ABSTRACT

The demand of mobile technology is growing and mobile information services including the gathering of information and manipulating them are also becoming more critical in the world of mobile technology. These allow mobile users to download useful data, possibly from multiple sources. In this article, we introduce two basic mobile query processing: (i) mobile device side processing (MDSP), and (ii) server side processing (SSP). Our focus in this article is on performing relational division and multiple division operations using both MDSP and SSP techniques. In addition, walkthrough examples are also illustrated. A series of performance evaluation of our proposed techniques are presented and analyzed. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: Database; Mobile Databases; Mobile Technologies; Query Processing

INTRODUCTION

Mobile technology has been increasingly in demand and is widely used to allow people to be connected wirelessly without having to worry about the distance barrier (Waluyo, Srinivasan, & Taniar, 2005c,d; Bohl, Manouchehri, & Winand, 2007). This new technology enables users to access information anytime, anywhere. Mobile devices are capable of processing and retrieving data from multiple remote databases (Lee, Zhu, & Hu, 2005). This allows mobile users who wish to collect data from different remote databases by sending queries to the
servers and then be able to process the multiple information gathered from these sources locally on the mobile devices (Lim, Taniar, & Srinivasan, 2005). By processing the data locally, mobile users would have more control of what they actually want as the final results of the query. They can therefore choose to query information from different servers and join them to be processed locally according to their requirements. Also, being able to obtain specific information over several different sites would help to optimize results to mobile users’ queries, as different sites may give different insights into a particular issue.

In order to derive and assemble data from several servers in a mobile device, a new research domain known as **Mobile Query Processing incorporating Multiple Non-collaborative Servers** has arisen (Lim, Taniar, & Srinivasan, 2005). Since servers may be just independent service providers, often these servers are specialized within the domain. Hence, the information they are providing, such as information on restaurants disseminated by a server, normally just focuses on the restaurants information with perhaps additional limited supporting information which might include how to get there (e.g. information about transportation). However, this is only supporting information since it does not exactly show the route that the user should take from his present location. Therefore, there is still a need to obtain full information from multiple servers, in this case, the servers that deal with restaurants and transportation separately.

**Example:** An international tourist, while traveling in a foreign country, does not know the whereabouts of the available vegetarian restaurants. He looks for restaurants recommended by both the Tourist Office and Vegetarian Community. First, using his wireless PDA, he would download information broadcast by the Tourist Office (Gulliver, Ghinea, & Patel, 2007). Then, he would download the information provided by the second organization mentioned above. Once he has obtained the two lists from the two information providers that may not correspond to each other, he may perform an operation on his mobile device that joins the contents from the two related providers.

This example illustrates the importance of being able to collate, in a mobile device, information obtained from various non-collaborative sources. In addition, not all service providers are supported by the use of a mediator. Therefore, information obtained from other independent non-related service providers needs to be processed individually. It should not be assumed that every service provider is linked through a mediator. Hence, in our research we focus on non-collaborative service providers and we refer to them as independent servers. Thus, it is vital to gather information from independent servers because it is often not enough to obtain data from just a single server.

This article focuses on a query type, called **division**, which is common in relational databases (Elmasri & Navathe, 1994). Division is even more common in mobile query processing involving multiple non-collaborative servers. In this article, we particularly focus on two types of division queries, namely: (i) relational division, and (ii) multiple group division. While relational division is already common traditionally in relational databases, multiple group division is a novel query type (Taniar & Rahayu, 2002a, 2002b). In this article, we proposed a number of algorithms to process these query types.

Division query processing is a powerful concept for querying databases, which enables a database system to evaluate complex “for-all” predicates (Elmasri & Navathe, 1994). This is also known as the universal quantification query and has been neglected in past research even though the power of universal quantification and relational division enables the analysis of many-to-many relationships and set valued attributes. The same goes for queries within the mobile environment. This type of division query processing appears to be useful and appropriate in certain circumstances and therefore is vital to explore its potential use in the mobile environment.

The rest of this article is structured as follows. Firstly, we review mobile database environment and the basic of mobile query pro-
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