

# Topics On Nondestructive Evaluation

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## **Topics on Nondestructive Evaluation Series**

B. Boro Djordjevic and Henrique Dos Reis, Series Editors

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## **Volume 4**

### **Automation, Miniature Robotics and Sensors for Nondestructive Testing and Evaluation**

Yoseph Bar-Cohen, Technical Editor

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**9.3      *Robotics NDE of Steel Highway Structures and Bridges - Margarit G. Lozev, Virginia Transportation Research Council, Charlottesville, VA***

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**9.4      Application of Automated NDT in Nuclear and Steel Plants - Tariq P. Sattar, South Bank University, London, England**

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**9.5      *A Review of Applications of MEMS for NDE - George Matzkanin, TRI, Austin, TX***

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	<b>JOSEPH BAR-COHEN, PASADENA, CA</b>
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## PREFACE

Automation made the greatest impact on many elements of our modern life. This has been the result of enabling the production of extremely large number of affordable products with known performance within predefined specifications. The dictionary definition of automation suggests a self-acting mechanism, i.e., a mechanism or technique of executing a process or making a product without physical labor. When applied to nondestructive testing and evaluation, the process can be done significantly faster, more reliably and at lower cost. Automation transitioned the inspection technology from batch operation to a self-acting inspection of industrial products and processes. Real-time, on-line process evaluation improves the quality and ensures the integrity of products throughout their life cycle.

The evolution of microelectronics, computers and the internet helped making superb automatic capabilities that can also be controlled remotely. Robotic systems represent an important element of automation - they emulate biologic mechanisms, and sometimes they are equipped with a locomotive capability. Robotic NDE is a relatively new field and there is still some misconception perceiving it as science fiction or as an expensive and inapplicable to perform one-of-a-kind inspection. In recent years, significant progress has been made in robotics and there is a growing recognition of the potential role that it can play to become an effective inspection workhorse. Generally, automatic NDE minimizes human errors, increases the probability of detecting flaws, can be operated at harsh environments and rapidly provides accurate data for quantitative NDE. Besides improving the speed and reliability of inspection processes, automation is increasing the probability of detection (POD) of small flaws. Using computerized signal processing, NDE systems are now capable of handling extremely large number of replicate samples and related databases at unprecedented speed and efficiency. Such systems greatly increase the efficiency of NDE methods and they are improved continuously with the evolution of science and technology.

Technology evolution took such systems as ultrasonics C-scanners from analog rigid mechanical bridges to computer controlled systems with contour following capability for lab and shop conditions. For field inspection, portable scanners have emerged and wall climbing crawlers were developed for scanning of complex geometry structures. The recent introduction of open-architecture robotic platform approach (see discussion on Chapter 3), in the form of Multifunction Automatic Crawling System (MACS), enabled the simultaneous operation of several NDE methods using a single scanner. Such a crawler can travel on the inspected structure and automatically perform tasks that can be controlled remotely and can eventually be made autonomous. Using a robotic platform that integrates a suite of sensors and intelligently scan structures is expected to introduce more affordable systems and rapidly transition new technologies to practical use. This approach allows using commercially available components and standard personal computers' bus structure to lowering the cost of hardware allowing NDE manufacturers to concentrate on implementing their technology into board level products.

Generally, NDE is an interdisciplinary field, which covers a wide range of science and technology areas. Even though automation is an important element of NDE, traditionally, it was left mostly to the industry responsibility and it evolved with the overall progress in electronics, computers and NDE. The number of related projects and the portion of government research funding invested in this area have been relatively small compared to the resources that were

dedicated to developing new methodologies and inspection techniques. Further, the issue of automatic NDE was not a theme of major conferences or symposia. Even seminars and workshops on this topic have been numbered and one of the notable ones is a small Topical Seminar entitle "Automated Nondestructive Testing," which was held at Idaho University in 1983 [McGonnagle, 1983]. The maturity of the field of robotics and the growing trend towards greater use of automation is now well recognized by the American Society of Nondestructive Testing (ASNT). Since October 1996, under an initiative of the Editor of this volume, the topic of robotics and automation has been routinely covered by Sessions of the ASNT Semi-Annual Conferences. Further, the Editor of this Volume led to the inclusion of Automation in the theme of the 8th Annual NDE Research Symposium (held at the end of March 1999 in Orlando, Florida).

The emphasis of this book is on NDE of structures, where its Editor took the challenge to bring the topic of robotics and automatic NDE to the spotlight and the center stage of the field. He solicited a team of leading experts who contributed chapters and/or sections to making this book an informative resource. This book is covering such topics as automation, robotics, sensors, actuators, intelligent NDE, signal and image processing as well as applications of automatic NDE. The technology is rapidly evolving and it is impossible to avoid obsolescence, therefore this book should be viewed as a technology bookmark for the status of automatic NDE at the beginning of the 3<sup>rd</sup> millennium.

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**Reference:**

McGonnagle W. J. (Ed.) "Automated Nondestructive Testing: Proceedings of a Topical Seminar 1986," Gordon and Breach, New York, Proceedings of a topical seminar sponsored by ASNT, South Idaho Section, June 1983.