Study on Query Type and Data Structure for Mobile Meteorological Services

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Abstract— For the mobile meteorological services, sensed data should be gathered at a server from various clients like as Ubiquitous Sensor Network, mobile phone or public traffic vehicle by wireless network. The gathered data at server have huge volume and increase continuously. Therefore, a special query method and data structure should be considered. This paper studies on all possible query type on the data and processing steps for the mobile meteorological services. Some query spaces will be discussed. After that, this paper proposes effective data structure for the sensed data to support the query types.

Index Terms— Mobile Map Services, Meteorological Services, Query Type, Meteorological Map

I. INTRODUCTION

THE atmospheric and meteorological information services in a city area are becoming commonly necessary on our life. Especially, wide spread of smart phone, mobile atmospheric and meteorological information services are becoming essential.

The atmospheric and meteorological information includes temperature, humidity, wind velocity, atmosphere values, and air pollution degree. On recent days, because of the accident in Hukusima nuclear plant, the need on air pollution information is increasing highly. However, to collect the information, related facilities with the sensors have to be constructed or sensor network system must be installed. These systems require high construction cost and maintenance cost. Therefore a new approach to apply an existing public traffic system as a mobile sensor can be considered.

A private phone can be one approach. If several related sensors are embedded on a phone, it will work as a mobile meteorological center. The information are collected the mobile phones on the road. The mobile phone is possessed by over 3 billion peoples, connected to the internet always, and equipped by many micro sensors. It is becoming true that to accept the mobile phone as a sensor node to build a sensor network. And the public traffic vehicles can be another attempt [1]. A bus runs

routine course periodically. A taxi runs randomly in the urban area. If the vehicles equip some devices, they can act as mobile sensors.

This paper focuses on the internal structure of the information gathered from various sources to support mobile atmospheric and meteorological information services. Possible user query types are researched and as the result, it is discussed which data structures are best in mobile atmospheric and meteorological information services.

II. RELATED WORKS

Recently, meteorological forecast services are developed into mobile environment due to the evolution of information techniques. Furthermore it is possible that various sources can be used as meteorological measurement means. Therefore, there have been many researches to extend the existing service concept into new paradigm.

[2] proposed SITUMET, SITuation-based, Ubiquitous METteorological Services. They point out that weather data are often collected by different sources that are unable to interact. Therefore, important data are not being processed complementarily and a great number of potential weather information products remain unused. Thus they aim at developing an IT based platform that can collect and integrate weather information from all over the world. They insist that the platform can generate highly personalized and situation-based services. Figure 1 shows a part of the full proposed SITUMET platform.
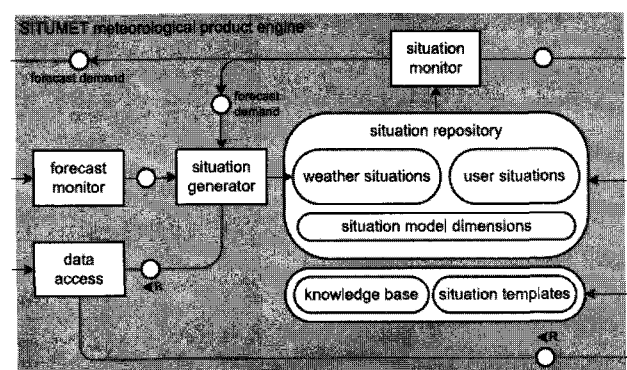

Fig. 1. SITUMET Platform (Engine Part).

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In research [3], they argue that meteorological information system plays very important role in many GIS application files during the past years. In this research, they proposed a new meteorological decision-making service system (DMSS). The system is developed on their framework including 3 layer databases.

These researches mainly set their focus on the integration of data format between GIS data and meteorological data. This thesis focuses on the user query types and data structures for mobile meteorological services.

III. QUERY TYPE

For analysis of query types, the kinds of data gathered on server should be considered. Because the aggregated data have 3 kinds of information, the query could be classified as follows: the stored data are composed with a time (set as X axis), a location (as Y axis), and sensing values (as Z axis). Then the query types on the storing data would be dependent on two of X,Y,Z axis. That is, all queries will be one of the X-Y-Z pairs. Because 3D GUI is not discussion issue yet, this paper ignores 3 dimensional type queries.
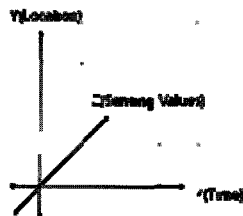

Fig. 2. X-Z Query Example.

In figure 2, most user query type seems to search 2 dimensional planes in a 3 dimensional space. Because the sensing values in Z axis are multi-values, it may be possible to query some information among the sensing values. This type is 1 dimensional case. All possible query types are shown in table 1.

TABLE 1
QUERY TYPES ON STORING DATA

	X	Y	Z
X	N/A	Type 4	Type 1
Y	Type 4	N/A	Type 2
Z	Type 1	Type 2	Type 3

In table 1, there are 4 query types of 2 dimensional queries. In this application the type4 is meaningless case because sensing data is absent. Type 3 is 1 dimensional query type. A query about correlation between 2 or more sensing data is an example of this type. Type 1 and Type

2 are 2 dimensional query types.

There are one 3 dimensional query(Type 5). To support this, a new user interface to support 3 dimensions should be developed. The query type will be like this : at some area(Y axis) of a city, during some times(X axis), display some sensing values (Z axis).
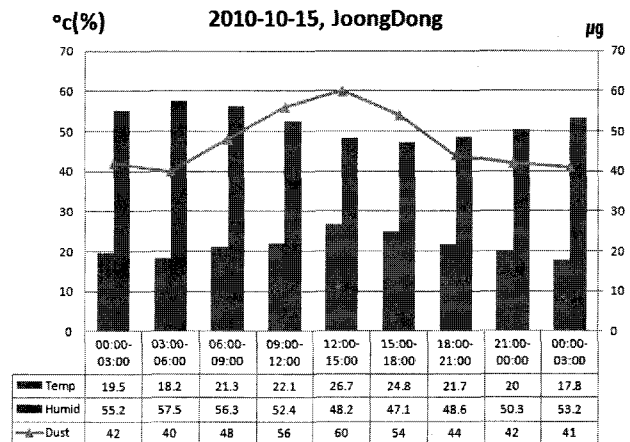

Fig. 3. Type 1 Query Example.

Type 1 gets all or some time and its' sensing values, at certain location. The query will be like this: at certain area of a city, during some times (X axis), display some sensing values (Z axis). The Z values could be displayed with various user interfaces. The user interfaces could be chart, text table, or mixed form. Figure 3 shows this GUI example of this query type. Here, query results are displayed as chart and table.
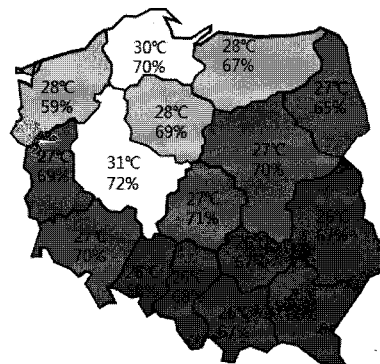

Fig. 4. Type 2 Query Example.

Type 2 is Y-Z query, which gets all or some locations and its' sensing values, at certain time. Figure 4 shows this example. In this figure, the query will be like this: at most recent Time Interval, in all districts in a city (Y axis), display some sensing values (Z axis). The Z values will be displayed with various GUI (color, text, symbol, etc.).

IV. DATA STRUCTURE

According to the study of the query types of mobile atmospheric and meteorological information services, it is clear that there are 3 factors to be considered in order to construct effective data structure. According to the 3 factors, the data structure could be figured out.

First, the sources of sensing data are various and the sensing devices could equip different sensors. Thus there will be many differences among the data. To aggregate the information at a server, they should be normalized. The differences are data type, measurement unit, etc,. After this processing step, the gathered data could be compared and aggregated if needed.
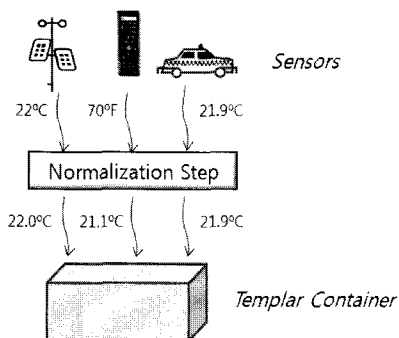

Fig. 5. Normalization Step.

Second, noise or malfunction of the sensors also has to be considered. The sources of sensors are various and heterogeneous, and some of the sensors could be very small and sensitive in the condition of sensing location. Thus the possibility of sensor malfunction is somewhat high. This process is refinement step and is based on the average or near values of at same MBR in same time interval.
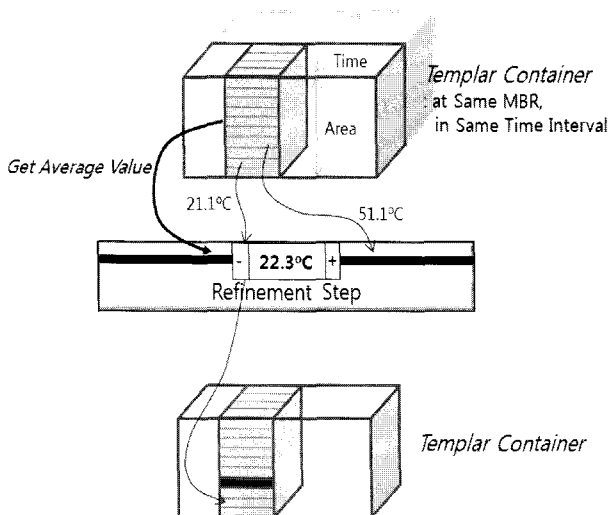

Fig. 6. Refinement Step.

Third, after the refinement step, the templar sensing data might be spars. Basically the sensing data have very huge volume and are generated continually and periodically. Furthermore the sensing data sensed at near area and in near time interval, have very similar values. The raw data could be aggregated by big rate. This is compression step. To support user query effectively this step is most important. Because data volume could be decreased dramatically after this step, the size of stored at sensing value database could be minimized, and therefore user query efficiency will be increased.
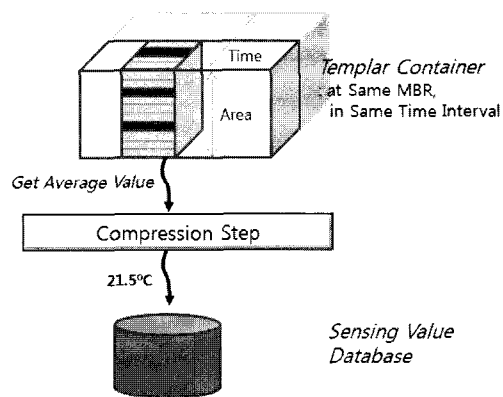

Fig. 7. Compression Step.

The data should be stored with consider of search time. Type 1 query requires various time and sensing data on fixed area. Type 2 query requires various area and sensing data on fixed time. Furthermore Type 5 query(3 dimensional query type) more flexible indexing techniques will be required. The data structure should support the efficient access time.

V. CONCLUSIONS

According to the popularization of smart phone, the needs for meteorological services will be moved into mobile environments. The various applications worked at smart phone, already give a user various meteorological information. These days, the need and the scope of meteorological services are being extended. The need for atmospheric information is actually increasing highly due to the frequent air pollution accidents recently. The information would be displayed at mobile phone with time and location information.

This paper studies on user query types possible on the services and suspects considering factors to implement the data structure. All possible query types on storing sensing data are classified and discussed their data structure. Though, the environment to use mobile sensor requires many prerequisite conditions, the mobile sensor will be generalized in various application fields, because of its obvious advantages.

Further researches are needed to design and implement the proposed query type and data structure considering the factors.

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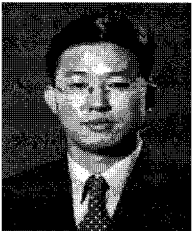
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