Computational Method in Building Database for Crack shape Recovery Arising in Eddy Current Testing

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Abstract: This paper is concerned with computational method in building database, called ECT database, which is used in crack shape recovery arising in eddy current testing. Firstly, ECT simulation model with nodal-based FEM is introduced. Secondly, computational method using parallel virtual machine in building ECT database is overviewed. Finally, usage of this database is discussed.

Keywords: Eddy current testing (ECT), simulation, database, finite element method (FEM), parallel virtual machine (PVM).

1. Introduction

Eddy current testing (ECT) has been widely used by in-service inspection for detecting flaws in conducting materials, especially in nuclear plan, because of its high detection ability and rapid scanning process. Recently, many advance methods of ECT scan have been developed, including T-scan, U-scan...etc. In these scanning methods, pairs of coil, transmitter and receiver coils, is used to produce two-dimension magnetic images. Then, defects in the conducting material can be recovered from those magnetic images.

This paper introduces a strategy to build database, using ECT simulation with nodal-based finite element method (FEM), for later use in flaws detection based on the images produced by scanning process. The database stores pre-calculated data with various parameters regarding crack dimension, coil specification, location of source points, measurement points and output values of the model corresponding to input parameters.

In ECT simulation with nodal-based FEM, tremendous computational efforts are required in calculating output values at each scan point. To reduce the time consuming in building database, a master – slave model running in parallel virtual machine is introduced. The module working in PVM is acting as a Solver service in the TCP/IP networks. The service allows clients from independent platforms to access for submitting requests and retrieving results to store in the database.

This paper is organized as following: In section 2, ECT simulation is introduced, input parameters are also discussed. In section 3, database structure is proposed. Section 4 introduces computational models, including client-service model and master-slave model in PVM. Final part of the paper is devoted to concluding remarks and potential usage of ECT database.

2. ECT simulation with nodal-based FEM

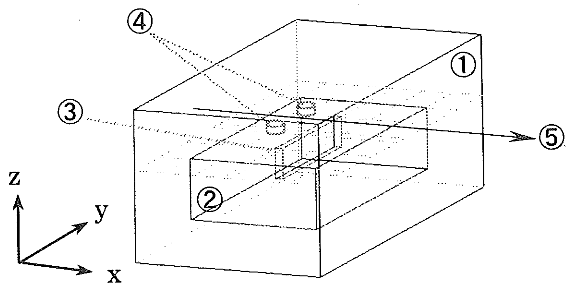

Fig. 1 Perspective of ECT simulation model

① air region
② conducting material
③ crack
④ transmitting and receiving coils
⑤ scanning direction

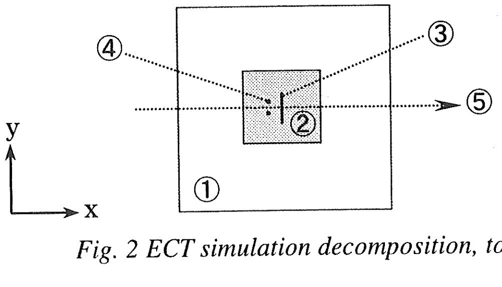

Fig. 2 ECT simulation decomposition, top view

Figure 1 depicts the overall characterization of the ECT simulation model, using in building ECT database. Another view of ECT simulation decomposition is shown in Figure 2.

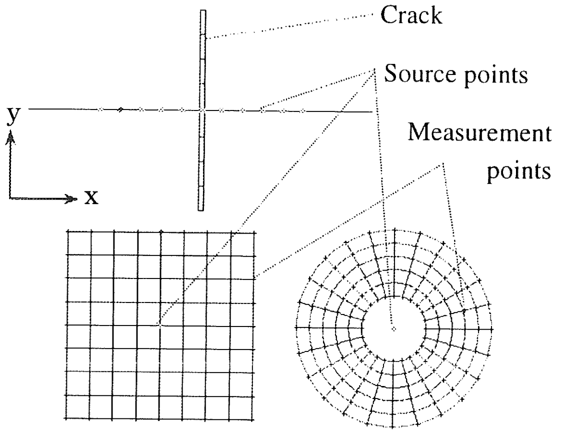

Fig. 3 Source points and measurement points

Figure 3 shows the strategy of assigning source point and measurement points for calculation. These points are equivalent to the position of transmitter and receiver coils in the real system.

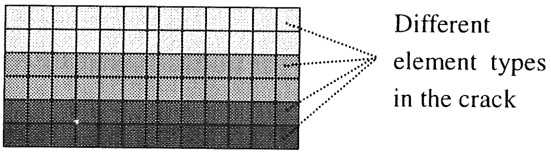

Fig. 4 Crack conductivity shape

Figure 4 describes the crack conductivity shape information. Each element type in the crack conductivity shape is equivalent to one value of sigma, ranging from 100% to 20%, 10%, 2%, 1%, 0% of conducting material.

3. Database structure

The structure of ECT database is proposed as follows:

(i) Table *Coil*: Coil information, including size, current value, frequency...etc
(ii) Table *Crack*: Crack width, length and depth
(iii) Table *Shape*: Conductivity shape of the crack
(iv) Table *Sigma*: Values of sigma corresponding to element types in crack.
(v) Table *Output*: Simulation values corresponding to positions of source and measurement points.

4. Computational model

This model provides a scalable service for building ECT database. The host service is waiting for requests from clients. Once a request is accepted, the workloads are distributed to slaves in the PVM pool. The results then will be collected to be sent back to client.

In client side, users can select input parameters, such as coil information, crack dimension...etc and send request to the host service via TCP connection.

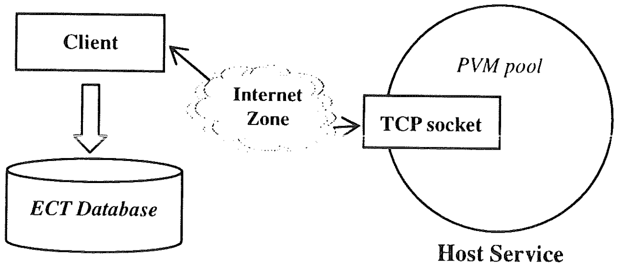

Fig. 5 Solver service model

5. Conclusion

A feasible method was introduced to build ECT database, including simulation model, databases structure and parallel distributed computational method using PVM.

The next state of our study is concerned with developing an artificial intelligent approach to use ECT database in crack shape recovery, to detect not only flaws but also determine the size, shape and orientation of the cracks in the conducting material, based on magnetic images obtained by ECT scanning technique.

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