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EDITORIAL

Special Issue on Electromechanical Coupling Design for Electronic Equipment

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With the development of electronic equipment to high accuracy, high density, high frequency, and atrocious service environment, the functional surface in this type of equipment has increasingly serious problems, because it not only guarantees the equipment electrical/magnetic/light/heat specific physical properties, but also restricts the improvement of equipment performances. Therefore, it is necessary to study the key scientific problems of functional surface and to develop the systematic theory for accurate design, refined manufacturing and performance guarantee of functional surface. It will also makes the solid science foundation for design and manufacture of the next generation electronic equipment.

Thus, we issue a special issue column in Chinese Journal of Mechanical Engineering (CJME) on Key Scientific Basis for Accurate Design and Performance Guarantee of Functional Surface. Our special issue column aims to provide an overview of current research about the key scientific problems of functional surface and summary the new theory and the new methods about solving the problems that exist in the design and manufacture of the functional surface. By the deadline at the end of May 2016, we have received many submissions to the special issue. In order to publish selected papers timely, the Journal has decided to publish peer-reviewed papers in several issues.

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In this first issue, 7 papers are accepted covering several aspects such as new methods for analysis and optimization of functional surface, coupled modeling between different disciplines, exploring of the influence mechanism, integrated optimization design, etc. As for the aspects of new methods and new theories, the paper by Zhenyu LIU shows us a new method for the shape error analysis of functional surface. In order to overcome the drawbacks of traditional finite element geometry, the Isogeometric Analysis (IGA) is proposed. By developing a new IGA beam element, the maximum relative errors of the deformation in the three directions of cantilever beam benchmark problem between analytical solutions and IGA solutions are less than 0.1%. In addition, through the application of the developed IGA beam element in the Root Mean Square (RMS) error analysis of reflector antenna surface, the IGA method is able to achieve the accurate solution with less degrees of freedom than standard Finite Element Analysis (FEA).

Besides, it is also necessary to deal with multiple constraints and to improve computational efficiency of optimization techniques. Chao JIANG in his paper gives an improved technique for constrained optimization. In order to improve efficiency, an improved differential evolution with shrinking space technique and adaptive trade-off model, named ATMDE, is proposed to solve constrained optimization problems. The proposed ATMDE algorithm employs an improved differential evolution as the search optimizer, and uses the adaptive trade-off model to select better individuals to retain into the next population. Then the shrinking space technique is designed to shrink the search region according to feedback information in order to improve computational efficiency without losing accuracy.

What's more, Enming MIAO makes some research about the thermal error modeling method. As the existing of the volatility of temperature-sensitive points, the

forecasting accuracy of multivariate regression model is severely affected, and the forecasting robustness becomes poor. In order to overcome this effect and enhance the robustness of thermal error compensation model, a modeling method of establishing thermal error models by using single temperature variable under the jamming of temperature-sensitive points' volatility is put forward.

In the research about the key scientific problems of functional surface, the most important things are the coupled modeling among the different disciplines and the exploring the influencing mechanism of different factors. Wei WANG studies the effect of facet displacement on radiation field. As low accuracy and low efficiency are the common disadvantages for traditional panel alignment and adjustment, a new method is presented to determinate the panel adjustment values from far field pattern so that the surface accuracy of large reflector antenna will be improved.

As for the radome, another form of functional surface, the paper by Peng LI shows a novel and simple compensation strategy based on phase modification to mitigate the degradation of radiation characteristics caused by composite material radome, which is different from the modification of geometric shape by grinding process. The modification formulas are proposed which are used to calculate the adjustment magnitudes of feed or sub-reflector, so that the modification of phase distribution in the original aperture of an enclosed reflector antenna can compensate the phase shift caused by composite material radomes and minimize the phase difference in transmission aperture.

In order to find out the influence mechanism of surface roughness on the functional surface, in the paper of Na LI, the roughness is simulated using the electromechanical coupled (EC) model in order to obtain the relationship between roughness and the antenna's radiation properties. Through a contrasting experiment, the advantage of the EC model is validated, and the conclusion is obtained that the existence of roughness strongly broadens the beamwidth and raises the side-lobe level of SWA, and with the maximum value being 1.2 times greater than that obtained by a smooth antenna.

How to do the optimized design of the functional surface is the key to make the theory applicable in the reality. As for this aspect, Shuxin ZHANG in his paper proposes two-step structural design strategy to overcome the beam squint phenomenon for high beam pointing accuracy design of circularly polarized offset cable mesh reflectors. As for the design strategy, a simple structural optimal design and an integrated structural electromagnetic optimization are combined. Besides, in order to increase the efficiency of integrated optimization, an update Broyden-Fletcher-Goldfarb-Shanno (BFGS) Hessian matrix is employed in the optimization iteration with sequential quadratic programming.

Summary, this first issue attempts to provide the latest research achievements about the key scientific problems of functional surface. Coupled modeling, exploring of the influence mechanism, analyzing and solving of coupled problems and optimization design of functional surface, all of these are indispensable parts of the research, which are also the foundation for design and manufacture of the next generation electronic equipment.

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