

Poster Abstract: A Declarative Interface for Smart-phone Based Sensor Network Systems

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ABSTRACT

Resource constrained traditional sensor network platforms contain so many limitations while modern smart-phone platforms are highly resource rich with increasing sensing capabilities. Therefore smart-phone platforms can be used for implementing sensor network applications but good application development interfaces are necessary.

We present an implementation of a SQL database abstraction layer for smart-phone based sensor networks where application developers can write applications to interact with large number of smart-phones in a network using SQL queries.

Categories and Subject Descriptors

H.m [Information Systems]: Miscellaneous

General Terms

Experimentation, Design

Keywords

smart-phone, wireless sensor networks, database abstraction

1. INTRODUCTION

Traditional wireless sensor networks (WSN) involve highly specialized hardware and software platforms to implement their functionalities. Typical WSN deployments have the sensor nodes spreading over large geographical areas, where an individual node of the network is unreachable or hard to reach [4]. Because of this nature, WSNs are having their own weaknesses and challenges to be solved. A sensor node is a resource constrained device from almost all the aspects including memory capacity, CPU power, energy source and even in communication range.

Modern day smart-phones contain nearly the capabilities of a desktop PC which are used for applications like web browsing, gaming and social networking. All these capabilities became possible because of the resource richness of current smart-phone devices. In addition to powerful CPUs and large memory capacities, almost all commercial smart-phones are coming with an attractive number of different sensors enabling them to be aware of the environment. This resource richness has enabled smart-phones to be used in sensor networks from recent time. Even though

we have to accept the fact that there are WSN applications where smart-phones are not a feasible alternative to traditional hardware, we can find various applications in which smart-phone based sensor networks are applicable like human-centric scenarios.

Since WSNs involve a large number of nodes, application developers face the difficulty of handling them in the WSN and at the same time the large amount of data. Therefore it is hard for mobile application developers to write useful sensor network type applications taking the advantage of sensing capabilities of smart-phones. In this situation, we identified the requirement of having a developer-friendly interface for smart-phone based sensor networks.

Considering the traditional WSN approaches [3, 2] we implemented a software framework that provide an SQL abstraction layer to smart-phone based sensor networks. The advantage of considering network as a database is the declarative structured query language (SQL) available to acquire data on top of the relational model. We adapted the acquisitional query syntaxes in TinyDB [3] because of the proven functionality of them in the real world applications.

The interconnection between smart-phones is built using a peer-to-peer network based on distributed hash tables (DHT). Node failures and other network level issues are handled by P2P protocol releasing the user application from worrying about them. Our prototype implementation is done on Android mobile operating system with the help of TomP2P [6], a DHT based P2P networking library.

The prototype implementation provides an Android service class which has functions like initiate a WSN, join to an existing WSN, send queries to a WSN and leave a WSN. A simple SQL parser is included to parse user queries and generate query packets before sending them to the other nodes of the network. These query syntaxes are almost similar to TinyDB [3] queries such as Query:1 given below.

Query:1

```
SELECT nodeid, loc, accelx, accely, accelz
FROM sensors
WHERE accelx > 5 AND accely > 5 AND accelz > 5
SAMPLE PERIOD 1 FOR 10;
```

Developers can use this activity class to implement sensor networks in their applications. For evaluating the functionality of this declarative interface, we wrote a simple sensor network application named as *mTikiriDB* using our prototype interface. *mTikiriDB* has a simple user interface (UI) on an Android smart-phone which provides the necessary

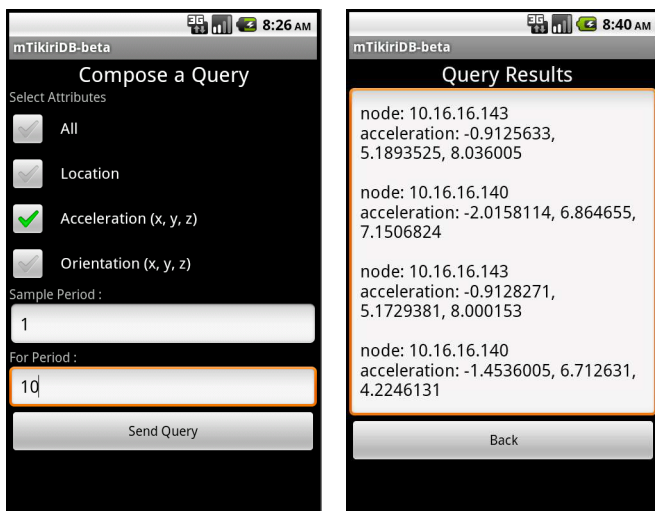


Figure 1: Querying and receiving data

functionalities for its user to be a part of a sensor network system.

Although our Android service class accepts user queries only as SQL query strings, *mTikiriDB* application provides two ways of querying the network. First way is allowing the user to simply type SQL queries on screen of the smart-phone and send to the network. The second way is providing some UI controls to express the criteria of data acquisition graphically. Even though the second way is easy to use, the first method provides the real advantage of SQL interface to the end user since he or she can specify even a very complex data acquisition criteria by typing it as an SQL string.

When *mTikiriDB* application receives queries from other smart-phones of the network, it acquire and send data as a result packet to the query originator node. The *mTikiriDB* application running on query originator node displays the received results. Fig: 1 shows the *mTikiriDB* user interface. This functionality can be extended to store the received data on the smart-phone itself for future manipulations if necessary.

2. DISCUSSION

The *mTikiriDB* application demonstrates the basic functionalities which are necessary in a typical smart-phone based sensor network. We believe that smart-phones will be the next generation of sensor network hardware platforms because of the increasing capabilities and user base we can observe in the domain. There are various kinds of possible sensor network applications that can be developed using smart-phones. For example, when groups of people contribute to a field work like fire services, search and rescue operations etc, interconnecting each person to a network so that everybody can get to know each others situation is an important requirement. Instantly creating sensor networks using each persons hand held device is a good way to achieve this functionality. The DHT based P2P overlay ensures the scalability of the sensor network allowing large number of nodes to join the network without adding too much overhead to each node.

Even though the prototype development of *mTikiriDB*

was done on the Android platform, it is possible to implement it for other platforms too such that multiple types of smart-phones can be part of the same sensor network. Because of the declarative SQL query interface, an application developer on any smart-phone platform will view the sensor network in the same way and interact with it in the same way as on any other platform. In addition to SQL database abstractions, recently researchers have discussed about NoSQL database abstraction for WSNs[1, 5]. One advantage of SQL abstraction is the declarative nature of its queries which is easy to read and write than NoSQL queries while NoSQL contains its own set of advantages over SQL. We hope to integrate NoSQL abstraction functionality to the same interface we implemented as a future work so that we can let the developer to decide which way is more preferable to him or her.

An important problem that remains in *mTikiriDB* is the privacy issues of the smart-phone owners. By issuing queries to the network, users can find personal information of other users in the network like their geographic location and movements. Therefore protecting user privacy information while he or she is connected to a *mTikiriDB* type smart-phone based sensor network is an interesting research problem that we hope to work on in the future.

3. CONCLUSIONS

Implementing smart-phone based sensor networks have become possible in the recent times due to the increasing sensing capabilities they contain and at the same time due to the increasing popularity of them in the market. In this poster we present a prototype implementation of a SQL database abstraction layer for smart-phone based sensor network systems. Such abstraction layers can play an important role on enabling easy development of smart-phone based sensor network applications in the future.

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