THE USE OF FINITE ELEMENTS AND NEURAL NETWORKS FOR THE SOLUTION OF INVERSE ELECTROMAGNETIC PROBLEMS

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Introduction

The Finite Element Method (FEM) is a widely used method for solving electromagnetic problems. It is usually used in an analytical manner where a solution of the electromagnetic field is found for a defined set of boundaries and sources. The resultant potential distribution is then processed for quantities such as induced voltages, forces and so on. However in many instances the requirement is the synthesis of a design to satisfy a specific performance criteria. This requires the solution of the inverse electromagnetic problem which leads naturally to the design systesis of electromagnetic devices. An example of the inverse electromagnetic problem is the design of a motor.

Inverse electromagnetic problem

The inverse problem has been addressed in some recent publications [1,2]. In the methods described, the geometric structure and the distribution of materials are represented by a set of parameters. An objective function is set up to describe the difference between the ideal and actual characteristics of the device. Therefore, changes in the parameters in the optimization process will cause the value of the objective function to change. These parameters are adjusted in the optimization process till the objective function is minimised. This method requires a FE calculation to follow every change in parameters. It is thus computationally intensive and can be prohibitive.

The Use of Finite Elements and Neural Networks

In this paper the use of neural networks (NN) with the FEM in the solution of the inverse electromagnetic problem is introduced. Neural networks have many applications. The solving of mapping problems is one of its strength [3,4]. Once trained a NN provides very quick solution in mapping. This mapping capability can be combined with FE to solve inverse problems. This method the primary data is similar to those describe by earlier publications and are decided by experience. Hoever the objective function formed is used to describe the difference between the ideal properties and the actual properties of the neural network and not the design. The design parameters, the geometric structure and the distribution of the materials, are represented by the weights of the network. Fig.1 shows the flow chart of the application of finite elements and neural network.

In this method the FE calculation are used to form the training patterns to train the net then the optimisation process would only require a FE to check the optimised design. The optimization is process is thus performed by the neural network which has been trained. If the mapping error is unacceptable, the structure of the network will be adjusted until it is acceptable. This is an effective method as optimization with neural networks have been widely publised. In the method proposed, the main component of the computer time is taken for training the neural network. In our implmentation the Forward Generating Neural Network (FGNN) [3] is used and the one time training of this net takes very little time.

FENN : its application in the design of a permanent magnet motors

The FENN method is used in the design of a permanent-manget motor which is characterised by a trapeziodal airgap flux waveform.

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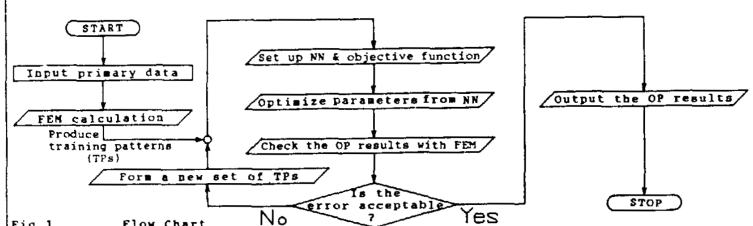

Fig.1 Flow Chart For Solving Inverse Electromagnetic Problems Using FE-Neural Network

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