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Cloud Computing System Based on Wireless Sensor Network

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***Abstract*— In this paper, the system presents an integrated wireless sensor network (WSN) to monitor the information from agriculture systems namely temperature, humidity, pondus hydrogenii (pH) value…etc. The purpose is to provide a faster and more convenient platform for the client to obtain information from an array of sensor nodes that has been set-up in an agricultural system. A WSN will collect the values of various parameters from the front-end sensors at the host end. At the client sides, one can use the internet to request for Web Services that will store this big data into distributed SQL databases which are already in our proposed cloud system. In addition, this work presents the concept of cloud computing and services. The benefits of this system include basic computing hardware and reasonable storage capacities making it suitable for any smart device which can monitor real-time farmland information anywhere. The customers can fully access our cloud service using devices that have internet capabilities.**

I. Introduction

WIRELESS sensor network (WSN) consists of a large number of sensor nodes that are interconnected to form a wide communication network. Usually, it can achieve small size, low cost, low power consumption, fewer network components and other features easily. In recent years, it has been readily implemented in agriculture, industry, environmental protection and other fields.

With the development of hardware limitations, and in pursuit of a better performance and enhancing greater computing capability, people turn to find other techniques to achieve these goals. Therefore, the concept of "Cloud" was born. In fact, as early as the Internet appeared, the "Cloud" has already existed silently providing for us some services.

In recent years, the "Cloud" concept has become more and more popular, especially on the business sector. There are also many types of cloud computing platforms such as Google, Amazon, IBM, and Microsoft…etc. However, the true essence of using "clouds" was not completely understood. "Cloud" was then not a specific technology but rather a concept.

II. Cloud Computing

"Cloud" refers to a network. In the beginning, engineers drew a network diagram in the form of a cloud to represent Wide Area Network. This had an undefined volume of interconnected computers and network routers [1]. So to the client, this "cloud" was just a means of interacting with other sides.

A. Distributed Computing

According to literal interpretation [2], the idea of distributed computing is to divide the whole work load into smaller units. Each work fragment will be given to a corresponding slave computer that will do the computing and then will send back the results to the master computer. This is shown in Fig. 2.

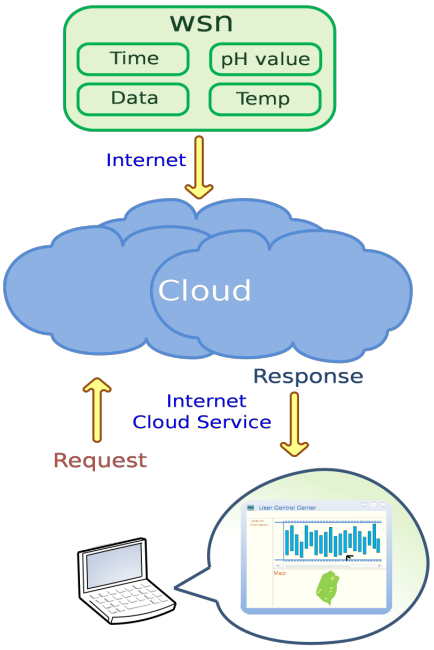

Fig. 1. Cloud concept

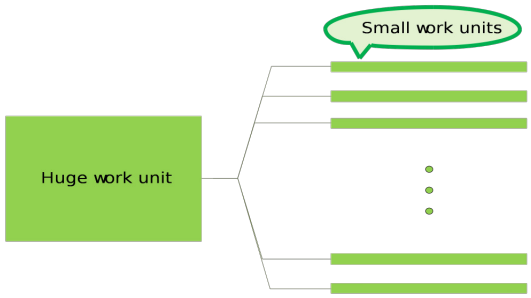

Fig. 2. Distributed computing

Through this technique, cloud computing can achieve a similar processing power to that of a “Super computer” with relatively lower cost and lesser fabrication complexity.

B. Virtualization Technology

Virtualization is a kind of software technology which can be applied to many fields. In fact, the concept of “Cloud” appeared very early [3], but due to lack of network bandwidth, insufficient storage space, and premature virtualization technology it was unstable and lacked flexibility.

However, with the development of virtualization technology, the development of clouds has been accelerated. In the past, our computing power was based on personal computers locally, but through virtualization technology we can now use cloud computing power which is centralized.

The proposed cloud system consists of a master server computer and four virtual slave server computers. The data are distributed onto the respective storage spaces of the four slave server computers which shall be used in the distributed computing process.

III. Database Design

A. Database Concept

Database refers to a particular subject or a theme arranged in a structured set of multiple and complex data in the computer. As a storage structure, the database can be broadly divided into: Hierarchical, Network, Relational, and Object-oriented. We used relational database in our project. Relational database is a database that has a collection of tables of data items which are formally described and organized based on the relational model. In this model, each table must identify a column or group of columns referred to as the "primary key" to uniquely identify each row. The rows of one table can relate to rows of another by establishing a "foreign key" which is a column or group of columns in one table that points to the primary key of another table.

B. Stored Procedure

The Stored Procedure (SP) could be divided into four instructions : Insert, Update, Delete, and Select in the database. These basic instructions can also control the data in the database and even combine more complex instructions so that the user can handle data more efficiently. In this project, we used T-SQL to write the database instructions. Every time one accesses a regular database, it has to check the syntax and this consumes a lot of time. So we implemented another technology that is “Stored procedure” which is written using T-SQL. Stored procedure will process the composition, verify the syntax by T-SQL, and then store. After that, one just needs to use it directly.

IV. Web Service Design

A. Web Service Concept

With XML (Extensible Markup Language), SOAP (Simple Object Access Protocol), WSDL (Web Service Description Language), UDDI (Universal Description, Discovery and Integration) appearing one by one, Web Service-oriented software, a new generation of distributed computing technology, and Web Services were born. Web Service through the open-type standard (e.g. XML, SOAP... etc.) of Web communication protocol alongside with the data provides services to other applications. Web Service consists of reusable components that can be published, discovered and invoked across the Web [4].

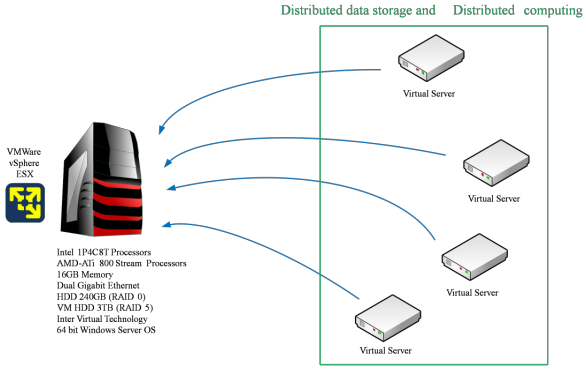

Fig. 3. Cloud system structure

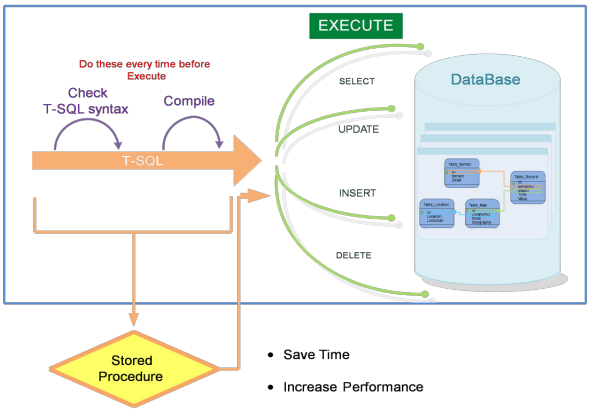

Fig. 4. Stored procedure’s concept

Its basic function is to respond to the call from the client to the server. Its purpose is to let the application from different platforms intercommunicate. When using the program, one inputs a value onto it, and then the program will request the Web Service to compute. The project used C# to design the user interface; while the platform was built

using .NET that can do the integration and implement the application.

B. Related Technologies

XML is a language form and a kind of syntax which can easily be read by the user and that the computer program can easily identify. It emanated from the SGML (Standard Generalized Markup Language). XML was developed by the XML Working Group, an organization formerly known as SGML Editorial Review Board; and so, XML is reviewed by a group of SGML experts. XML does not replace HTML. HTML focuses on how the file appears in the browser; while XML focuses on how to represent them in a structured way.

SOAP, Simple Object Access Protocol, SOAP is a kind of protocol that defines the way XML data are delivered and the various transmission protocols, like HTTP, FTP, SMTP, and TCP. SOAP uses XML as the data transmission format, and combines with the aforementioned transmission protocols to send the message.

C. LINQ-to-SQL

LINQ is a kind of method to link different program languages. Without LINQ, it is hard to establish a communication link between the SQL database and the programming language. LINQ can do object-oriented programming; it can also make the T-SQL language easily readable in C#, where the basic language is different; and it can also automatically generate the corresponding data type.

V. User Control Center

The relationship between user control center and Web Service are divided into two directions: “data” and “Panorama Map”.

A. Data Curve

Due to the large amount of data coming from the front-end sensors of temperature, humidity, and pH value… etc., a virtual machine is therefore used as a storage medium whose contents shall later be extracted via the Web Service. The process is as follows: one will first get the display window size to the Web Service, then he will extract the quantity of data from the database. The cloud will then compute the result which will be fitted onto the screen. [5]

B. Panorama Map

Because the farm we can monitor can be of large scale covering entire Taiwan or even the whole world, we therefore made reference to the operation of Google map. At first, the program will send the start instruction to let the cloud side know the user side’s display window size, and then the cloud will compute the image result and relay it back to the user control center.

Seven parameters have been designed to operate the map, namely: user control center’s display window width and height, X and Y coordinates of present location map, X and Y coordinates of displacement, and the presented map hierarchy.

When the user zooms in or out of the map, the user control center will send the new map’s hierarchical parameters to the cloud to regain the map. As the map’s display is maximized, it will show the images of the farmland as well as the corresponding sensor information. When the sensor is clicked, the user will get its information and data.

C. Interface

The design of the data curve is divided into three parts, namely: initial, static and dynamic. Regardless of whether the user starts the user control center or changes the window size, the coding of the initial status will still redraw the screen. It will calculate the window size, split the X axis, and then use the amount of data it gets from the Web Service to calculate the initial screen size.

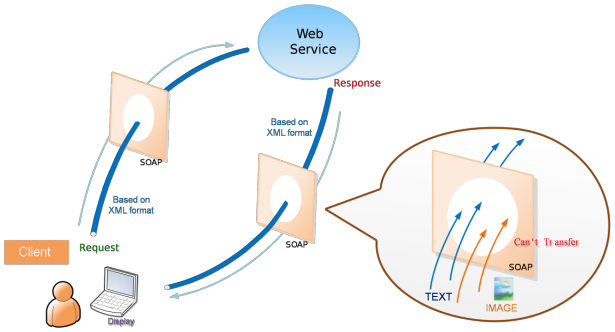

Fig. 5. Web Service concept

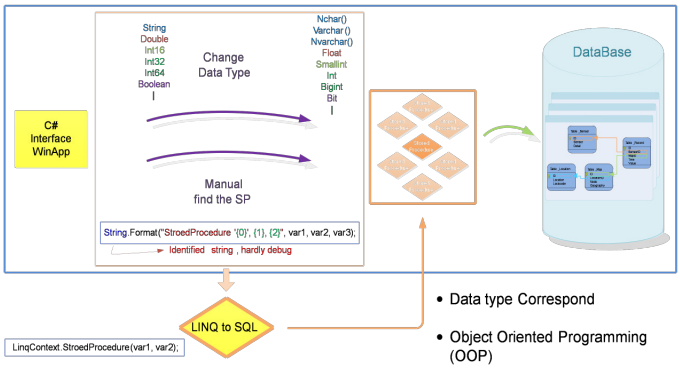

Fig. 6. LINQ-to-SQL concept

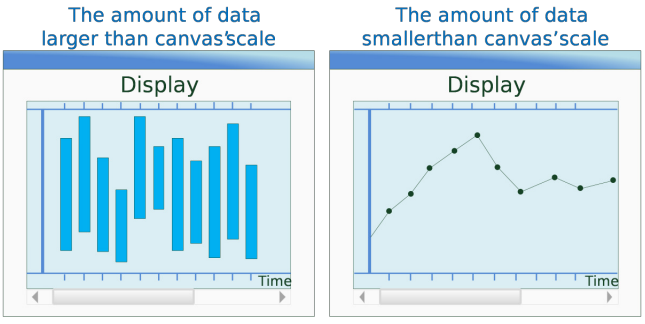

Fig. 7. Relation between data curve and data

The design of the relational database involves two concepts: one is that the data in the database should not be multiple repetitions, and the other is that two separated

tables should be established with a correct relation to ensure the consistency. A good database design depends on its characteristics. Because of the related characteristics, data duplication between tables can be minimized. This design results into saving the storage space and establishing a correct relation. Hence, one doesn't need to modify each data over and over again.

VI. Conclusion

The system proposed an internet database design by using the SQL database, LINQ-to-SQL technique, Web Service, virtualization technology and C# interface. By using this paper's method, the client's end can monitor the environmental condition of the agricultural place at any place. The major elements of this work are wireless network applications, C # interface, cloud computing system, database design, Web Service, and user control center.

Data packets were sent via a USB connection to the host-end which transmits the values of various environmental parameters coming from the front-end sensors. The number of WSN nodes can be more than 600,000 and each node can return the value for every one second. Therefore, the database will become enormous. The issue of quick access of information at the client end has been addressed by our system. C# interface will be designed to display the data curve which will aid in the decision making of the client with regard to getting better yield from his farm. Besides this, the sensor data will be uploaded to the cloud database allowing the client to use our Cloud Service as long as the user's display facility has internet connectivity.

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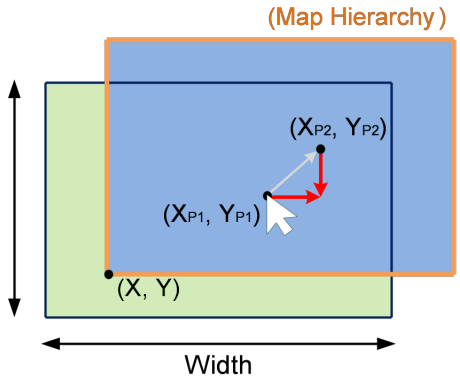

Fig. 8. Seven map parameters

Fig. 9. C# User control center interface

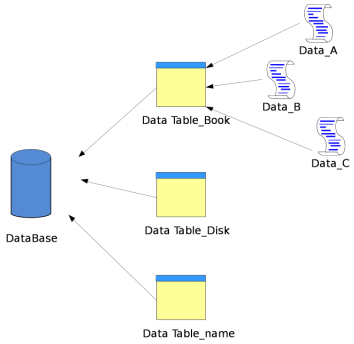

Fig. 10. The connection between the system data table and data

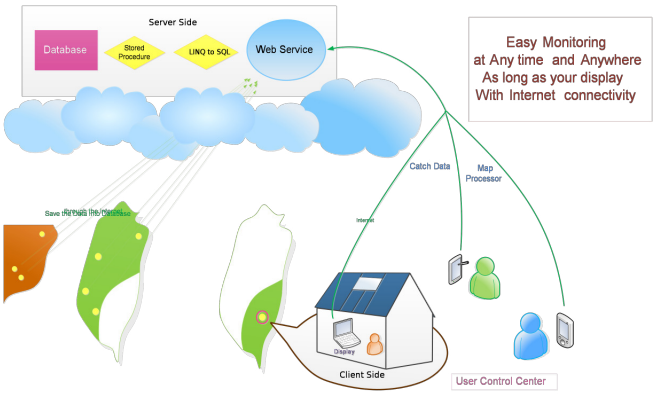

Fig. 11. The benefit of the cloud computing database system

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