The Method of Internet Sharing for Innovation Experiment in Engineering Education

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Abstract—As the progress of innovation experiment in engineering education, especially open innovation experiment, it is urgently needed to investigate the internet sharing method. Through Technical performance analyzing of Web GIS, the method of network sharing with MapXtreme is discussed, the real time calculating in server and browse of experiment results in client are developed. As an example for safety evaluation, system structure and MapXtreme resolution of internet sharing for innovation experiment is discussed. The method of Multi-Criteria Evaluation (MCE) for safety evaluation is introduced; calculating method of weights in MCE method is analyzed as basis of Analytical Hierarchy Program (AHP). System application of weights input and calculating results browse is developed with JavaScript and VBScript as Active Server Page (ASP). Finally, the internet sharing method is analyzed and some advice is proposed.

Keywords- Internet sharing; Innovation experiment; Engineering education; WebGIS

I. INTRODUCTION

As the informatization progress of engineering education, especially the need of open innovation experiment, it is urgently to investigate the internet sharing method. The construction of web-based education and knowledge sharing environment has been developed quickly, and it is an unprecedented challenge to the experiment design with personal learning environment [1]. Many kinds of services can be provided for any users in the world by Internet, such as web-based spatial analysis, maps display, user access, etc. In internet environment, WebGIS technique, such as MapXtreme, can be integrated with web, and GIS analysis, such as MCE evaluation or decision making, can be work out. WebGIS has been applied in many fields, its application in engineering education, will changes the manner of engineering education, especially, innovation experiment design [2-4].

About the evaluation method for engineering safety evaluation, GIS-based multi criteria evaluation (MCE) is a relatively new method. Two types of multi-criteria method are including in GIS. One is Boolean overlay method that is as basis of Boolean operation of intersection and union. Another method, represent as weighted linear combination (WLC), is more important and popular. In weighted linear combination, evaluation criteria are sequential standardized, and weights can be calculated based on Analytic Hierarchy

Process (AHP) [6-9]. Due to the advantages of AHP, it has been combined with GIS software and Multi-Criteria Evaluation (MCE) method [10-16]. For example, its combination with IDRISI makes the calculation of factor weights in IDRISI becomes very convenient, where the module WEIGHT utilizes one by one comparison method to help users to construct a comparison matrix. Finally, weights and a consistency ratio are calculated, which is the foundation of MCE safety evaluation.

Internet sharing method and weights calculating method based on AHP for innovation experiments in safety evaluation are discussed in this paper. An example application is practiced and analyzed, comprehension ability for innovation experiment design of college students is improved, and some advice for internet sharing in engineering education is proposed.

II. INTERNET SHARING METHOD

Main methods for WebGIS are CGI, plug-in of GIS, Java, ASP, and ActiveX in browser. CGI is the acronym of Common Gateway Interface, and it is a method to integrate gateway scripts into programs. Therefore, it is an HTTP servers' agreement. With this method, customers can interact with Web Server, but difficult for GIS analysis. GIS plug-in, which can be downloaded from the server, receive data vector from the server and process it. In this method, most processing work is completed in the client, and the ability of GIS server is limited. ActiveX is similar to the plug-in, in which GIS analysis is work out in the client through GIS data access. The difference between plug-in and ActiveX control is that ActiveX control is in fact a dynamic link library module.

ASP is a server side technology. Pictures or other content can be dynamic displayed in web pages. This method is easy to learn and developed raptly. All works is work out in the server side, and the ability of GIS server is full used. With this method, HTML page can be created for users, HTML page is combined with dynamic server module and scripts technology.

In this article, ASP method and ActiveX control are combined based on MapXtreme. Through system application development, the input parameters table and evaluation results are displayed to customer as asp web page. System application program are developed by VBScript and JavaScript language in ASP environment. Real-time calculation and evaluation in GIS server, real-time display in

web server, real-time browse and parameters input in client are achieved.

A. Internet sharing system strucutre

A three layers model based on B/ S (Browser/Server) is created for this system, which is shown as figure 1. The three layers are web browser for users, Web server and GIS Server (MapXtreme). GIS analysis and map process are achieved in GIS server, data transmitted between GIS server and web server based HTTP, parameters input table and results display are controlled by web server. Customers interact with GIS server through web server. Input data management and spatial data analysis are operated by customers with browser. Most works of GIS analysis, such as decision making, spatial variability analysis and weights calculation, are achieved in the server side.
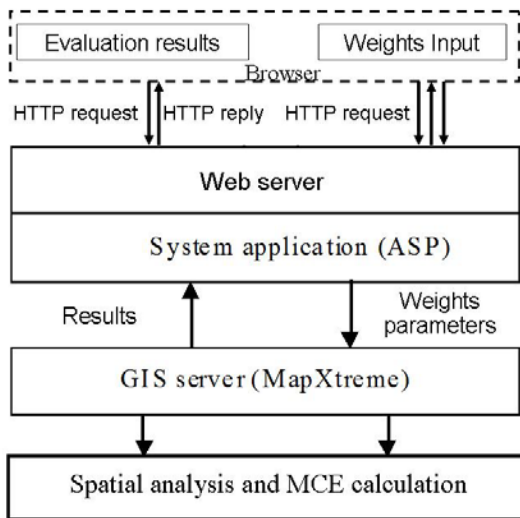

Figure 1.   Internet sharing System for Innovation Experiment

B. System application development

Through the development of system application, many performances of the system, such as pan, zoom in and zoom out, are worked out. For example, the main system application, such as ASP files Edser.asp, is wrote as,

```
Edser.asp:
 "EDserConstants.asp"
<SCRIPT                       LANGUAGE="VBScript"
RUNAT="Server">
Function GetServerGroup Name ()
    GetServerGroup Name = cEdServerGroup Name
End Function
Function Restore ()
    Dim Result
    Dim objmaps
    On Error Resume Next
    Set objmaps = Getmapengine()
    If   (Strcomp   (Request.server   variables
(cRequestmethod), cPost, vbTextcompare) = 0) Then
    Dim objmapxst
    Result = Createmapxst ()
```

```
    Set objmapxst = Getmapxst ()
    objmapxstate.   Stream   =   Gethtmlformfield
(cCdPreviousmapst)
    objmapxst.Restore objmaps
    Result = Destroymapxst ()
Else
Result = Setmapsize(Getmapwid(), Getmaph()
Result=Setmapcenter         and         zoom         to
(cCdefaultcenterc,cCddefaultcentery, cCddefault zoom)
Result = Setlayerper(objmaps. layers (cCdbd), True, True,
False)
    Result  =  Setllayerper(objmaps.layers (cCdwell), True,
 True, True)
    Result  =  Setlayerper (objmaps. layers (cCdleg), True,
False, False)
    Result  =  Setlayerper (objmaps. layers (cCdnub), True,
False, True)
    Result  =  Setlayerper (objmaps.layers(cCdEdser), True,
True, True)
    End If
    Restorestate = True
    End Function
    </SCRIPT>.
```

III.   EVALUATION METHOD

During safety evaluation, every factor is treated as layer, and weights can be calculated by AHP method. According to the advantage of AHP, AHP provides an effective evaluation method for safety evaluation, especially weights calculation. As usually, or very common cases, weights can be calculated by a simple method that is to divide 1.0 among all influence factors. In fact, there are more than 3 numbers of influence factors, this make weights calculation as a whole set very very difficult. During the safety evaluation procedure for many engineering problems with WLC method as basis of GIS environment, the sum of all the weights must be one. In AHP method, the principal eigenvector can represent calculating weights, and the principal eigenvector comes from the pair wise comparisons for any two factors in all influence factors, and that is shown as a square reciprocal matrix. The relative importance of any two factors can be treating as the comparisons indexes, which determine the situation of engineering safety. Generally, we can use a 9 or 7 points' scale. For example, in 9 points' scale, 7 means very strongly important for one to the compare factor. If the inverse were the case, one would set 1/7. And the like, we can deduce the rest number from this.

In WLC method, weights are an eigenvector. For example, in comparison matrix A, the maximum latent root is writing as $\lambda_{\max}$, W represents eigenvector, and weights can be obtained from the calculation of eigenvector W, as following,

$$AW = \lambda_{\max}W \qquad (1)$$

The Eigenvector is calculated as,

$$\overline{a}_{ij} = \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \quad i, j = 1, 2, \cdots, n \qquad (2)$$

Plus every rows,

$$\overline{W}_i = \sum_{j=1}^{n} \overline{a}_{ij} \quad i, j = 1, 2, \cdots, n \qquad (3)$$

Through standardized, Vector $\overline{W} = [\overline{W}_1, \overline{W}_2, \cdots, \overline{W}_n]^T$ is obtained from,

$$W_i = \frac{\overline{W}_i}{\sum_{j=1}^{n} \overline{W}_j} \quad i, j = 1, 2, 3, \cdots, n \qquad (4)$$

The weights can be obtained from eigenvector that equal to $W = [W_1, W_2, \cdots, W_n]^T$.

$\lambda_{\max}$ represents the maximum latent root, is calculated as,

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i}. \qquad (5)$$

In which, $(AW)_i$ means the i-th factor in AW.

C.I. is the acronym of consistency index, it is calculated as,

$$C.I. = \frac{\lambda_{\max} - n}{n - 1} \qquad (6)$$

Consistency ratio (C.R.) is as follows,

$$C.R. = \frac{C.I.}{R.I.} \qquad (7)$$

In which, R.I. is randomly consistency index.

For a good consistency, the value of consistency ratio should be less than 0.10.

If the value of consistency ratio is large than 0.10, it means that we should modify the comparison matrix and to calculate it again. In order to keep good consistency, we need to know the reason where the inconsistencies aroused. Of course, we know the inconsistency comes from the matrix, thus, we can analyzed this from comparison matrix investigation. For example, if we construct a comparison matrix as follow,

$$A = \begin{bmatrix} 1 & 2 & 6 \\ 1/2 & 1 & 4 \\ 1/6 & 1/4 & 1 \end{bmatrix} \qquad (8)$$

The weights for each column are achieved by the process that averaging over all columns and make each column sum to 1.0. For example, if the sum of first column is 1.67, all factors in first column divided by 1.67. The calculating results of weights are 0.60, 0.30, and 0.10. Through repeating this process for each column, then make all column averaged, the weights are obtained. The principal eigenvector are approximately calculated, and the results as equation (9),

$$w = \begin{bmatrix} 0.588 & 0.322 & 0.090 \end{bmatrix}^T \quad \lambda = 3.010. \qquad (9)$$

It can be found that the sum of weights with this method is 1.0. Then the weights can be used in safety evaluation.

If we modify equations (8) as,

$$A = \begin{bmatrix} 1 & 2 & 6 \\ 1/2 & 1 & 3 \\ 1/6 & 1/3 & 1 \end{bmatrix} \qquad (10)$$

The results of equations (9) are,

$$w = \begin{bmatrix} 0.6 & 0.3 & 0.1 \end{bmatrix}^T \quad \lambda = 3 \qquad (11)$$

Through compare equations (8) with equations (10), the lack of consensus comes from the inconformity of A1, A2, and A3. Because A1/A2=2, A1/A3=6, then should A2/A3=3. But in equations (8), A2/A3=3.010≠3, this is the reason of lack of consensus.

IV. APPLICATION EXAMPLE

As an example application, four factors that influence the oil well safety, and there are 120 oil wells in the research area. The purpose of this experiment is to evaluate the oil field safety based on 120 oil wells production data. The relative importance between any two factors is given a significant value in analytical hierarchy program method. The comparison matrix "A" is constructed as table 1.

TABLE I. COMPARISON MATRIX

Factor	F1	F2	F3	F4
F1	1			
F2	1/2	1		
F3	4	6	1	
F4	1/5	1/3	1/8	1

As a symmetrical matrix, only the upper or lower triangular is needed to complete. The remaining cells in the upper triangular half of comparison matrix the reciprocals of the lower triangular half. Such as, the rating of F3 to F1 is

value 4, the relative important rating of F1 to F3 will simply be 1/4).

With equations (7), an index of consistency is calculated, this is named consistency ratio.

The calculating results of weights for safety evaluation are,

$$w = 0.2077 \quad 0.1164 \quad 0.6248 \quad 0.0511^{T} \quad C.R. = 0.04 < 0.1$$

The calculating steps are shown as figure 2. The application safety evaluation result of this experiment is shown as figure 3.

The experiment design provides several common tools in browser, such as pan, zoom in, and zoom out. User can browse the vector image with mouse action very simply; operations include dragging, zoom and click. Therefore, ASP method is effective for open remote experiment design through internet. All calculation and evaluation are work out by the server. User can do the experiment through browser conveniently.
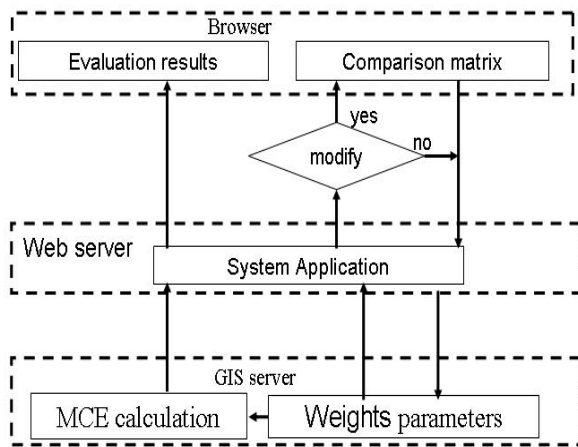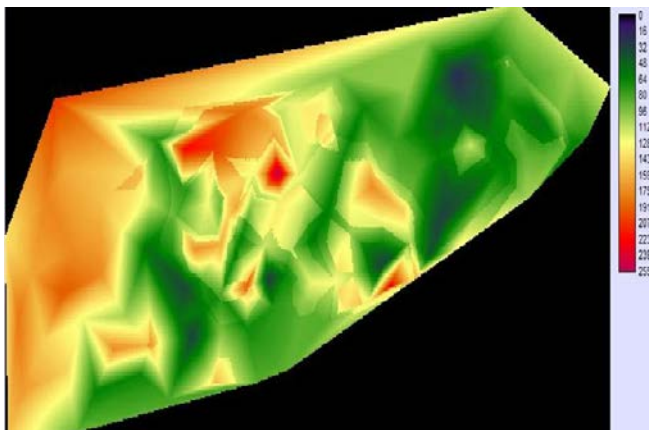

Figure 2.   Evaluation process

Figure 3.   Experiment calculating result

V.   CONCLUSIONS

MapXtreme is applied to open innovation experiment design, and remote access is achieved through system application development. User can input experiment parameters and obtain experiment results through browser conveniently. With GIS server, MCE method is applied to evaluate the safety of oil well based on production data. Through analysis of AHP method, the relation between comparison matrix and consistency index is investigated. With any change of the pairwise comparisons, the degree of consistency will change. The key of good consistency is to keep the pairwise ratio conformity of all factors.

Therefore, open experiment can be developed for distance education through combing of browser, web server and GIS server.

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