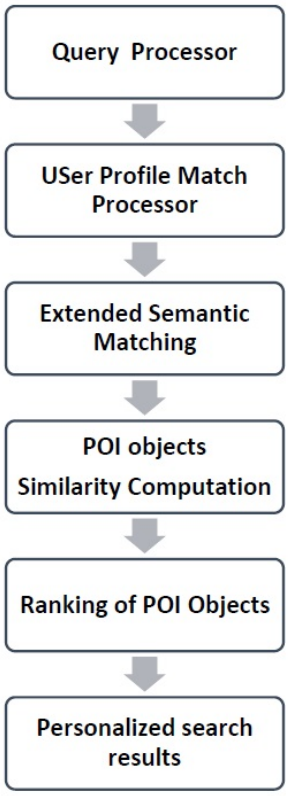

Figure 5: NNQ processing using user profile ontology

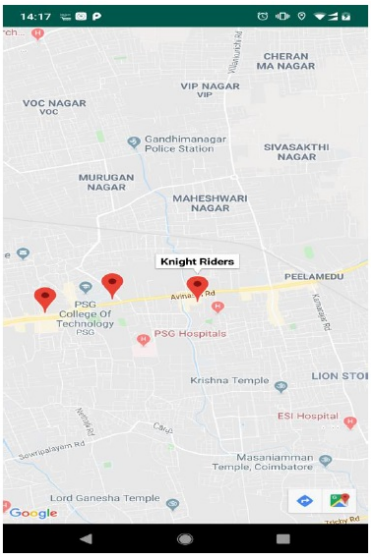

Figure 6: nearby restaurants

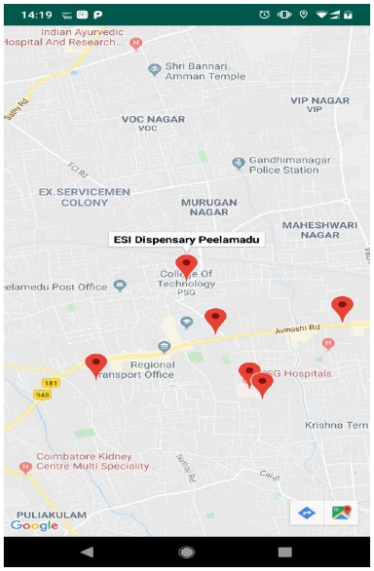

Figure 7: nearby hospitals

The results returned to the mobile user are based on the user profile and hence it is called personalized search results. The retrieved results are much relevant to user needs when compared to the results without matching user profile.

5. Conclusion

The objective for collecting user profile and preferences is studied and an ontology-based user profile preference framework is designed for discovering the most relevant points of interest services with respect to user preferences. LDIS is also needed to consider the interactions and dependencies among services, user and context for the information filtering and delivery in order to fulfill the needs and constraints of mobile users.

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