## Proceedings of 2024 International Symposium on Flexible Automation

(ISFA2024)

July 21-24, 2024 Seattle, Washington

Conference Sponsor
Dynamic Systems and
Control Division

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

© 2024, The American Society of Mechanical Engineers, 150 Clove Road, Little Falls, NJ 07424, USA (www.asme.org)

All rights reserved. "ASME" and the above ASME symbols are registered trademarks of the American Society of Mechanical Engineers. No part of this document may be copied, modified, distributed, published, displayed, or otherwise reproduced in any form or by any means, electronic, digital, or mechanical, now known or hereafter invented, without the express written permission of ASME. No works derived from this document or any content therein may be created without the express written permission of ASME. Using this document or any content therein to train, create, or improve any artificial intelligence and/or machine learning platform, system, application, model, or algorithm is strictly prohibited.

INFORMATION CONTAINED IN THIS WORK HAS BEEN OBTAINED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS FROM SOURCES BELIEVED TO BE RELIABLE. HOWEVER, NEITHER ASME NOR ITS AUTHORS OR EDITORS GUARANTEE THE ACCURACY OR COMPLETENESS OF ANY INFORMATION PUBLISHED IN THIS WORK. NEITHER ASME NOR ITS AUTHORS AND EDITORS SHALL BE RESPONSIBLE FOR ANY ERRORS, OMISSIONS, OR DAMAGES ARISING OUT OF THE USE OF THIS INFORMATION. THE WORK IS PUBLISHED WITH THE UNDERSTANDING THAT ASME AND ITS AUTHORS AND EDITORS ARE SUPPLYING INFORMATION BUT ARE NOT ATTEMPTING TO RENDER ENGINEERING OR OTHER PROFESSIONAL SERVICES. IF SUCH ENGINEERING OR PROFESSIONAL SERVICES ARE REQUIRED, THE ASSISTANCE OF AN APPROPRIATE PROFESSIONAL SHOULD BE SOUGHT.

ASME shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B7.1.3). Statement from the Bylaws.

For authorization to photocopy material for internal or personal use under those circumstances not falling within the fair use provisions of the Copyright Act, contact the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, tel:978-750-8400, www.copyright.com.

Requests for special permission or bulk reproduction should be addressed to the ASME Publishing Department, or submitted online at: https://www.asme.org/publications-submissions/journals/information-for-authors/journalguidelines/rights-and-permissions

ISBN: 978-0-7918-8788-2

## TABLE OF CONTENTS

Real-Time Recovery From Cyberattacks on Manufacturing Processes	1
Brijesh Mangrolia, Jeremy Cleeman, Anandkumar Patel, Adrian Jackson, Rajiv Malhotra	
Digital Fringe Projection for Interlayer Print Defect Characterization in Directed Energy  Deposition	10
Guanzhong Hu, Rujing Zha, Yaoke Wang, Jian Cao, Ping Guo	10
Multi-Fidelity Sensing and Digital Twin System for Automated Monitoring in Cooperative Robotic Additive Manufacturing	17
Sean Rescsanski, Tyler Nardi, Vihaan Shah, Jiong Tang, Farhad Imani	
Improved Machined Accuracy Under a Constant Feed Speed Vector at the End-Milling Point Considering Machining Force and Machining Area in Tool Approach	23
Takamaru Suzuki, Toshiki Hirogaki, Eiichi Aoyama	
Monitoring of Chip Flow State in Drilling With Tool Wear Progress	29
Geometric Error Identification Method for Swiss-Type Automatic Lathe by Using Reference Sphere and Displacement Sensor	36
Ryota Kawai, Ryuta Sato	
Verification of Draft Standards of 8-Shaped Motion Test on Five-Axis Machining Centers	42
Forced Chatter Sound in End-Milling Processes for Bamboo Fiber Extraction Using a Machining Center	45
Kaito Tanaka, Reo Kitazaki, Yutaro Nakahara, Masao Nakagawa, Toshiki Hirogaki, Eiichi Aoyama, Hiromichi Nobe	
Effects of Vibration on Performance of Wire-Sawing of Rock in Vacuum	51
Study on Dynamic Characteristics Control System of Machine Tools for Avoiding Chatter Vibration	54
Akio Hayashi, Shotaro Takeuchi, Yoshitaka Morimoto	
Development of a Contactless Load Generator for Spindle Dynamic Compliance Measurement	57
Automated NC Program Generation for Complex Shapes With 5-Axis Indexing Machining	60
Reduction of Roughing Process by Near-Net Shape Manufacturing Using Sheet Metal Laminated Molds	64
Chihiro Ota, Hidenori Nakatsuji, Isamu Nishida	
Dynamic Behavior Analysis of Yarns During Knitting Process of Fabrics	68
Deformed Shape Prediction of Knitted Fabrics at the Stitch Level Based on Deep Learning	74

Design Optimization and Visualization of the Scope of Influence on Requirement Changes Using	90
Systems Modeling Language	80
Development of Sand Compaction Control System Using Admittance Control Approach in Sand Molding Robot	86
Haruki Ichiyanagi, Yoshiyuki Noda	
Design of Facile Dielectric Elastomer-Based Bending Module for Soft Robotics Applications	92
A Buffer-Based Steel Production Scheduling Under Uncertain Environment	102
Production Planning Algorithm for a Pre-Cut Lumber Factory Using Metaheuristics	106
Machine Learning-Enhanced Model Predictive Control for Incremental Bending of Skeletal Fixation Plates	112
Yixue Chen, Jianjing Zhang, Tyler Babinec, Brian Thurston, Glenn Daehn, David Dean, Kenneth Loparo, David Hoelzle, Robert X. Gao	
A Proposal of Production Planning Method Including Parts Allocation Change for Realization of Mass Customization	120
Daisuke Kokuryo, Toshiya Kaihara, Shinsuke Tsutsui, Kenichi Harano, Yasuhiro Nomura	
Designing a Mobile Manipulator and Motion Planning for Autonomous Navigation With A* and Q- Learning Algorithms	126
Md. Kaimujjaman, Tatsushi Nishi, Tomofumi Fujiwara, Ziang Liu	
Development of a Digital Metal Forming System	132
An Improved Method for Job Shop Scheduling by Means of Machine Learning and Mathematical Optimization	139
Eiji Morinaga, Atsuya Oda	
Development of Camera System for Monitoring Robotic Polishers	145
A Study on Hierarchical Production Planning Framework for Engineer-to-Order Production of Large Products	151
Koji Iwamura, Eiji Morinaga, Yoshiyuki Hirahara, Masamitsu Fukuda, Ayumu Niinuma, Hirotomo Oshima, Yasuo Namioka	
Geometric Simulation of 5-Axis Machining With Descrete Placement of Tool Models	155
Prediction of Blind via Hole Quality Based on Stacking Ensemble Learning for Laser Drilling Condition of Printed Circuit Boards	159
Nowatari Soma, Nakagawa Masao, Hirogaki Toshiki, Aoyama Eiichi	207
Development of Training Simulator With Graphs of Operational Status for Efficient Acquisition of Pouring Skill in Casting Industry	167

Offline Teaching Algorithm to Pass Through the Singularity for Robot Machining	172
Prediction of Touch-Trigger Probing Error Profiles by a Six-Axis Robot	178
Agile Surface Inspection Framework for Aerospace Components Using Unsupervised Machine Learning	184
A Lightweight and Transferable Design for Robust Lego Manipulation	191
Transforming Motion Into Sound: A Novel Sonification Approach for Teams of Mobile Robots	201
Modelling Posture-Dependent Denavit-Hartenberg Errors of a Six-Axis Robotic Manipulator	207
Nonlinear Modeling of Ball Rolling Motion on a Horizontal Surface for Improving Grasp-Less Handling by Applying Rolling Friction Torque	213
Error Compensation for a Six-Axis Robot Applied to the Machining of Sand Mold	219
Construction of Robot Drilling System for Large Scale Workpiece Based on Offline Programming	225
Investigation of Localization and Posture Accuracy of AMR During Indoor Mapping Using SLAM With LiDAR and Camera Technology	232
3D Scanning and Reconstruction of Objects Using Cobot System	240
A Recurrent Neural Network Enhanced Unscented Kalman Filter for Human Motion Prediction	244
Integrating Mediapipe Module for Learn From Demonstration on Cobots	252
Anomaly Detection in Square Butt Joint by Friction Stir Welding Using Variational Autoencoder	256
Virtual Sensing by Dense Encoder for Process Signals in Resistance Spot Welding	260
Repetitive Action Counting Through Joint Angle Analysis and Video Transformer Techniques	270
Implementing Eye Movement Tracking for UAV Navigation	277

Ball End Milling and Cutting-Force Monitoring of Small Number of Circular Arc Tooth Gears by	202
4-Axis-Controlled Machining Center	283
Investigation of Tooth Surface Temperature Based on High-Speed Thermography Monitoring Under Meshing of Hypoid Gear With Small Number of Teeth	289
Synchronous Averaging Preprocessing of Gearbox Vibration Signals: A Comparison of Classification Performance	297
Efficient Fault Detection in Bearings: Synergizing Transformer Adaptations With Convolutional Kernel	304
Bearing Remaining Useful Life Prediction Using Personalized Soft Aggregation in Federated  Learning	312
Effect of Thermal Load on Specific Energy Consumption in Heavy-Duty Cutting	319
A Graph-Theoretic Approach for Designing Cable Routes in Buildings	322
Investigation of Tooth Meshing of Natural Fiber Bevel Gears Composed of Only Bamboo Fibers  Extracted Using a Machining Center	325
Developing a Research Instrument to Capture and Understand the Individual Perception of Artificial Intelligence and Automation in Manufacturing	331

**Author Index**