The Application of Web-GIS in the Bus Information and Transfer System

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Abstract

The Bus Information and Transfer System is based on ArcGIS Spatial Analysis. We used Network Analysis technology to analyze the attribute data of bus stops. According to different customer's behavior on transferring, a bus transferring formula was developed. The formula helps to find the shortest paths from start to destination to reduce waiting time of customers. For a web-GIS system that can widely apply to multiple fields, MapObjects was used with a DCOM/ActiveX-based Load Balancing component that was developed in this project. We proposed a method of load balancing for Web server clustering composed of Web Map Sever Sets that are based on GIS multi-threads mechanism. The mechanism is capable of assigning the requests to the most efficient web server to reduce response time. This project aims to provide a better service to users and promote the usability of bus service.

Capter 1. Foreword

The people's income of Taiwan has raised in recent years, it accelerates the fast growth of the automobile, under the situation of the limit of transporting system capacity, produce the severity impact to the road transportation environment. For solving the gradual worsen transporting environment, the government agency have been promoting the public transportation to replace the automobile, hoping through the public transportation system of the good service quality, promoting the public transportation of utilization rate, to reduce the impact of the automobile to the road transportation.

The motivation of lacking of the related information of the bus, therefore, reducing the taking bus, caused the automobile increased, and cause the road hustling of road. Currently the automobile passenger transportation in the Taiwanese region and local government owing to the seriousness of this problem, in succession and actively put into all kind of resources, to promote the public transportation taking rate, to improve the service quality of the automobile passenger transportation. Therefore, the project proposed to provide each bus operators to search the route, and make use of the characteristic of the internet GIS to integrate with the intelligent public transportation information search, combine more than 40,000 store, with the information searching of the diversity electronic map, designing the schedule planning of taking car route. In addition, we used the GIS NetWork Analysis and the bus stop database, calculate the related

transfer and taking car route information between the two points of the beginning and the end. General users can easily get the related information of bus.

Therefore, we will use the interface of integration type, letting all operation steps completed under the same homework windows, to simplify the using process and shortening the operating time. With the intelligent interactive map search function, provide people make use of 1/1000 of electronic map, depending on the administrative area search, the landmark search, crosses the street corner search, key word search and the route search and quickly search, etc, diversity data search system, quickly appears the searching information by the way of the diagram an interface. We can through the map in addition to zoom in, zoom out, even moving, it can also mark the position of the bus route and the station card, to combine together more closely the public transportation and the citizen's life, it also can limber up the business opportunities through the bus route, making the bus no longer just pure vehicle, but also can provide more diversity service space.

Capter 2. The system development technique explains

___ The Web-GIS technique analysis

In order to combine with the original GIS technique and internet, with Web technique to emerge all kinds of GIS functions. In regard to the Web-GIS technique level, it will be divided into the Client and the Map Server to carry the explanation as follows:

1. The Client

Web-GIS out-putting the sketch of going to the web page can be divided into the image format (ex. png , gif, jpg) and the vector format (ex. swf , svg, gml, sdf), currently, the vector format needs a plug-in compatible in the web page, however, the advantage is that the little file amount, the GIS data download to the Client not need to repeat download from the serve carry, it also will not have the problem of drawing the quality loses really, this kind of development technique mostly has the FLASH, Map-Guide, Java Applet, the ActiveX Control etc. technique development. And the image format then can design the higher sketch beauty degree, for example, the set folds the geography diagram, the aviation photograph or the satellite image, the file format is pure, can apply the DHTML technique development, did not need the plug-in problem, also can combine the FLASH to increase the web page interaction.

2. The Map Server

Map Server main with the GIS manufacturer software develops, mostly through CGI or Server API (as Microsoft ISAPI, Netscape NSAPI) method, allow the users through the web page instruction to start the program exist in the web page server host, however, this kind of method usually needs to be depended on the particular WEB server, it can transplant worsen. Meanwhile applying this kind of method, when the network discharge is higher, the system reaction will become slowly, it can't attain the loading balance of the single host effectively.

This system use the concept of designing the sample product, apply the DCOM/ActiveX standard, construct the Web-GIS scatter the type article structure, it's biggest advantage to promote the significantly speed, also can carry on the mechanism of the load balance effectively. Meanwhile, it can depend on the different GIS data format or function, change the map component, it can look after both sides of the biggest flexibility, save the two times development of the software.

___ The system technique development explains

This system makes use of the website editor development tool, Microsoft FrontPage 2000, Dream weaver 2004 MX, combine the DHTML, JavaScript, ASP etc. internet development technique in the head diagram usage the interface (Web-Viewer) develops, also using Microsoft Visual Basic 6.0 development tool carries on the COM/COM+, ActiveX Control etc. the development of the software component, again with COM/COM+, the ActiveX Control software component carries the Web-GIS the map service the server after adopting configure with the Windows DNA dispersion type software and the dispersion the type software component the development the mode take into integration to develop, however at develop in the process have ever suffered the Application after carry with the Web head the interface integrated with some technique bottlenecks, through design the sample product can resolve the interface integration and the space data format commutation problem in front and back, succeed make traditional GIS file(as Shape file, coverage, etc.) can accesses to integrate the set to fold with the space database meanwhile, overcome with old GIS system space data compatibility problem, validly improve the efficiency of the access space data.

By head diagram set Web-Viewer provides the operation search interface of an intuition, simplification, the convenience type, with through behind carry the Web-GIS map service server, combines together the technique and internet of the electronic map, and read directly meta data, searching the result and the electronics map image are directly to present the demonstration on the internet.
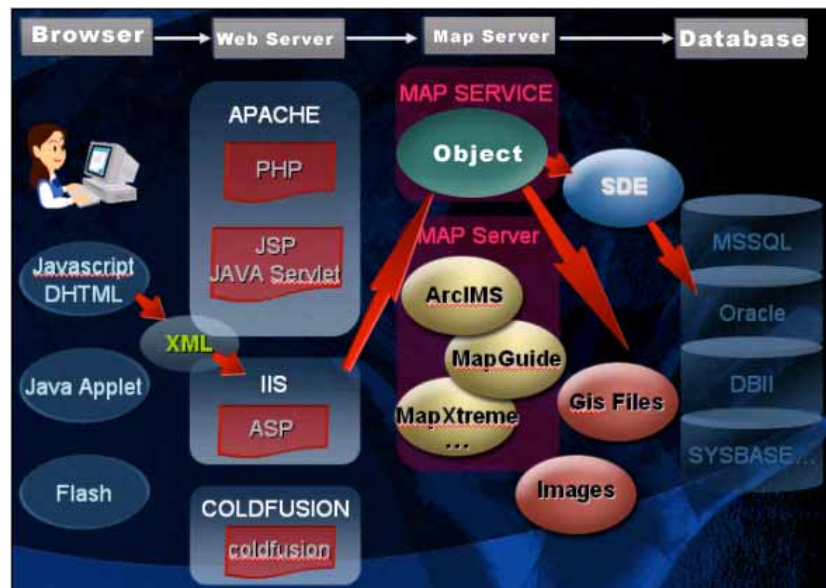
Figure1   A composition of Web-GIS system

Taking into the analysis by the bus stop card and the driving route data characteristic can find, the data structure can make use of the toward diagram (the Directed Graph) to indicate, matching the characteristic of the bus route one-way drive at the right moment. Having toward diagram is a kind of abstract sketch structure, a toward diagram D constituted by a group of Vertices and Edges. The bus stop card that is can immediately be regarded as the top, the bus driving the route between two station cards is side, and link all sides is the complete bus route. Each bus stop if the station card that pays different route more but belongs to same location, then only take one of the bus stop card be representative, make same bus stop of the same location all for only value. As for the two routes if can transfer through the certain bus stop, then can order the different route with the same bus stop totally .If is through two neighbor bus stop to transfer by foot, then can link two bus stops to make two bus routes connected through the side formation, to build the transfer route to provide the system analysis judgment, and should transfer to take the side and give it differently belonging in order to have the differentiation with generally bus driving route.

__   The most suitable bus transfers to take the route choice algorithm

Connect down to design the bus transfer taking algorithm after building up the data structure. Because the bus route transfers is to solve the Shortest Path problem, and The Shortest Path problem is in the Graph

Theory research a very algorithm problem of the classic, the main purpose is finding out having toward diagram the two most short-circuit path. Solving the sketch problem usually has to waste a great deal of calculation time, so the Time Complexity is the lower the better, that is the time cost lower indicate that algorithm quicker. The in common use and the most short-circuit path algorithm has : Dijkstra algorithm, A*algorithm, Bellman-Ford algorithm, the Floyd-Warshall algorithm ……etc., the different algorithm is applicable to the different condition, after this research analyzes the merit and shortcoming of more various algorithm thoroughly, decide to adopt the checking form method to be the foundation and take the bus transfer characteristic to design a set of transfer searching algorithm, it can find out the most short-circuit taking car path quickly.

1. The path programming method

After general user provides the point of departure and the terminal point position, the system according to the road data belongs to the database, limit the condition…etc., then combine the bus route and the card station data, to program a most suitable going path. First, depend on the station card data to know whether the two points from the beginning to the end are located the same bus route, if on the same way then start from the point of departure, regard as prognosticate to order with the point of departure, search the most close and there is road to go to next point, also bring into it to the prognosticate point. Thus, again with this prognosticates to be the departure point finding out the road to the next point, therefore, go round and begin again until terminal point.

If the two point of the beginning and the end can't on the same of bus route, it have to classify the cross characteristic of bus route, be the foundation of converting the mechanism. Knowing from the bus network that it crosses at most three roads, calculating the various alignment combination.

1.1 The bus changes direction characteristic.

Go forward and change direction for bus, induce to threes directions, turn to the left, turn to the right, turn around, (as figure 2).
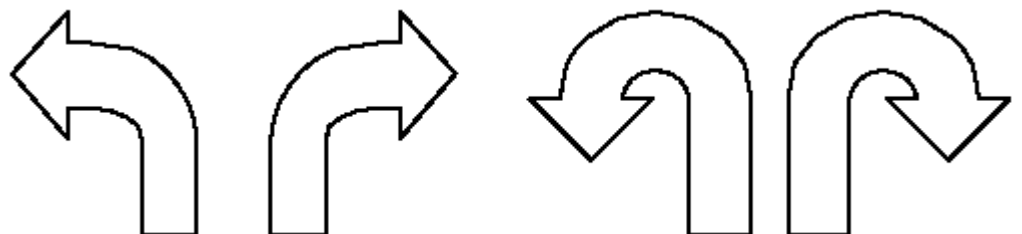

Figure2 Bus change direction sketch map.

1.2 The judgment of change direction mechanism.

A thing that indicates with the lines sketch under the array coordinates system, all can use the most basic sketch vegetable-vector, constitutes the property of its lines sketch vector to have the start point, length and direction. In addition to decide the route direction of the start coordinates and the terminal point coordinates, also have to consider the road one-way characteristic.

1.3 Hand over the Cape of two straight lines.

At judge the bus change direction mechanism, in addition to explain turn left or turn right, there are one more road to turn left or turn right, it is not enough to tell the users that should transfer to which stop if only explain turn left or turn right, so we have to first know the two points of start and finish each falls on which bus route, then depend on the hand over cape of these two buses, decide transfer point. Then take transfer point to be the departure, with the terminal point coordinates to take the direction.

So give generally users the information that takes the public conveyance transportation is as follows:

- The start orders(currently position).
- Park the car the station the direction.
- Transfer stop name and the turn direction.

2. Transfer point searching algorithm

2.1 Transfer point algorithm analysis process.

```
        ┌─────────────────────────┐
   ┌───→│  Input departure point  │
   │    └─────────────────────────┘
   │                 │
   │                 ▼
   │         ╱───────────────╲
   └────────⟨ Compare the stop ⟩
            ╲  card data.     ╱
             ╲───────────────╱
                     │
                     ▼
        ┌─────────────────────────┐
   ┌───→│  Input the finish point.│
   │    └─────────────────────────┘
   │                 │
   │                 ▼
   │         ╱───────────────╲
   └────────⟨ Whether the direct⟩
            ╲  bus route.     ╱
             ╲───────────────╱
                     │
                     ▼
         ╱───────────────╲          ┌──────────────────┐
        ⟨ List the card data⟩──────→│ Transfer database.│
        ⟨ from the start to ⟩       └──────────────────┘
        ╲    finish.     ╱                   │
         ╲───────────────╱                   ▼
                 │                   ╱───────────────╲
                 │                  ⟨  Transfer once  ⟩
                 ▼                  ⟨ route of the bus.⟩
   ┌──────────────────────┐         ╲───────────────╱
   │List the card data from│                 │
   │the start to finish and│                 ▼
   │between the transfer   │        ┌──────────────────────┐
   │points.                │        │List the card data from│
   └──────────────────────┘        │the start to finish and│
                                    │between the transfer   │
                                    │points.                │
                                    └──────────────────────┘
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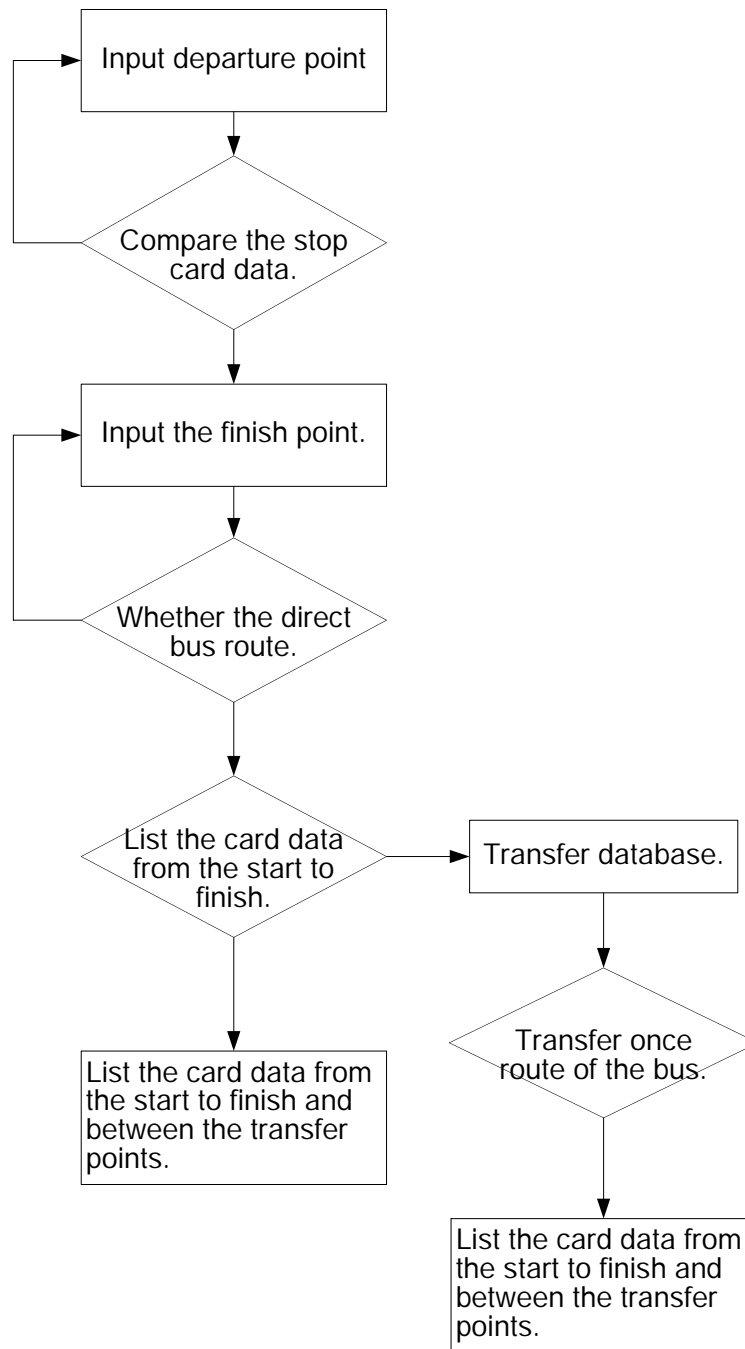
Figure 3 Transfer point algorithm analysis process.
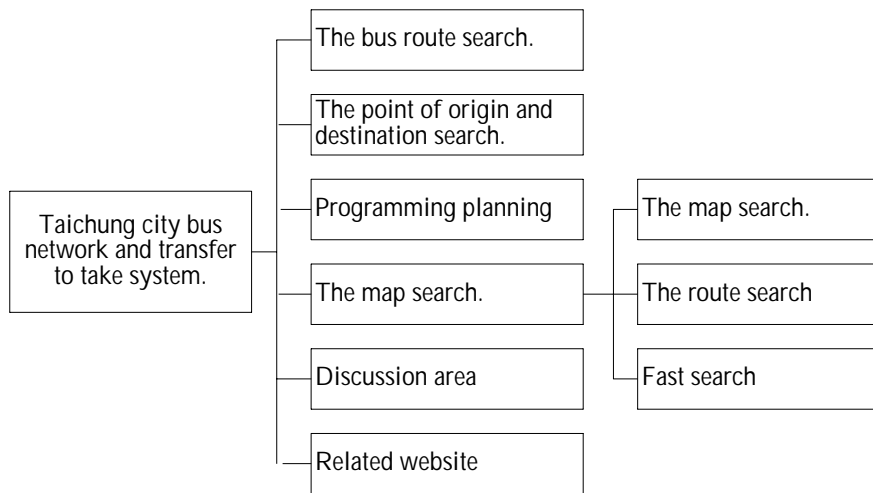

2.2   Transfer point algorithm analysis explanation

_ Build up the bus stop card data form: Takes the only value of the
    same bus stops location.
_ Build up the route station card data form: Depend on the driving
    sequence to weave the ordinal number, if is the double station
    card then the return journey will repeat card serial number but
    ordinal number is dissimilarity.
_ Build up transfer station card data form: The close two station cards

       all probably alignment combines.

_ Input the beginning and the end by the user, to search the two most close bus stop card by the two points.

_ Sets the beginning value of the start and the beginning supported by the users, distinguishing to take into the explanation with two kinds of conditions:

_ If the two points of origin and destination are on the same bus route: Indicates that don't need to transfer, directly list the close station cards at the two points.

_ If the two points of the beginning and the end are on the different bus routes, then suitable for checking the form method to find the most short-circuit path:

_ Obtain the point of departure bus route serial_the point of departure station card ordinal number, the finish point bus route, the finish point station card ordinal number.

_ Search transfer station card: With the bus route of the two points of origin and destination to do the search for the station card data, the point of departure station card ordinal number have to be smaller than the transfer station card point of departure ordinal number, and the finish point station card ordinal number must be smaller than the transfer stand card of the finish point card ordinal number, the t search algorithm for:

_ SELECT* FROM [transfer station card data form] Where [route 1]=[the point of departure bus route serial number] AND[transfer station card point of departure ordinal number]>[the point of departure station card ordinal number] AND[route 2]=[the finish orders bus route serial number] AND[transfer stand card finish orders ordinal number]>[the finish orders station card ordinal number].

_ Lists one after another the stand point of departure card, transfer station card, finish order stand card.

The exploitation checks the form method to combine the transfer search algorithm, can resolve the generally most short-circuit path algorithm must waste a great deal of calculation time, and the problem of take up a great deal of database memory space, and further reduce the load of the server, can let the users acquired the result that the most suitable bus transfers to take the route in the most short time.

# Capter 3. The system function explanation

       "The bus transfers to take the information search system" programming takes friendly operation interface as the principal axis, constructing the exclusive web page that a bus transfers to take the information search system, integrating the complete information, such as bus route data, bus stop card data, road data and the landmark data...etc., providing the city government website for the guide message of taking bus. One can provide diversified news;   on the other hand also can smooth the conveniences way for the citizen service, descend the diagram is to the information search system transfer to take structure diagram for the bus:

```
                          ┌─────────────────────────┐
                          │ The bus route search.   │
                          └─────────────────────────┘
                          ┌─────────────────────────┐
                          │ The point of origin and │
                          │ destination search.     │
                          └─────────────────────────┘
┌──────────────────┐      ┌─────────────────────────┐      ┌────────────────────┐
│ Taichung city bus│      │ Programming planning    │      │ The map search.    │
│ network and      │──────┤                         │      └────────────────────┘
│ transfer to take │      │ The map search.         │──────┤ The route search   │
│ system.          │      │                         │      └────────────────────┘
└──────────────────┘      │ Discussion area         │      │ Fast search        │
                          └─────────────────────────┘      └────────────────────┘
                          ┌─────────────────────────┐
                          │ Related website         │
                          └─────────────────────────┘
```

Figure4 A composition of bus transfers to take information search system

"The bus transfers to take information search system" takes the city number geography diagram in pedestal as the foundation, combine "the bus information database" content to show on the electronics map, the people can enlarge, shrink, even move the selection to carry on the different magnification sketch manifestation, the bus information that let the people to know taking bus information through the network search also can print it out. Website another increase to establish child's version, in addition to the basic search function, add the children's playground and the small common sense of transportation. The system website is http://citybus.tccg.gov.tw/citybus/.
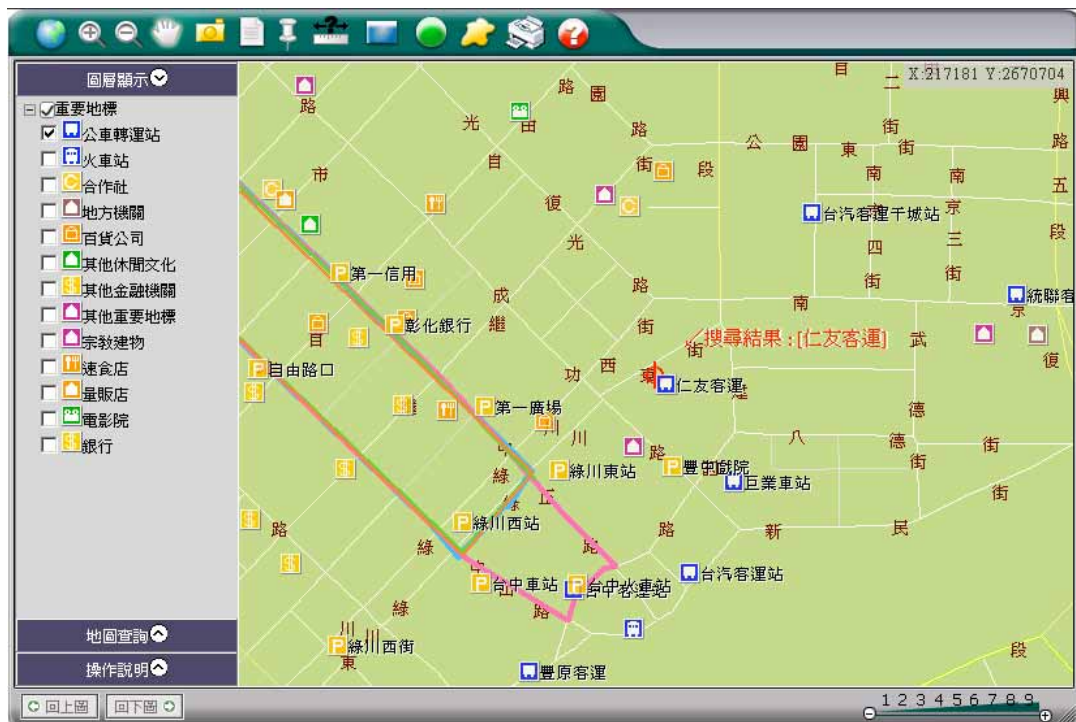
Figure 5 Show the station tablet places diagram.

Capter 4. Applied result

1. The internet GIS and bus information data integration and application which can promote the service quality of the public conveyance system provide the immediate and stable bus driving information for people.
2. The geographic information systems and the intelligent public conveyance information searches the integration of the system offer the convenient public conveyance takes and transfers to take the information, to transfer the partial private trip time to the public transportation, to reduce the usage of the private transportation, to reduce the transportation problem to the impact that is caused by the environment.
3. The intelligent public conveyance information search system combine with business data. That will make the depressed economic prosperity of economy be better and arouse the economy recovery of the Taichung City's business.

Capter 5. Reference

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