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Virtual Manufacturing

Springer

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Preface

According to MSN Encarta the term 'virtual reality' is commonly used to express Simulated Reality, Computer Simulation, Simulation, Cyberspace, Computer Modeling or Computer Graphics. In today's scientific scenario, virtual reality is classified on a continuum from Real environment to its variations to virtual environment. These variations of virtual reality are from real environment to augmented reality to augmented virtuality to the virtual environment. All the intermediate representations are known as mixed reality.

Azuma et al. describes the Augmented Reality (AR) in their survey paper published in IEEE Computer Graphics and Applications [November/December 2001] as having the following properties:

1 AR combines real and virtual objects in a real environment;
2 AR runs interactively and in real time, and;
3 AR registers (aligns) real and virtual objects with each other.

The world of virtual reality still requires a specific definition of virtual reality considering the domains it is addressing. In such cases the particular research group provides a relevant definition. In this book, the augmented reality as defined by Azuma et al. is considered applicable.

A discrete manufacturing operation involves tangible activities such as machinery and its operation, use of tools and measurement gadgets, use of pick and place technology and use of storage and transportation equipment etc. On the other hand, the intangible part includes services such as process planning, scheduling, inventory, management information system and business accounting etc.

Establishment of discrete manufacturing facility for specified range of discrete products includes the factory and offices layout, machinery layout, operation of design office, operation of new and old machinery, production planning and control, scheduling, assembly, quality assurance, inventory, transportation, budgeting and accounting and financial activities. Monitoring of all these and other functions is required once the facility has been setup and is functional.

Modern virtual reality techniques using programming languages such as VRML (Virtual Reality Modeling Language), Open GL and object oriented tools C#, Java and Small Talk have allowed extension of concepts of real time simulation to real time simulation with user control in feed back environment. The simulation can be implemented to the extent that from an elaborate statement of corporate strategy to the smallest movement of part of the machine can be modeled and controlled. The supporting database allows maintenance of properties of metal in interaction with a moving tool, storage of different type of simulated machinery and other models and parameters. These models are based on mathematical or procedural methods facilitating functional characteristics of processes such as scheduling and process planning respectively.

The scope of this text is to describe development of virtual factory simulation software for discrete manufacturing based on Object Oriented Design (OOD) using Unified Modeling Language (UML). This book builds up from description of a micro level virtual reality construction of machine component to the virtual reality construction of discrete manufacturing organization. The executable version of virtual factory software for discrete manufacturing is available at the publisher's website (www.springer.com/). There is a scarcity in the market for a title, which has been written to introduce the students and professionals with virtual reality for Discrete Manufacturing as that of subject that can be practiced best through the study of relevant subject areas and that also addresses the relevant components of the technology. This book describes the concepts and technology associated with manufacturing equipment and their control at process and system level for product realization in modular form. It uses examples elaborating procedure to virtually describe processes and systems used in discrete and continuous manufacturing while experiencing flow of material, flow of information and flow of energy. The major emphasis is given to develop Augmented Reality (AR) for the following control gadgetry:

1. CNC based processes,
2. PLC based processes,
3. Industrial Manipulators,
4. Embedded systems based processes,
5. Mechatronics based processes and
6. SCADA based processes.

These micro level virtual realities are later amalgamated into virtual discrete manufacturing systems composed of procedural and mathematical models for intangible production functions.

The book has been divided into twelve chapters. The book can be consulted on the basis of individual chapters depending on the level of the reader. Chapter 1 sets the theme for the establishment of Augmented Reality based various levels of human computer interactions as the necessary requirement of the factory of the future. Chapter 2 explores the discrete and continuous manufacturing processes and examines the current technological trends. Chapter 3 surveys the current use of automation and control in manufacturing and comments on future directions it

may take. Chapter 4 examines the possibility of using sensors, transducers and actuators in a feed back virtual environment. Chapter 5 provides methodology for converting EIA 274 D based Computer Numerical Controlled (CNC) machinery into corresponding AR based machinery. Chapter 6 provides methodology for converting JIS SLIM (Standard Language for Industrial Manipulator) based manipulators into AR based robot controller. AR for gantry and conveyor is also discussed in this chapter. Chapter 7 details AR based process control using IEC 61131-3 based PLC programming languages. Chapter 8 examines conversion of embedded system based control to AR based processes. Chapter 9 details AR for SCADA based processes. Virtual reality for Mechatronics based applications are explained in Chap. 10. Methodology to simulate the intangible production functions is described in Chap. 11. Step by step construction of AR based discrete manufacturing facility based on either single or multiple CNC based processes, PLC based processes, embedded system based processed, SCADA based processes and/or Mechatronics based processes is described in Chap. 11. Chapter 12 provides the rationale for adopting AR strategy. The description of virtual discrete manufacturing organization uses both UML diagrams and software listing in part. Appendices at the end of the book provide basic information regarding software development process, Comprehensive bibliography is also provided at the end of each chapter to guide reader to the wealth of information available on the subject. This book is intended for manufacturing professionals with a background in mechanical engineering, industrial engineering, computer engineering and computer Science.

This work requires support from its user in order to improve the further editions. The authors welcome comments and suggestions. Authors may be contacted through authors20@yahoo.com

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Professor Dr. Wasim A. Khan holds the first degree in Mechanical Engineering from NED University of Engineering and Technology, Karachi, Pakistan. He later obtained a PhD degree in the area of Operations Research from the Department of Mechanical Engineering, University of Sheffield, UK. He is a chartered engineer (CEng) of the Engineering Council, UK; and a Fellow of the Institution of Mechanical Engineers (FIMechE), UK. He has diverse work experience including working with manufacturing industry, software development for local and overseas clients and teaching production engineering and computer science students. Currently, Dr. Wasim holds a position of Professor at the Faculty of Computer Science, Institute of Business Administration, Karachi, Pakistan.

Professor Dr. Abdul Raouf

Professor Dr. Abdul Raouf is a distinguished scholar of international ranking, having a doctoral degree in Industrial Engineering and over 57 years experience in teaching, research and industry. He was at the University of Windsor, Ontario, Canada for more than two decades as Head of Industrial Engineering. He served King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia as Professor in Systems Engineering Department for ten years. He was Rector Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Pakistan for six years. He has been University Professor and Advisor of University of Management and Technology, Lahore since 2005. Dr. Raouf has been appointed Patron and Professor, Institute of Quality and Technology Management, University of Punjab.

Dr. Raouf has published extensively in the areas of Performance Evaluation which include Modeling and Optimization of Tasks involving Information Conservation, Information Reduction, Information Generation and Production System Optimization in the areas of Quality, Safety and Maintenance of Production

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Recognizing his scholarly pursuits, Dr. Abdul Raouf was bestowed upon the coveted title of 'Sitara-e-Imtiaz' by the Government of Pakistan. He was declared "Best Scientist" in the field of engineering by the Pakistan Academy of Sciences. The Higher Education Commission of Pakistan conferred upon him the title of Distinguished National Professor.

Besides being the Editor-in-Chief of International Journal of Quality in Maintenance Engineering Dr. Abdul Raouf is on editorial advisory boards of nine international research Journals. He is Chairman, National Quality Assurance Committee constituted by HEC. He has been appointed as a member of the Accreditation Committee, Education Department, and Government of Punjab. He is member of Governing bodies of number of public and private Universities.

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