Non-destructive assessment of three-dimensional profile of real cracks from eddy current testing signals

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Abstract **The paper addresses real cracks' reconstruction from eddy current non-destructive testing signals. Novel approach for three-dimensional diagnosis of real cracks is presented. Eddy current testing signals are recorded during two-dimensional scanning over a material surface and they are employed for solving the inverse problem using the tabu search stochastic method. Moreover, three spatial components of the perturbation field due to the cracks are sensed to enhance the preciseness of diagnosis.**

Keywords **Non-destructive evaluation, eddy currents, real cracks, three-dimensional profile, inverse problem, tabu search**

I. INTRODUCTION

Eddy current testing (ECT) is one of the widely utilized electromagnetic non-destructive evaluation methods. However, several drawbacks limit full employment of the ECT potential in practical applications. One of them comes from a fact that the ECT is relative method and the inverse problem is ill-posed [1]. Recently, quite satisfactory results are reported by several groups for automated evaluation of artificial slits [2] and even for several parallel notches [3]. However, evaluation of real cracks from the ECT response signals remains still very difficult. One of possible reasons is that actual ECT probes do not provide sufficient information resulting from findings that a stress corrosion cracking is partially conductive while its conductivity is not known in general and can vary from one case to the another [2].

Usually, one dimensional signal gained by scanning just above an indicated crack along its length is taken as an input to an evaluation procedure. Mostly, three variables of the defect are estimated, i.e. its depth, length and position of its centre, while a profile, a width and the electromagnetic parameters of the defect are considered to be known in advance. Additionally, standard ECT probes sense only one spatial component of the response electromagnetic field; however, the other two components can also essentially contribute [4].

The authors have already developed novel algorithm for three-dimensional reconstruction of multiple notches from ECT signals by means of a stochastic optimization method, such as tabu search [3]. Several original studies of the authors have also focused on enhancing information level of eddy current testing signals and on decreasing uncertainty in evaluation, especially in case of partially conductive cracks' diagnosis [4]. Promising complementary results gained by authors in their previous works create new challenges concerning development of automatic procedures for precise diagnosis of real cracks.

II. NOVEL DIAGNOSIS OF REAL CRACKS

The tabu search [3] is applied for the three-dimensional diagnosis of real cracks. Novelty of the proposal comes from the utilization of two-dimensional response signals for the inversion and moreover, all the three spatial components of the perturbation electromagnetic field are employed for the diagnosis. A database approach originally developed for fast-forward computation of the ECT response signals due to multiple notches [3] is used in this paper. The database is designed for a three-dimensional defect region and not as usually for a two-dimensional one where a crack is considered as a non-conductive one with a fixed width. Three-dimensional crack model of complex shape is applied for the diagnosis of geometry as well as conductivity of an indicated crack. The full paper will present detailed background of the study, description of the proposal, gained results and corresponding discussions.

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