

Study on the method of test and control system for low speed wind tunnel

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Abstract. The wind tunnel test control is the key to the wind tunnel tests. This article Studied 0.75m × 0.75m With backflow wind tunnel measurement and control technology, through the transformation of the wind tunnel motor to improve the stability and uniformity of the airflow and reduce turbulence degree; through transform angle institutions, increase the angle of attack, sideslip angle and roll angle finesse; through the study of data acquisition and control system, to ensure the fidelity of the data. Effectively improve the scientific nature of the wind tunnel.

1 Introduction

The wind tunnel is one of the basic means of air dynamics research, is a simulation test device is used to generat eartificial wind and man-made airflow, through wind tunnel test can be (volume) of each point on the test model of air pressure, airspeed, air density and other characteristics, get the relevant wind total air pressure distribution of the data, the aerodynamic research aircraft and other objects are used to model the movement in the air in effect or air. At present, widely used in aerospace, weapons, industry, agriculture, building industry, energy, shipbuilding etc.

2 Parameters of wind tunnel index requirements and test measurement

If the device of generates airflow windtunnel is the heart,test system of wind tunnel wind tunnel is the eyes and ears to get the data accuracy and precision is very important link to guarantee the successful test, performance test system of the wind tunnel experiment is very important.

2.1 Requirements of some index of wind tunnel device

For the wind tunnel, flow stability is the key, in relation to the measured data is true, can be applied to actual project, the following general commonly used indicators: (1) the stability of airflow (relative fluctuation amount does not exceed the $\sigma \leq \pm 0.25\%$); (2) the velocity uniformity (a section of each point gas velocity and the cross section flow the average velocity root mean square deviation); (3) direction uniformity (air flow direction and wind tunnel axis angle more than plus or minus 0.5 degree or plus or minus 0.75 degrees); (4) the turbulence intensity (low speed wind tunnel flow turbulence, the original $\varepsilon = 0.16\%$).

2.2 Parameters of wind tunnel measurement

Wind tunnel tests include conventional force, pressure test, flow field test, dynamic test.

During a routine test measuring parameter balance signal, lift, drag, side force, yawing, pitching moment, all kinds of the hinge moment of control surfaces. And all the balance cavity and core pressure, temperature, pressure balance cavity, the bottom model wind tunnel, static pressure, total pressure, total temperature model angle of attack: about a dozen to twenty several parameters.

The pressure surface model measurement parameters have dozens of points to thousands of points. The wind tunnel of range pressure measuring parameter dozens of points to hundreds of points. Dynamic test parameters of pressure fluctuation and vibration signal of various alternative general points to dozens of points.

Parameters of wind tunnel test, is a physical quantity through a variety of sensor output into voltage, current, frequency signal and other , the simulated signal sensor sends is converted into a digital signal is sent to a computer storage, data acquisition, transform(A/D) and calculate etc; the acquired data collation, analysis, calculateon, filtering, compression, extension, prediction and assessment to the extraction of information from data is very important for calculateon etc, and

expressed in text, charts, graphics, image or sound way out, data processing.

2.3 wind tunnel measurement principle

The quality of data in wind tunnel experiment is very high and very low, from the experimental data uncertainty measure to assess the size of the data, the evaluation of uncertainty is the key of the wind tunnel experiment process.

We designed the experiment research process, gives a wind tunnel experimental study of flow and experimental data on the influence factors of uncertainty, do:

(1) the wind tunnel the purpose of the experiment and experimental data uncertainty analysis are put forward at the same time, in the experimental design at the same time, estimation of uncertainty of the experimental data.

(2) experimental data uncertainty analysis runs through the whole process of the experiment.

(3) the quality of the experimental data with "veto power" for the wind tunnel experiment.

(4) the experimental data uncertainty analysis and estimation is an important part of the report of the experiment.

(5) the reliability design of experiment and test system is the key link to ensure the quality of the experimental data.

(6) do not consider the air compressibility, considering the air compressibility.

3 The design of the wind tunnel testing system

3.1 basic requirements for wind tunnel testing system

Wind tunnel testing system should meet the following requirements:

(1) online self calibration function. Energy detection, diagnosis and troubleshooting in the process of wind tunnel test, improving test efficiency, guarantee the reliability of test data.

(2) meet the routine test, wind tunnel test of a complete detection platform under the unified construction test and dynamic test.

(3) multi trigger modes to meet the test requirements.

(4) should have to display the detection process and method is direct viewing, with friendly man-machine interface.

(5) is stable, in the complex work environment, to ensure the accuracy of test data.

3.2 Analysis of testing system

At present when we the detection of equipment for wind tunnel test of continuous is high precision, intelligent, high reliability direction, modular instruments computer is most used in wind tunnel test method and device and simulation, the principle is through modular instruments to some external intelligent measurement, and the make data back to the computer, realize, display, print, calculation and other functions. Modular instrument is based on bus structure of certain integrated A/D converter and D/A converter, interrupt system, has the advantages of high integration, small volume, strong function, low power consumption, strong anti-interference ability, stable and reliable, flexible assembly, moderate price etc..

Bus structure, mining is a kind of mature technology for the wind tunnel experiment, reliability and integration are high modular instruments, as an experimental equipment for the wind tunnel experiment of conventional force, experiment of coefficient, special force and dynamic force measurement experiments can by provide online test self calibration function, module instrument provides programmable gain and filtering function.

provide a very effective method for the test data and system, the DSP chip module inside the instrument provided by the main control computer can reduce the heavy calculation work, the main control computer system resources can be greatly released and optimization of system resources.

More commonly used is VXI bus structure. The utility model has the advantages of high integration degree.

(1) the structure is compact, has high reliability and strong anti-jamming capability.

(2) DSP (digital signal processing) chip, the function of the instrument is improved.

(3) online calibration function with, simplifies troubleshooting.

(4) improve the local bus makes module information exchange between ability, also support the

1394 protocol, easy and computer communication.

(5) with open structure, flexible use, easy to expand.

3.3 data acquisition

Include sample and hold conditioning, signal data processing system involved, various signal processing (digital, analog / digital / analog, voltage / frequency), DSP chip, bus interface, analysis and processing, digital signal display and other recording advanced database, computer local area network, the anti-interference technology.

The data acquisition system consists of signal conditioning, data acquisition, computer and interface circuit, the digital to analog converter, the digital quantity input / output (frequency) etc.

Design points of 4 FD-1 wind tunnel testing system

The advanced measurement and control system for low speed wind tunnel of our $0.75\text{m} \times 0.75\text{m}$ reflux was modified, with industrial control computer as the core, the re establishment of the computer control software, the software based on the WINDOS2000 and above as the programming platform, control of the whole control system of the wind tunnel and the data acquisition and data processing system. Powered by the DC speed regulator; the model angle of attack, sideslip angle by using full digital AC servo control, model angle, wind speed is controlled by computer unified issued the instruction execution, automatically by the actuator, the computer at the same time data acquisition and data processing, and gives the experimental data curve model of each component and under different conditions, and the establishment of model experiment the database, so that the query and print. Wind tunnel control system after transformation and data acquisition system to achieve automatic function.

4 angle mechanism and system control

4.1 angle mechanism

The perspective of mechanism design for automatic control, using the Japanese full digital AC servo angle control. Its characteristics: (1) high control precision, the high precision angle, speed control performance, which is widely used in CNC equipment and related fields. The output shaft of the motor angle accuracy is up to $5'$; (2) the output torque, constant torque output, zero speed also has torque output; (3) good dynamic characteristic, can be quickly stop without affecting the control precision; (4) small volume; (5) simple control and easy maintenance.

4.2 system control and data acquisition

Using industrial control computer as the core. diagnosis and troubleshooting, DC drives, AC servo respectively isolated type 12 D/A card, servo multi axis control card consists of industrial control machine (do not consider the aircompressibility) according to realize the automatic control of the experimental requirements through. Force measuring experiment balance data(with open structure), wind speed by computer through a 12 bit high-speed A/D acquisition. Using the micro differential pressure transmitter for measuring wind velocity, i.e. using micro differential pressure transmitter to measure atmospheric static pressure to calculate the relative velocity in the test section. With the use of high input impedance, high common mode rejection ratio, low offset voltage and the offset current, and it has a wide frequency band. The motor control cabinet to replace, and with low voltage electrical apparatus corresponding (low voltage electric appliance use Schneider products) and display instrument. Can display the current speed(multi trigger modes), the motor working current and voltage.

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