

# Keyword-Based Language for Mobile Phones Query Services

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## INTRODUCTION

A mobile system is a communications network in which at least one of the constituent entities—that is, user, switches, or a combination of both—changes location relative to another. With the advancements in wireless technology, mobile communication is growing rapidly. There are certain aspects exuded by mobile phones, which make them a high potential device for mobile business transactions. Firstly, there is a growing statistic on the number of users who own at least one mobile phone. In 2003 alone, the numbers of mobile phone users were as high as 1.3 billion, and this number is growing steadily each year. Secondly, more and more mobile phones are equipped with much better features and resources at a considerably lower price, which make them affordable to a larger number of users. And thirdly, and most importantly, the small size of mobile phones makes them easily transportable and can truly be the device for anywhere and anytime access (Myers & Beigl, 2003).

Database querying, which is the interest of this article, is a kind of business transaction that can benefit from mobile phones. In general, database querying concerns the retrieval of information from stored data (kept in a database) based on the query (request) posed by the users. This aspect of the database transactions had been the focus of many database researchers for a long time. The mobile phone aspect of the transaction had only recently gained interest from the database communities, and these interests were mainly targeted to the “fatter” mobile devices. The work on mobile database querying can be grouped into those focused on the technology and techniques to handle the limitations of the mobile transmissions due to the instability of the mobile cellular networks, which were concentrated on developing applications that involved access to databases for the mobile environment, and those that handled both of the above issues. For example, caching (Cao, 2002) and batching (Tan & Ooi, 1998) are some of the popular techniques that were and still are investigated in detail to handle the problems of the mobile transmissions. On the other hand, Hung and Zhang’s (2003) telemedicine application, Koyama, Takayama, Barolli, Cheng, and Kamibayashi’s (2002) education application,

and Kobayashi and Paungma’s (2002) Boonsrimuang transportation application are some examples of the work on mobile database application. These works were observed to be application-specific and supported a very limited and predefined number and type of possible queries. Each of the possible queries, in turn, requires several interactions with the server before a full query can be composed.

This article will highlight the framework opted by the authors in developing a database query system for usage on mobile phones. As the development work is still in progress, the authors will share some of the approaches taken in developing a prototype for a relationally complete database query language. This work concentrates on developing an application-independent, relationally complete database query language. The remainder of this article is organized as follows. The next section presents some of the existing work related to the study. We then introduce and describe the framework undertaken in order to develop a database query system for mobile phones, and discuss the prototype of the database query language used by the system. We end with our conclusion.

## RELATED WORK

Query languages are specialized languages for asking questions, or queries, which involve data in a database (Ramakrishnan & Gehrke, 2000). Query languages for relational databases originated in the 1970s with the introduction of relational algebra and relational calculus by E.F. Codd. Both relations are equivalent in their level of expressiveness or query completeness. These two formal relations had interchangeably been used as the benchmarks for measuring the completeness of the later query languages. Codd originally proposed eight operations to be included in the relational algebra, but out of the eight, five were considered fundamentals as they allowed most of the data retrieval operations. These operations are known as selection, projection, cartesian product, union, and set difference. If a query language supports the five operations, then it is considered as being relationally complete (Connolly, Begg, & Strachan, 1997). Throughout

the years, several other measures of query completeness were proposed such as datalog, stratified, computable, and others (Chandra, 1988). However, in the authors' opinion, these later measures might be too extensive to be considered for mobile phones and their users' application.

Although both relational algebra and relational calculus are complete, they are hard to understand and use. This resulted in a search for other easy-to-use languages that are at least compatible to relational algebra and calculus. Some of these query languages are transform-oriented non-procedural-based languages, which use relations to transform input data into required outputs. Structured Query Language (SQL) is an example of such a language. Besides non-procedural languages, visual query languages have also gained much acceptance in the database community. Some of the work on visual query languages found in the literature, such as Czejdo, Rusinkiewicz, Embley, and Reddy (1989), Catarci (1991), and Polyviou, Samaras, and Evripidou (2005), used the entity relationship diagram and other data modeling as the basis for query formulation, and some used icons to present pre-defined queries (Massari, Weissman, & Chrysanthis, 1996). Query languages are textual languages that caught the interest of some database query language researchers. Some of these languages were represented in the form of natural language (Kang, Bae, & Lee, 2002; Hongchi, Shang, & Ren, 2001), and some were represented in the form of keywords (Calado, da Silva, Laender, Ribeiro-Neto, & Vieira, 2004; Agrawal, Chaudhuri, & Das, 2001). This type of languages is less restrictive compared to the other types of languages. However, they need extra work in approximating the meaning of the terms or keywords used in a query. Thesaurus and ontology are few approaches used to approximate meanings of terms or keywords (Kimoto & Iwadera, 1991; Weibenberg, Voisard, & Gartmann, 2006) in this type of query language.

Even though each type of query language mentioned above has its own advantages, very few of them, except for Polyviou et al. (2005) and Massari et al. (1996), were tested on small devices. SQL, for example, would be too tedious to be entered using mobile phones and too complicated for ordinary users. Visual query languages, on the other hand, would require considerable screen space as well as resource consuming in order to be rendered. Natural language and keyword language would also be difficult to be textually keyed in using mobile phones. There were, however, attempts to use spoken method for query languages (Chang et al., 2002; Bai, Chen, Chien, & Lee, 1998). But this approach leads to another problem in matching the intonation of users. The textual form of query languages (keyword method in particular) might be the most suitable language to be used on mobile phones since they are the least resource consuming and easily extensible. However, there must be a method to ease the input part of the query formulation process. To date, the authors have not been able to find any publication

of the investigations of the same method as applied to mobile phones. Therefore, we believe that the keyword-based language is worth some investigation.

## **Framework Model**

Polyviou, Samaras, and Evripidou (Kang et al., 2002) laid down several challenges that must be dealt with in order to develop a modern search interface. The challenges specified were: the search interface must be usable, powerful, flexible, and scalable. These challenges are adopted in our approach while developing the database query system for mobile phones. The concept of usable is implemented in our design by providing a language that supports menu-based guidance for the users to form valid queries. The concept of powerful is implemented by making sure that the language is relationally complete. The concept of flexible, on the other hand, is implemented in the language by allowing the language to work with any type of relational databases and any type of applications. Finally, the scalability aspect is handled by allowing the language to accept a database of any size, but at the same time filtering the data to be presented to the users according to some form of user grouping and access patterns. The keyword-based language is developed to answer the above challenges. The reasons for choosing such a language, among others, are due to the ability of such a language to present complex relationships with a minimal number of keywords, and it takes lesser space for presentation. For example, it is possible to access information from two indirectly linked relations, no matter how far apart the relations might be, by simply providing the name of the two relations as query keywords. This ability makes the language scalable and easily extensible. However, keyword-based language does have constraints. Firstly, it is in textual form and therefore is tedious and prone to typing error. Secondly, it requires users to have exact knowledge of the keywords to be entered in order to form valid queries. Therefore, the authors have modified the keyword-based approach by providing users with selectable keywords in a menu form. This approach has another advantage: it allows users to point and click the keywords needed without having to type them manually, which is a way to handle the input mechanism problem of mobile phones (most phones only have keypads as an input mechanism). This approach requires lengthy display space, which is lacking for mobile phones. Therefore, the authors intend to handle this problem by providing only selected keywords to users based on their personal profiles and preferred queries. Figure 1 shows the general framework of the query language, and Figure 2 shows the position of the query language with respect to the rest of the whole database query system. As shown in both figures, the query language basically resides in two locations: in the mobile phones as the query interface, and in the application server as the query engine that transformed the keyword

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