# Mixed programming with LabVIEW & Matlab and its application in explosion field test

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**Abstract**: Several methods of mixed programming with LabVIEW and Matlab are introduced. Taking explosin test as application background, the design method and implementation process using MathScript node and COM technology are mainly discussed. Based on this, the advantages of LabVIEW's interface development and Matlab's rich data operation functions are combined to achieve the fitting of explosion pressure field and dynamic compensation of temperature measured.

**Key words**: LabVIEW; MathScript node; COM; mixed programming; explosion field test

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Explosive blasting is a transient process with high temperature and high pressure, spreading out in the form of shock wave and thermal radiation. Explosive pressure spreads so quickly that it is difficult to observe it directly. Therefore, the distributed multi-point test method is used to simulate the explosive pressure field. In addition, the explosive signal measured by contact temperature measurement is weak even if it is amplified, therefore dynamic compensation is needed to modify test results.

At present, the virtual instrument measurement technology based on LabVIEW is more and more important in the modern measurement and control fields[1]. The explosion field test system based on LabVIEW saves a lot of hardware investment as well as makes full use of the functions of LabVIEW, such as data acquisition, control, analysis, display, etc. In particular, the man-machine interface written on the LabVIEW platform is friendly, which is convenient for the user to operate and control. However, LabVIEW performs inefficiently in calculation, analysis and processing[2]. If you want to carry out complex data and image processing, you need to use Matlab to make up for LabVIEW's deficiencies. Therefore, using the mixed programming with LabVIEW and Matlab, which not only makes use of advantages of LabVIEW in graphics design, but also covers the powerful data processing capabilitiy of Matlab, is easy and intuitive to perform analysis, design, calculation and processing work, thus the efficiency of test system can be improved greatly[3].

The mixed programming includes many ways: dynamic link library (DLL), dynamic data exchange (DDE), Matlab script node, ActiveX function template, MathScript node, COM component technology, etc. It is noteworthy that DLL and COM components as well as MathScript node can work away from Matlab environment. This paper focuses on the application of MathScript node method and COM component technology in explosive field measurement by introducing several hybrid programming methods.

## 1 Mixed programming with LabVIEW and Matlab

1) DLL technology: Matlab's M-file is translated into C++ code with the same functionality by MAT-

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COM translator; then the code is compiled into .dll-file by VC++ 6.0 compiler; finally, calling DLL function by the call library function node in LabVIEW, you could communicate with Matlab. However, this method can not be applied to the later version of Matlab 6.5[4].

2) DDE technology: In LabVIEW's DDE library, exchanging data, requesting order and providing service can be accomplished by both client program and service one; communication can also be achieved by calling Matlab program on DDE server client. DDE is an important way in interprocess communication (IPC) mechanism of early Windows, but few to be used now[5-6].

3) Matlab script node: It is the most simple and fast communication mode[7], which communicates with Matlab server by the ActiveX control. Although the script node has been executed, Matlab can not shut down automatically, therefore it will interfere with foreground program, which is not conducive to its wide application.

4) ActiveX function template: In LabVIEW, the reference of MLApp. DIMLApp object is opened by Automation Open in order to start the Matlab automation server; then Matlab can be controlled flexibly by using object's methods and properties, which include window size, interface hide, program exit and other functions. This method has a better control ability for Matlab. However, it is important to note that using ActiveX function template will reduce the amount of data transmission and the number of Matlab automation server[8-9].

5) MathScript: Users who need not to install Matlab can directly use more than 600 functions including mathematical operations, signal processing and analysis, which are built in MathScript of LabVIEW. Therefore, to achieve seamless integration with the graphics programming of LabVIEW, it is necessary to write the M-file of Matlab directly into the MathScript node, or to compile and run the M-file by using MathScript's interactive window[10].

In the case of more complex fields, e.g. neural networks, image processing, etc., it was found that LabVIEW needs to be combined with Matlab.

6) COM component technology: By creating engineering file as well as adding, compiling and packaging M-file in Matlab environment, the development algorithms in M-file are made into components, this is, becoming independent COM objects directly called by LabVIEW. Its high efficiency is beneficial to publish independent release of user application software, but some of data structures in LabVIEW still need to be supported and improved.

## 2 Application in explosion field test based on mixed programming

### 2.1 Explosion pressure field fitting based on MathScript

It is well known that it is extremely difficult to be observed directly that the transient explosion and shock process with the effect of high temperature and high pressure. In order to be convenient for analyzing the blast phenomenon, it is necessary to simulate the formation of the pressure field after the explosion. However, there are the response errors caused by dynamic characteristics of sensor, therefore a shock tube is used to dynamicly calibrate the sensor for reducing the dynamic error. During the static blast measurement, a distributed test system composed of multiple test nodes based on storage test technology is established for testing explosion shock waves, where the overpressure peaks collected by sensor array using B spline interpolation algorithm are measured to reconstruct the shock wave pressure field. Fig. 1 shows the front panel of explosion pressure field fitted, and the corresponding results related to the site layout of explosive test can be written into "Input Controls".

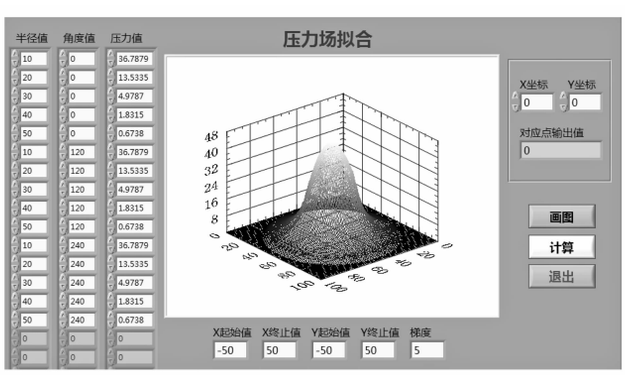


**Fig. 1 Front panel of explosion pressure field fitted**

When clicking on the "Drawing" button, a three-dimensional wave of explosive pressure field can be obtained, which is implementted by MathScript node of background program, as shown in Fig. 2.

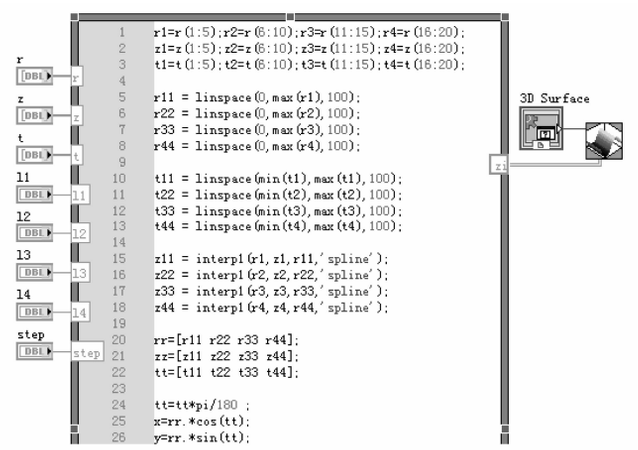


**Fig. 2 Program block diagram of MathScript node in the fitting of explosion pressure field**

MathScript contains two methods: one is the interactive window of MathScript, similar to the Matlab's development interface; the other is using MathScript nodes in the program block diagram. MathScript node is not only a simple and convenient way, but also away from Matlab environment.

Researchers can directly edit the program code in the MathScript node, or not copy and paste the M-file into MathScript until successfully debugging in the Matlab environment, then right-click on node border to add input and output variables and specify the data type for ensuring the compatibility of interactive data. Furthermore, MathScript internal nodes have the error check function, if the input code does not comply with its syntax, the red forks are displayed in front of the line numbers. Table 1 lists the corresponding relationship between the variables names in MathScript node and the data type in LabVIEW.

**Table 1 Input and output data types in MathScript node**

| LabVIEW data type | Variable name |
|---|---|
| Double floating point | $l_1$, $l_2$, $l_3$, $l_4$, $step$, $xx_1$, $yy_1$, $pp$ |
| 1D array double floating point | $r$, $z$, $t$ |
| 2D array double floating point | $z_i$ |

According to users' requirements, this method can be used to modify and update the program in the script frame momentarily, set the output parameters at any time, as well as debug program in time, which is simple and straightforward in application results.

## 2.2 Dynamic temperature compensation based on COM component

During measurement of transient high temperature of explosion field, there are the dynamic response errors due to poor dynamic characteristics of thermocouple. Therefore, a dynamic compensation method is adopted. Firstly, the dynamic calibration of thermocouples is performed by the traceable dynamic calibration system for analyzing the dynamic characteristics of the thermocouple. Secondly, with the quantum-behaved particle swam optimization (QPSO) algorithm on Matlab platform, a model of dynamic compensation filter is established. However, it brings about many problems, such as complex programming, huge amount of calculation and complicated interface operation. Lastly, to improve the efficiency of programming, reduce the amount of computation and operate easily for users, the model parameters of compensation filter can be edited into M-file directly, and made into COM component, thus it can be called by LabVIEW platform to realize the dynamic compensation of explosion temperature. The compensation results are presented in Fig. 3.

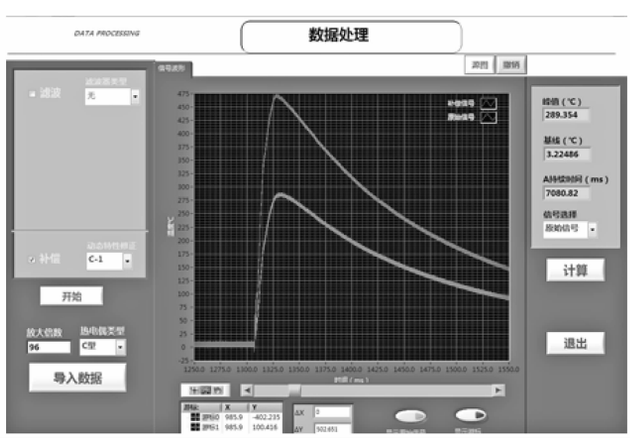


**Fig. 3 Front panel of dynamic temperature compensation**

In the following, we will introduce the implementation process of dynamic compensation on the LabVIEW platform.

LabVIEW 5.0 and later versions all support COM component technology, and Matlab since version 6.5

provides the COM generator. The process of generation and call is as follows:

1) Input the mbuild-setup command in Matlab window, configurate it gradually in accordance with the prompt and select C/C++ compiler, thus we can compile M-file into a COM component with .dll suffix.

2) Run the deploytool tool, create a new project, select the Matlab builder NE and generic COM component, this step provides a platform for the COM component and supports data conversion.

3) Fill in the project name as buch.prj in the name column, and select the save path for the project, but Chinese characters never appear.

4) Click "Add File" to add M-file for the new project. Click "Build project" in tool bar to produce buch.dll. Click "Package project" to create the _install.bat in the distrib folder, this is, completing COM component package, which is registered by running _install.bat into the computer, also into the Active object library of LabVIEW at the same time.

5) Finally, the "Automation Open" control is opened by Active operation function of LabVIEW, right click the function to select Active class, then select the generated buch.dll component from the object list, finally add it into the LabVIEW block diagram, thus the calls of COM component are completed.

Note that $x$ is a one-dimensional array, but the LabVIEW automatically converts the input data type to a variable type for meetting the input requirements of COM object. The nargout under Method node represents the number of output parameters. The input of $b$ (output parameter) can be created a constant or a custom data type, In fact, its output in Matlab is still a one-dimensional array, but becomes two dimensional data by the function of conversion to data[11-12]. The index array is shown in Fig. 4.

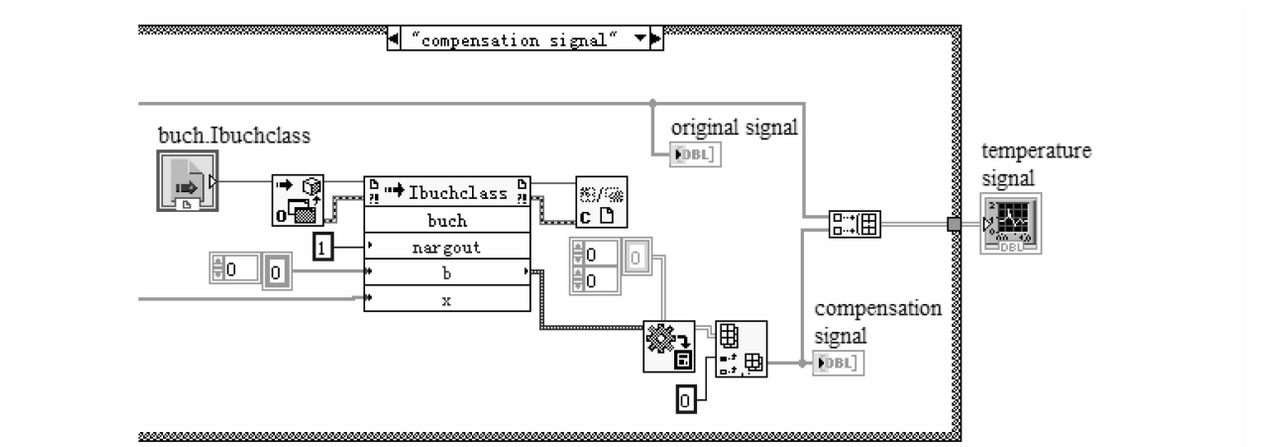


**Fig. 4 Program block diagram of calling COM component**

## 3 Conclusion

MathScript node with multiple input and output characteristics not only has a high-efficiency execution, but also runs fast. Unless the processing function is beyond the field where MathScript can cover, it does not need to combine with Matlab environment. In the reconstruction process of explosion pressure field, selecting MathScript node is convenient for researchers to modify the script in the node, rather than repeat the package as the COM component, which can greatly improve the efficiency of programming and save significant time.

In the transient temperature measurement, to correct the measurement results, a dynamic compensation filter model are established, where the constant parameters of model is integrated as the COM into LabVIEW library. Reading a set of data, the compensation results will be obtained by selecting the corresponding COM component object without starting from scratch every time. Thus using packaged components directly can reassemble and match the test system at any time. This method greatly improve the flexibility of dynamic compensation, simplify the process of data processing and shorten the

development cycle of the test system, therefore it is widely used. However, its starting time has a little long, the data structure is limited.

In short, each method has its own characteristics and application limitations. According to own needs, users should appropriately select the methods in LabVIEW to futher reduce the workload and improve work efficiency. In the explosive measurement, the mixed programming with LabVIEW and Matlab used to expand the LabVIEW's function has a high practical value and engineering value.

## References

[1] MENG Liang, GUO Xiu-yuan, CHUI Xin-qiang, et al. Thermocouple temperature control system based on LabVIEW. Process Automation Instrumentation, 2014, 35(1): 33-35.

[2] LI Fei, ZHENG Heng. Application of composite programming of LabVIEW and Matlab to test of digital antenna array. Measurement & Control Technology, 2007, 33(3): 1-3.

[3] YU Hai-qiang. Application of LabVIEW and Matlab mixed language programming in the bling signal separation. Microcomputer & Its Applications, 2011, 30(18): 11-13.

[4] SONG Guang-dong, WANG Chang, WANG Jin-yu, et al. Implemening mixed programming with LabVIEW and Matlab based on DLL technology and COM component technology. Computer Application and Software, 2013, 30(1): 287-289.

[5] CHEN Shu-xue, LIU Xuan, SHEN Da-wei. LabVIEW bible. Beijing: Publishing House of Electronics Industry, 2011.

[6] HUANG Shi-kui, PENG Yu-ning, XIE Shu-ping, et al. Methods and application of mixed programming with LabVIEW and Matlab. Research and Exploration in Laboratory, 2009, 28(7): 67-71.

[7] LU You-lan, PENG Tian-hao, ZHU Liu-ying. Mixed programming with Matlab and LabVIEW and its application in control system. Machne Tool & Hydraulics, 2009, 37(10): 209-212.

[8] PEI Feng, YANG Wan-sheng. Mixed programming with LabVIEW and Matlab. Application of Electronic Technique, 2004, (3): 4-6.

[9] ZI Jin-gan, LIAO Ke-jian, PAN De-hui, et al. Study and implementation on program method of LabVIEW combined with Matlab. Computer Measurement & Control, 2008, 16(5): 737-739.

[10] CHEN Xi-hui, ZHANG Yin-hong. LabVIEW8.20 programming from entry to the master. Beijing: Tsinghua University Press, 2007.

[11] YAO Juan. The design of software platform of distributed measurement system based on WALN. Taiyuan: North University of China, 2013.

[12] PEI Feng, WANG Cui-ying. Seamless integration between LabVIEW and Matlab based on COM technology. Electronic Instrumentation Customer, 2015, 12(2): 97.

# LabVIEW 与 Matlab 混合编程在爆炸场测试中的应用

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**摘　要：** 介绍了 LabVIEW 与 Matlab 混合编程的几种方法，并以爆炸测试为应用背景，研究了使用 MathScript 节点和 COM 组件技术进行混合编程的设计方法和实现过程。在此基础上，将 LabVIEW 强大的界面开发能力与 Matlab 丰富的数据运算函数相结合，实现了对爆炸测试的压力场拟合以及对温度测试结果的动态补偿修正。

**关键词：** LabVIEW；MathScript 节点；COM；混合编程；爆炸场测试

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