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Design Matlab Network Virtual Experimental System Based on Asp.Net and MATLAB Builder Ne

Qin Yong, Peng Jiansheng, He Qiwen, Wei Qingjin, Tan Haitao and Ding Weiwei
Department of Physics and Mechanical and Electronic Engineering,
Hechi University, Yizhou 546300, China

Abstract: Using MATLAB compiler component module, combined with ASP.NET to build a remote service, establish a network of virtual experimental system. Application of MATLAB Builder NE compiler component module, including the compiled M-file into a .NET components and used the compiled .NET components in the ASP.NET environment, combined with .NET component calls technology made the calculation of the M-file program are displayed in the WEB page. Graphics of MATLAB in ASP.NET controls WebFigureControl application can intuitive results of MATLAB graphics embedded in the page to display. Users can through a browser and through the way of input parameters to dynamic invocation remote services to call MATLAB functions perform computational analysis and output the results on the WEB, provide a new teaching and learning environment for the experimental teaching.

Key words: MATLAB, ASP.NET, virtual experiment, MATLAB builder NE

INTRODUCTION

MATLAB possesses strong data calculative, analytical ability and visual environment to make the efficient specialized valid date with more scientific calculation. Operators with no need of specialized computer operation ability also can use it breezily to use the window interface with brief and easy to use characteristics. Since MATLAB 6.0 and later versions accretion the service of WEB function, the WEB of MATLAB is in a wide range of using. Literature (Liu, 2009) is based on Web Services and SAR imaging simulation platform of MATLAB COM component. Literature (Pu, 2010) introduces the achievement of virtual laboratory which based on MATLAB Web Services. Structure virtual laboratory can save lab resources, avoid the trouble of managing laboratory. Adopt MATLAB WEB function as one scheme of structuring laboratory has been used widespread. Nevertheless, great majority existing literatures are used in the application of MATLAB Web Service of MATLAB legacy version, literature (Chen *et al.*, 2009; Zhuang, 2010; Hao, 2011). Since MATLAB 2006b, MATLAB stop to support MATLAB Web Service, use the solution that MATLAB Builder NE and MATLAB Builder JA combine with ASP.NET or JAVA substation for intrinsic MATLAB Web service to establish WEB application environment. Literature (Cai, 2012) introduces apply java web and

MATLAB Builder JA technology building remote math experiment teaching system. Therefore, make use of ASP.NET and MATLAB Builder NE can structure network virtual experiment system which with user date input, pass back handle results. Bring considerable convenient to teaching and scientific research.

DEVELOPMENT PLATFORM AND CORRELATION TECHNIQUE INTRODUCTION

ASP.NET introductions: ASP.NET is a frame platform for .NET Framework application program that is developed for creating webpage or website by Microsoft. It provide a powerful, high-efficiency, fast approaches to setting up websites. Multi-languages have been used to code application program alternatively, such as VB, C++, C#, F#, Jscript, etc. frequently-used development language is C#. With .NET specific language, C# absorbs the characteristics of inheriting C and C++. In addition, it is similar to Visual Basic possesses rapid development capacity. It is an object-oriented senior program design language with the feature of briefness, powerful and type-safe. Use C# develop ASP.NET WEB application program has improved programmer's efficiency, offered friendly interface and saved development time.

MATLAB builder NE introductions: MATLAB apply kernel code of itself compiler as compile generation tool,

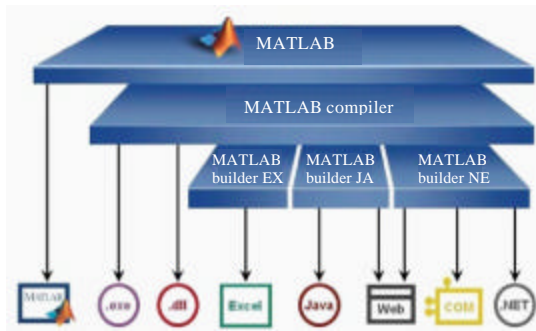


Fig. 1: Hierarchy of MATLAB compile generation tool

can create extensible assembly, as shown in Fig. 1. MATLAB Builder NE as a module of compile generation tool, user can use it establish mathematical formula which coded in MATLAB program, .NET graphic and COM component. Its module compiler work on the same compiles way that is macc command. Provide simple and speed operating modes rather than complex and palaver command generates components.

User can integrate those components into WEB application program projects. Call it and M file function components service coded in MATLAB via MATLAB Compiler Runtime (MCR). It is abides by CLS (Common Language Specification) that compiled by MATLAB Builder NE, it can make components fusion together with the environment of .NET's trusteeship seamlessly. Compiled .NET components can used in .NET environment by appending component quote ways directly. Version MATLAB 2011a MATLAB Builder NE supports Version 2.0, 3.0 and 3.5.

It can be created by .NET component by Deployment Tool of MATLAB view in MATLAB environment. It also can be created by mcc command.

Construct MATLAB remote execute environment:

MATLAB functions used in WEB environment not rely on webpage clients MATLAB software on user's computer. That is to say the webpage clients' user can operate that server supplied MATLAB program without installing any MATLAB software on their computers. However, it is need to be installed MATLAB or MCR on server-side. MCR is an execution engine which uses the same function library with MATLAB software, the main usage is execute MATLAB file that compiled by MATLAB Builder NE under the circumstance of the computer don't install MATLAB software. In case it is need to execute compiled MATLAB file while there isn't install MATLAB on computer, that MCRInstaller.exe which on the MATLAB install catalogue under the

direction of \toolbox\compiler\deploy\win32 should install on target machine and set the system environment variable to direct MCR install path. It's important to note that the MATLAB version of compiled file should correspond to MCR version when uses MCR execute MATLAB compiled file, otherwise, MCR cannot work normally.

MATLAB ESTABLISHES .NET COMPONENT

.NET component is the assembly of .NET Framework. Numerous basic system assemblies constitute .NET Framework. Assembly is a logical function unit what under the control of executing Common Language Runtime (CLR). It is exist with the file format of .dll in windows system. It can be compiled to .NET assembly while uses MATLAB Builder NE compile MATLAB M file assembly. Usually, there are three steps:

- The first step, new a MATLAB m file, code m file program as the format of function. For unit step response curve of second-order systems and its dynamic property
- %f is output image handle; r is characteristic equation root; s on behalf of system stability; ptime is peak value; %sigma is overshoot percentage; rtime is rise time; stime is adjustment time; dtime is delay time:

```
function
[f,r,s,ptime,sigma,rtime,stime,dtime]=TestFun(zeta,omega)
num=[0,0,(omega^2)];
den=[1,(2*zeta*omega),(omega^2)];
G=tf(num,den);
[y,t]=step(G);
.....
a=figure; % image handle
plot(t,y);
grid;
f=webfigure(a);
close(a);
end
```

New function webfigure MATLAB offered used in above mentioned code case. This function allows MATLAB to draw image on ASPX pages to display. After preparing m file well, input deploytool in MATLAB command line. Open compile tool MATLAB Builder NE, shown as Fig. 2.

Among of these, "name" is compiled assembly's project name. Contemporary it is the name of .NET assembly. "Location" is specified project folder location. There is compiled .dll file, cs file and relative project describe file in generated project folder after compiled. "Type" chooses ".NET Assembly", namely .NET Assembly.

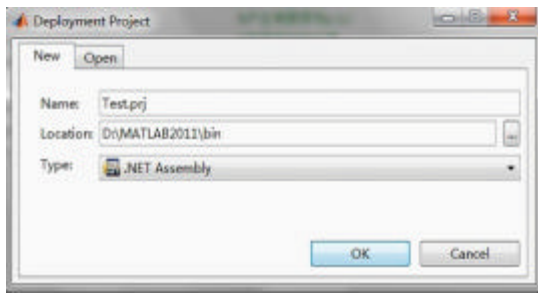


Fig. 2: Project interface of compiled tool MATLAB Builder NE

The second step, set up class name of which compiled C# file, yet it can also be added class name to compiling file and add m file. Under “Class” label in “Build” tab, addition, modify and remove class name can be done. Click “Add files” can add m file to relative class. As every m file be coded as an independent function, added m file will be a sub function of this class that be compiled.

The third step, compiled project file. Choose “Build” in menu bar “Project” or click icon in short cut menu bar, namely start compiling project file. All of output file and relative file of project file save to project folder.

USE MATLAB COMPILED .NET COMPONENT IN ASP.NET

Quote .NET component: After project compiled, the .dll file that generated in project folder can work on .NET Framework environment independently. Add compiled .dll file quote by Visual Studio 2010 in “solution explorer” of project file. So, MATLAB compiled m file function can be used in ASP.NET project. All of compiled M file function be called object instance member function. It is must instance member function before call M file function. Just like common .NET assembly, the visit form is “Instance name. Function name”.

Date type conversion: The data type of called M file is MATLAB specialized matrix data type object. As parameter incoming type and returned value type must be this type. But ASP.NET can’t recognize MATLAB data type. ASP.NET suit data type is what .NET Framework system build-in managed code supports data type. In order to make data interaction with .NET and MATLAB, it needs to add MWArray.dll quote which supports MATLAB data type component. This component can switch MATLAB matrix array into recognizable .NET type, or switch .NET data type into recognizable

MATLAB matrix data object. Chat 1 has shown the switched correspondence of MATLAB basic data type and .NET basic data type.

MWArray.dll is located into its installation directory foldermatlabroot\toolbox\dotnetbuilder\bin\arch\version\, copy it into startup bin folder of .NET network virtual experimental system item and add assembly quote. Adding “using MathWorks.MATLAB.NET.Arrays;” and “using MathWorks.MATLAB.NET.Utility;” import MWArray.dll namespace of assembly to allow these two namespace to use data type among it. Now .NET the data type “double” can use MWNumericArray described as MCR recognized data type in .NET edit environment such as “MWNumericArray array = 1.0;”.

DRAW MATLAB GRAPHIC IN ASP.NET

Add MATLAB Figure control in Visual Studio 2010

toolbox: WebFigures for .NET is offered by MATLAB R2008b later version to present MATLAB output drew image in WEB page. Terminal user can enjoy MATLAB drew application program anywhere and there is no need install any MATLAB relative tool. Figure 3 shown relational structure of Webfigures server and embed Webfigures webpage in single-server.

It is need to add WebFigureControl control into Visual Studio 2010 control toolbox when use ASP.NET WebFigures for .NET function. New a tool tab into Visual Studio 2010 toolbox, name tab name as any easily recognizable friendly name. Then use mouse right click “options...” on tab. Browse MATLAB installation direction toolbox\dotnetbuilder\bin\win32\v2.0 in .NET Framework component tab to find component WebFiguresService.dll and add it. When add component WebFiguresService.dll success, the component ASP.NET which named WebFigureControl can be seen in Visual Studio 2010 control toolbox, shown as Fig. 4.

Use webfigurecontrol control: After project compiled, the .dll file that generated in ASP.NET uses HTTP to process program to process requirements. WebFigureService is a HTTP processor in fact. So, web.config of ASP.NET needs to add below node before use control WebFigureControl to intercept server relative requirement to make corresponding processing:

```
<httpHandlers>
<add path="__WebFigures.ashx"
verb="GET"
type="MathWorks.MATLAB.NET.WebFigures.
Service.Handlers.Factories.
Http.WebFigureHttpHandlerFactory"
validate="false" />
</httpHandlers>
```

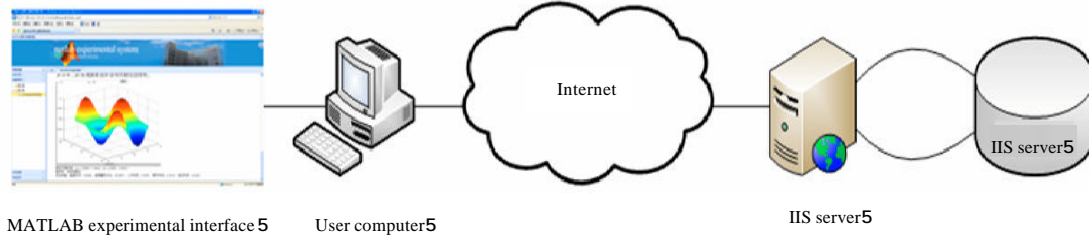


Fig. 3: Embed Webfigures webpage in single-server figure

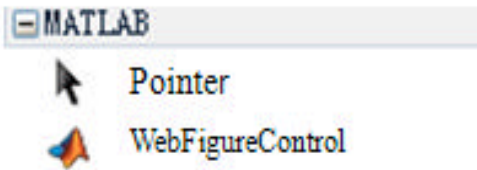


Fig. 4: Visual studio 2010 control toolbox that add control WebFigureControl success

Drag control WebFigureControl from toolbox to ASPX page of network virtual experimental system project to draw unit step response curve of second-order systems. Embed control WebFigureControl of ASPX page mark as `<ccl:WebFigureControl ID="Web FigureControl1" runat="server" />` in the front of page. Now, the control display frame can be changed in the environment of Visual Studio 2010 page design. Its size is same with MATLAB output image size. In debugging environment, control presents default image shown as Fig. 5 in the circumstance of inputting no data. Then, it indicate that control embed into page success. Inputting no data. Then, it indicate that control embed into page success.

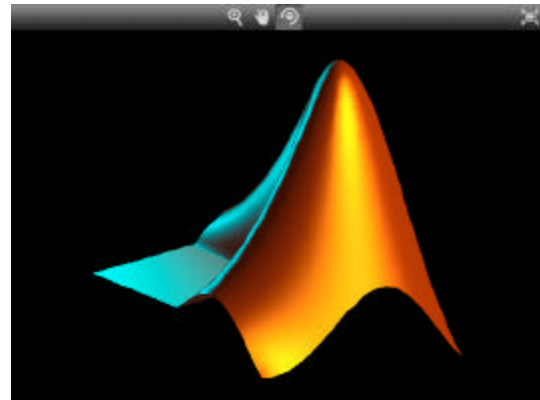


Fig. 5: Unbinding data control WebFigureControl default display

Bind webfigurecontrol control data: In order to WebFigureControl can draw example graphic, control WebFigureControl property WebFigure need to assign a WebFigure object. Control WebFigureControl is located in namespace MathWorks.MATLAB.NET.WebFigures. Employ using sentence bring in this namespace or this class's full qualified name when visit class .NET is necessary.

WebFigure object's constructor supports to instantiate which use the primary of type MWArray. In this example, MATLAB M file use function webfigure to income figure handle construct WebFigure object and return data type MWArray in .NET. So, it can assign to WebFigureControl.WebFigure after using keyword NEW instantiates WebFigure. And then, binding unit step response curve image which outputted by example.

Table 1: Switched correspondence of MATLAB basic data type and .NET basic data type

MATLAB type	.NET primary data type	.NET MATLAB switch class type
Cell	N/A	MWCellArray
Structure	N/A	MWStructArray
Char	System.String	MWCharArray
Double	System.Double	MWNumericArray
Single	System.Single	MWNumericArray
UInt64	System.Int64	MWNumericArray
UInt32	System.Int32	MWNumericArray
UInt16	System.Int16	MWNumericArray
UInt8	System.Byte	MWNumericArray
Logical	System.Boolean	MWLogicalArray

COMPILED .NET COMPONENT BY MATLAB AND DATA INTERACTION

Component receive input data: According Table 1, it is indicated that the value type of MATLAB is described as type MWNumericArray which the class is in MATLAB managed code. For the sake of MATLAB compiled .NET component can receive user input data. It is needed to do that use ASP.NET input control TextBox receive user input data at first and then via ASPX background page converts data operation. Conversion code shown as follows:

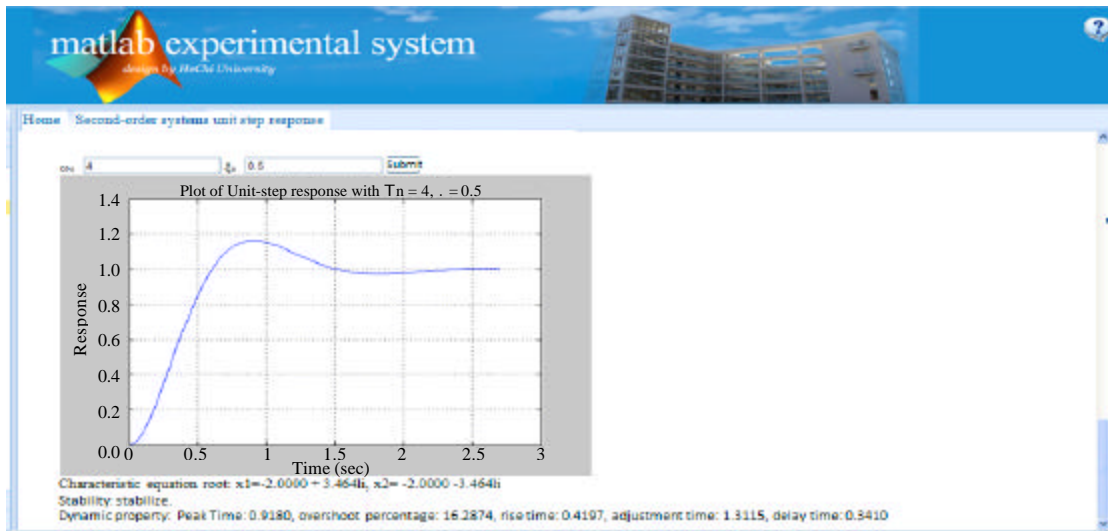


Fig. 6: Interface of network virtual experimental system work on IIS server

```

Double zeta=
Convert.ToDouble(this.zetaTextBox.Text.ToString());
Double omega=
Convert.ToDouble(this.omegaTextBox.Text.ToString());
try
{
    MWNumericArray M = zeta, n = omega;
    new LTI.Class1().TestFun(M, n);
    .....
}
.....
    
```

In this code, two parameters are delivered into compiled M file function. Represent damping ratio and natural frequency of second-order system. MCR will calculate damping ratio and natural frequency what second-order system step response curve and every index of dynamic property represent on remote computer (server). The last, returning the result to user.

Achieve component post back date: The return result type which calculated by way of MCR is decided by compiled M file returned value. If there is only one single returned value, the return type is MWArray; if it's multi-returned value, the return type is MWArray[]. What's more, when function has multi-returned value, it is need to assign an int type parameter when call the first parameter to express the number of return value. The code of receive multi-returned value function as followed:

```

.....
try
{
    MWNumericArray M = zeta, n = omega;
    MWArray[] mv = new
    
```

```

LTI.Class1().TestFun(8, M, n);
    WebFigureControl1.WebFigure=new
    WebFigure(mv[0]);
    .....
    resultLabel.Text = " dynamic property:
peak time:" + mv[3].ToString() + " ,";
    resultLabel.Text += "overshoot
percentage:" + mv[4].ToString() + " ,";
    resultLabel.Text += "rise time: " +
mv[5].ToString() + " ,";
    resultLabel.Text += "adjusting time:" +
mv[6].ToString() + " ,";
    resultLabel.Text += "delay time:" + mv[7].ToString();
    .....
}
.....
    
```

The above code use MWArray[] receive 8 return values of compiled M file function. Make the first return value, this is also the MWArray data type, as the parameter construction WebFigure object to bind second-order system step response curve to image control. Other return values use Label's ASP.NET control to do receive operation.

TEST AND CONSEQUENCE

Public network virtual experimental system by Visual Studio 2010, then mount it to IIS server. Input URL in address bar of browser IE7's to visit it. It is need to user authenticate to the designed website. Visit website all experiments while input correct user name and password. The example content is shown as Fig. 6. In Fig. is shown the nit step response curve and its dynamic property of the natural frequency value ω of second-order system is 4; the value of damping ratio is 0.5. Use javascript make

simple validate to front page. Only validated data can submit into server. Use try... catch sentence do exception handing job on Page background. Relevant exception information can be capture when user input incorrect data to point out user operating falseness.

CONCLUSION

The interaction ability of WEB function that MATLAB offered and other program that can use to web development use widely application into distance education and engineering verification, make the most use of MATLAB engineering calculation filed. Solve the tedious problem that involve in development of web application engineering calculation. Use ASP.NET technique as network application platform. Combine with network virtual experimental system which constructed by MATLAB computing engine offer demo, verification, operation, simulation and so on to distance education. MATLAB compiled component server can be called by browser simply. Provide a sample to this technique of develop MATLAB network platform. But virtual experimental system constructed by this technique just can work confirmation, demonstration experiment. Innovation and development cannot use this way to construct experimental system temporarily.

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REFERENCES

- Cai, Y.L., 2012. The design of distance education experiment teaching system based on java web and matlab builder JA. *Exp. Technol. Manage.*, 1: 83-85.
- Chen, W.X., J.B. Xiang and J.G. Chen, 2009. The realization with design is based on MATLAB remote command window of web. *Comput. Appl. Software*, 2: 138-141.
- Hao, C.H., 2011. Optimization distance cutting parameters method based MATLAB web server and ASP.NET technique. *Mech. Design* 12: 67-69.
- Liu, Y., 2009. The synthetic aperture radar imaging simulation platform based on web services and matlab COM components. *Comput. Knowledge Technol.*, 9: 2339-2340.
- Pu, Y.H., 2010. The realization of virtual laboratory based on matlab web server. *Chinese Mod. Educat. Equipment*, 19: 133-135.
- Zhuang, S.F., 2010. Use MATLAB web server realizes drawing online. *Comput. Appl. Syst.*, 6: 223-225.