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Intelligent Mobile Search Oriented to Global e-Commerce

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***Abstract*—**In this paper we propose a novel approach for searching eCommerce products using a mobile phone, illustrated by a prototype eCoMobile. This approach aims to globalize the mobile search by integrating the concept of user multilinguism into it. To show that, we particularly deal with English and Arabic languages. Indeed the mobile user can formulate his query on a commercial product in either language (English/Arabic). The description of his information need on commercial products relies on the ontology that represents the conceptualization of the product catalogue knowledge domain defined in both English and Arabic languages. A query expressed on a mobile device client defines the concept that corresponds to the name of the product followed by a set of pairs (property, value) specifying the characteristics of the product. Once a query is submitted it is then communicated to the server side which analyses it and in its turn performs an http request to an eCommerce application server (like Amazon). This latter responds by returning an XML file representing a set of elements where each element defines an item of the searched product with its specific characteristics. The XML file is analyzed on the server side and then items are displayed on the mobile device client along with its relevant characteristics in the chosen language.

***Keywords*—**Mobile computing, search engine, multilingual global eCommerce, ontology, XML.

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I. Introduction

THE mobile world is growing at an astonishing rate. In 2004, the number of mobile users worldwide reached 1.52 billion, 2.7 billion at the end of 2007 and according to Nokia, it's predicted that by 2009 this number will exceed 3 billion. The world market for mobile marketing and advertising is expected to be worth about $3 billion by the end of 2007, according to *ABI Research*[1]. By 2011, the value of this market will reach $19 billion, including mobile search and video advertising. According to *Madar Research*[2], in Arab world, mobile subscription grew from 51.19 million by end 2004 to 87.06 million by end 2005, exceeding all expectation and forecasts. By year 2008, *Pyramid Research*[3] forecasts 100 million mobile subscribers in the region, with five mobile operators exceeding $1bn in revenue.

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[1] http://www.abiresearch.com/
[2] http://www.madarresearch.com/
[3] http://www.pyr.com/

Mobile search is quickly becoming the primary mode to information access for users as it has been in World-Wide Web. Recently there has been significant industry activity in the mobile search space with major players within the search engines venturing in the mobile sector. Google and Yahoo which generates billions of dollars from online advertising, is racing to bring consumer services like local search and SMS-based search to the phone [1, 2, 3]. Ask.com[4] developed a wireless search application and recently integrated voice recognition feature into it. A number of mobile-specific search services have also come to the market including Mooobl[5], 4info[6] and Technorati[7] Mobile.

A mobile device is characterized by its limited power availability, its limited processing capacity, its minimum display screen and its constrained keyboard/mouse operations. Indeed all these problems combined together reduce usability and paradoxly[8] limit the user in "space and time". In [4] we found that 80% of small screen users begin their task with the search function of the particular website and were twice as likely to use search function compared to large screen users and less likely to browse websites to find the desired information. Clearly improving the ease of searching of information can dramatically improve the efficiency of searching of information on websites. Previous works have focused on easing text input with pen with auto-completion and keyword suggestions [5]. In [6] a mobile search by enabling the use of spoken queries is discussed and in [7] a framework for mobile web search is proposed that is based on iconized concept trees. In [8] the authors propose a framework of mobile search based on navigation and selection of hierarchical metadata (facet navigation) with incremental text entry to further narrow the results.

Our objective is to propose a globalized mobile search approach optimized to eCommerce context and a prototype to illustrate that, called eCoMobile. This approach presents a user interface to submit a query that relies on the ontology [9, 10] defining the knowledge domain of commercial products catalogue. Indeed the user can express his query by entering

[4] http://www.ask.com/
[5] http://www.mooobl.com/
[6] http://www.4info.com/
[7] http://www.technorati.com/
[8] Indeed a mobile device is supposed to free the user of the constraint of space and makes him organizing his time efficiently.

the name of the commercial product. A list of the corresponding properties is then suggested to the user who selects a property and assigns to it, a value. This operation is suggested while the user wants continue refining the specification of his targeted product. Afterward the formulated query is send to a server that is in charge of analyzing it and performing an http request to an eCommerce application server. The server is also in charge of analyzing the XML-based response replied from the eCommerce application server. In fact it extracts the relevant information corresponding to the searched product and communicates them to the mobile client which in its turn displays them conveniently. Our mobile search framework aims to satisfy globalization. Indeed it is oriented to English and Arabic spoken users.

The remaining of the paper is organized as follows. In the next section we present the general model of our mobile search framework eCoMobile and in Section 3 we discuss how the query is formulated based on the ontology of eCommerce products as well as its analysis on the server side. In Section 4 we discuss the execution of the retrieval procedure and how retrieved information is analyzed, filtered in the server and displayed on a mobile device. Finally, in Section 5, we sketch some concluding remarks.

II. PROPOSED MOBILE SEARCH MODEL: ECOMOBILE

Basically the search engine relies on information retrieval (IR) foundations [11, 12, 13]. The IR process consists of two steps: 1) the conceptualization and 2) the retrieval. In the conceptualization step, the user tries to represent his information need using the query syntax. The retrieval step consists in executing the query against an information repository by matching as perfectly as possible the query with the existing information resources.

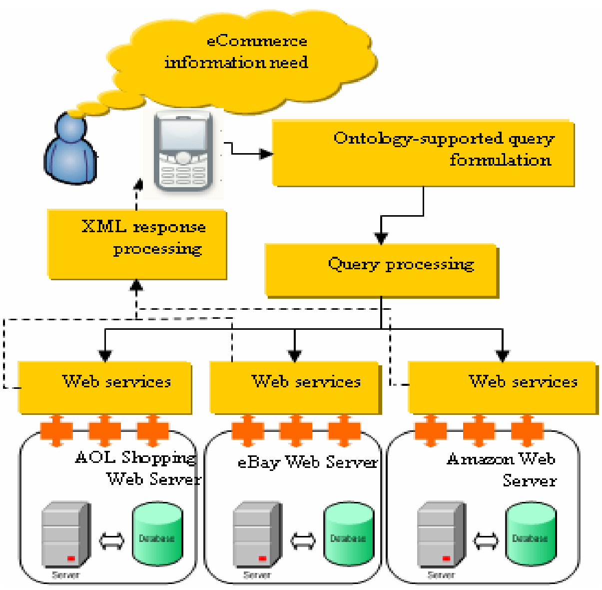

Fig. 1 A schematic description of eCoMobile information retrieval process

In the conceptualization phase, the user tries to approximate his need in a query, usually represented as sequence of terms. This step usually causes ambiguities that appear in a retrieval process. So in order to introduce structure and more precision in the formulation of the information need we use the notion of knowledge domain ontology [14, 15]. This permits to express the query as a set of concepts associated with their corresponding properties. Here, in our case, the knowledge domain is the eCommerce and the knowledge base is the product catalogue [16, 17, 18]. For simplicity we focus on Amazon product catalogue, but this can easily be extended to other product catalogues. We should note that in addition to the notion of semantic brought by ontology representation [14]. This data representation has the ability to overcome some limitations that characterize mobile environment like the limitation of power availability, limitation of processing capacity, the small size of display screen and the constrained keyboard operations. Indeed when the user submit precisely his query we gain in time processing and hence in power consumption. In the same time the amount of effort required to enter the query in a mobile phone is reduced since the user is guided[9] by the ontology representation of the commercial product. The positive impact of ontology representation w.r.t. the limitation of display screen is showed next when we deal with the response of the search operation.

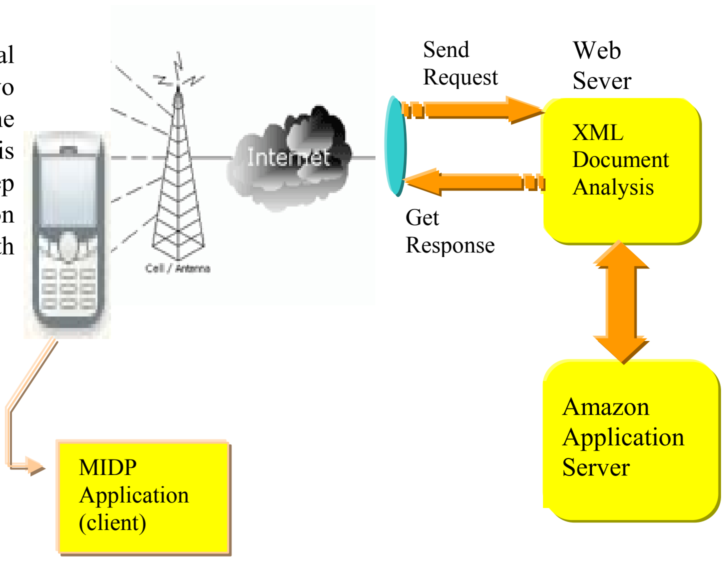

Fig. 2 A detailed description of eCoMobile information retrieval process

In our model (pointed out in Fig. 1) the user formulates his query as a concept followed by a set of attribute-value pairs specifying the constraints on the concept which is then interpreted as query executed on different eCommerce databases (Amazon, eBay etc). This data retrieval is performed by executing an http request including the name of the commercial product along with the specification of its

[9] Guidance based on ontology representation of knowledge domain may be viewed as an extension of Tegic's T-9 predictive entry system.

properties and their values, on the eCommerce application server. A more detailed information retrieval process is illustrated in Fig. 2.

A. *OWL Ontology Design of AMAZON Product Catalogue*

Ontology is defined as a formal specification of a shared conceptualization of some domain knowledge [16, 17, 18]. "Formal" refers to the fact that the ontology should be machine-readable (in other words it's described using a formal language such as RDF [19], DAML-OIL [20] and OWL [21]. "Conceptualization" refers to the fact that the knowledge domain is described as an abstract model where the main entities are represented as concepts with properties. "Shared" reflects the notion that ontology is not private and can be reused in other ontologies to define other concepts. In an ontology, concepts are organized using an inheritance relationship.

Our ontology is described using OWL-Lite language [21]. A typical entry for a concept is:

TABLE II
A CONCEPT

ID	Video
Label lang="en"	a video product
Label lang="ar"	فيديو
Subclassof	Entertainment

Where ***ID*** is the concept unique identifier, ***Label*** is the human readable name of the concept defined in both English and Arabic languages; subclassof indicates the relation to another class.

TABLE III
A RELATIONSHIP

ID	directedBy
Label lang="en"	directed by
Label lang="ar"	الذي أخرجه
Domain	Video
Range	Director

Table III describes the notion of the relationship or the property of the concept that is identified by the element ***ID***. ***Domain*** and ***Range*** contain the two concepts related to the described binary relation. Similarly to the definition of the concept, ***Label*** is the human readable name of the property. It's defined in both English and Arabic languages.

In Fig. 3, we show a snippet of the Owl-lite specification of the video product, that is a subclass of the entertainment product. The concept "Video" has two properties, namely "directedBy" and "withActors" whose the labels are expressed in both English and Arabic languages. "directedBy" has a type "Director" and it has no more than one value for each individual "Video". "withActors" indicates the actors that appear in the video product.

```
<owl:Class rdf:ID="Video">
<rdfs:subClassOf>
<owl:Class rdf:ID="Entertainment"/>
</rdfs:subClassOf>
<rdfs:label xml:lang="ar"> إنتاج فيديو </rdfs:label>
<rdfs:label xml:lang="en">a video product</rdfs:label>
</owl:Class>
<owl:FunctionalProperty rdf:ID="directedBy">
<rdfs:domain rdf:resource="#Video"/>
<rdf:type rdf:resource="../owl#ObjectProperty"/>
<rdfs:range rdf:resource="#Director"/>
<owl:inverseOf>
<owl:InverseFunctionalProperty rdf:about="#directed"/>
</owl:inverseOf>
<rdfs:label xml:lang="en">directed by</rdfs:label>
<rdfs:label xml:lang="ar"> الذي أخرج من طرف </rdfs:label>
</owl:FunctionalProperty>
<owl:ObjectProperty rdf:about="#withActors">
<rdfs:label xml:lang="ar"> مع الممثل </rdfs:label>
<rdfs:range rdf:resource="#Actor"/>
<owl:inverseOf rdf:resource="#whoActedIn"/>
<rdfs:domain rdf:resource="#Video"/>
<rdfs:label xml:lang="en">with actors</rdfs:label>
</owl:ObjectProperty>
```

Fig. 3 A snippet of Owl-lite specification of a video product

III. Query Formulation

The mobile user is guided in his query formulation by relying on the ontology of product catalogue. Assume that he is searching information about a video product so when inputting the name of that product (see Fig. 4), the system interactively presents a list of options including the option of refining the specification of the commercial product (as show in Fig. 5-top/left).

Fig. 4 Query Definition

When the user selects the option of product specification refinement, the system suggests a list of properties, expressed in a natural language, which corresponds here to the video product, namely: “directed by”, with actors”, “sold by”, “with maximum cost” etc. as shown in Fig. 5-top/right. The mobile user selects a property and then assigns to it, a specific value. In our example here, the user precise the video director “David Lean”, that represents the value of the selected property “directed by” (see Fig. 5-down/left).

The set of products can be refined by selecting additional properties with specific values. Like here in our example, we can repeat the refinement process by selecting the actors that appear in the video. Finally the request defined by the mobile user is: searching a video product of a movie that was directed by “David Lean”, and where the actor “Omar Sharif” plays in that movie (see Fig. 5-down/right). The other properties are naturally omitted in the searching.

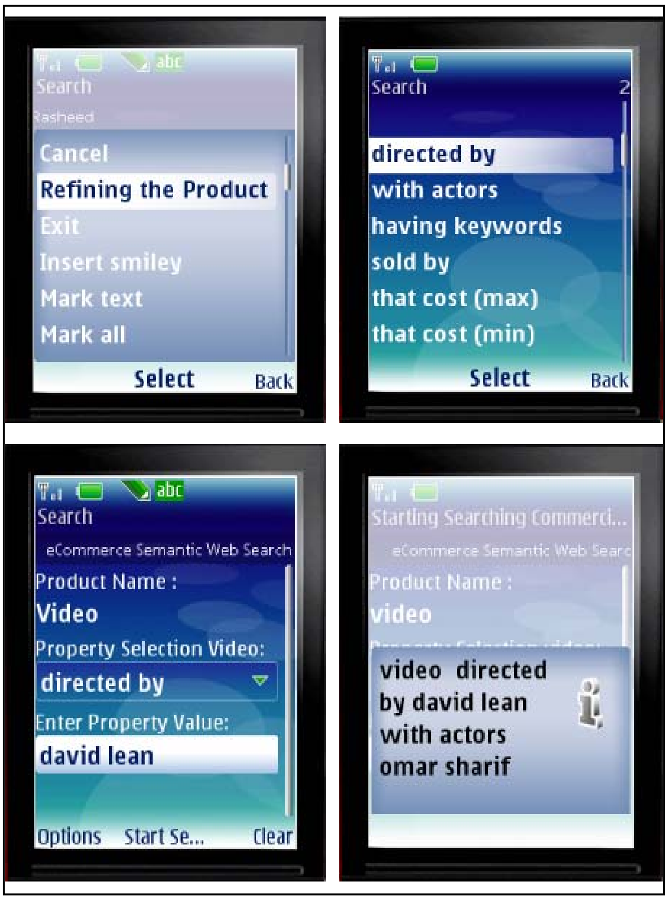

Fig. 5 Refining the query definition

The Arabic version of that query is: (1)

“omar sharif” مع الممثل “david lean” الذي أخرجه فيديو

property property concept

Notice that the values assigned to the properties in the Arabic query are not expressed in Arabic due to the fact that unfortunately the Arabic version of eCommerce Amazon Website does not exist. The process to define the query (1) in Arabic language is illustrated in Appendix A, Fig. 7. Next we explain how we analyze, execute the query and display the response in English and Arabic languages.

IV. Query Execution and Response Display

Once we define the query in the mobile phone, the system transmits it to a server where it is analyzed. A servlet component extracts the name of the searched commercial product, its properties and their corresponding values. Then the system on the server side invokes an operation of a Web service on Amazon Web Service for eCommerce (AWSE) Application Server. AWSE provides different search operations, particularly “ItemSearch” which returns information on the products, matching the specified criteria. Searches can return no data (if nothing matches the criteria specified) or multiple objects. The execution of the Web service is performed via an http request as illustrated below.

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http://Webservices.amazon.com/onca/xml?Service=AWSECommerceService
&AWSAccessKeyId=1D8MP3J2YET4JDXYHZG2
&Operation=ItemSearch
&SearchIndex=video
&Director=david%20lean
&Actor=omar%sharif
&ResponseGroup=Medium

This represents an interpretation of the query formulated above which consists in an invocation of Amazon Web service using the communication service REST. This service executes the operation “ItemSearch” with the following parameters:

1. AWSAccessKeyId: represents the access key ID which is assigned after signing up to use the Amazon Web services.
2. SearchIndex: tells the *ItemSearch* operation what type of product to search for. For this example the product is a video.
3. Director and Actor are instantiated with the value “david lean” and “omar sharif” respectively.
4. ResponseGroup: controls how much and what kind of data are returned. In this case it’s set to “Medium” which means that the response must contain all of the arguments passed in the service call in addition to other information like URL address, the offer summary, the product image and editorial review. All these information are returned in XML file.

The XML-based response returned to our server represents a collection of items, where each item corresponds to the searched commercial product with its specific characteristics. A servlet component on the server is in charge to analyze the XML file, extract the relevant information and return that to the client side that is the mobile phone. Among the set of information returned by AWSE, we selected as relevant to display (see Fig. 6): the title of the video, the list of actors playing in the movie, the Amazon price of the video, the price of used video, its availability, the customer review and the image of the video product corresponding to one item.

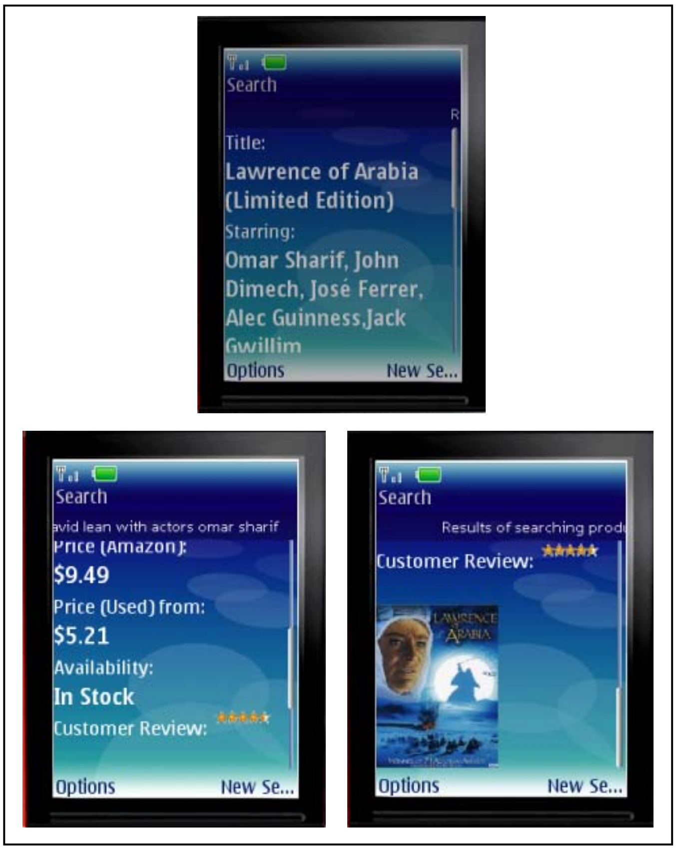

Fig. 6 Displaying the response of the query

V. Conclusion

In this paper we presented and idea and its prototype eCoMobile of English/Arabic mobile search framework optimized to eCommerce. This provides user assistance to formulate the query in both natural languages (English and Arabic). The query guidance is based on the ontology conceptualizing the commercial product knowledge domain. Indeed a query represents a concept that represents the name of the product and a series of pairs of property/value that characterize precisely the searched product. This feature remedy to the limitations that characterize mobile phones like their input limitations, power availability and processing capacity limitations. Indeed when the information need is expressed structurally and precisely, less effort in entering the query is furnished. In other sense, to get relevant response, one enters only relevant words in a query and in addition to that he carries out less session than in the classic search. Ontology may be viewed as a semantic extension of Tegic's T-9 predictive system. Consequently the mobile user consumes less processing time and less power capacity.

eCoMobile information retrieval procedure is executed in a server, that invokes the search operation of a Web service offered by e-commerce application servers for instance here, Amazon application server. This invocation is based on REST communication technique. The fact that the retrieval procedure is delegated to a server; this discharges our mobile client and hence saves its power capacity. The response returned by Amazon application server is in a XLM-based format and this permits to us to filter the response and display only the important information fields. And therefore this remedies to the small size of display screen of the mobile phone.

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APPENDIX

Fig. 1 Defining and refining a query in Arabic language

Fig. 2 Displaying the result of a query in Arabic language