

STEAM-H: Science, Technology, Engineering,
Agriculture, Mathematics & Health

STEAM-H: Science, Technology, Engineering, Agriculture, Mathematics & Health

Series Editor

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This interdisciplinary series highlights the wealth of recent advances in the pure and applied sciences made by researchers collaborating between fields where mathematics is a core focus. As we continue to make fundamental advances in various scientific disciplines, the most powerful applications will increasingly be revealed by an interdisciplinary approach. This series serves as a catalyst for these researchers to develop novel applications of, and approaches to, the mathematical sciences. As such, we expect this series to become a national and international reference in STEAM-H education and research.

Interdisciplinary by design, the series focuses largely on scientists and mathematicians developing novel methodologies and research techniques that have benefits beyond a single community. This approach seeks to connect researchers from across the globe, united in the common language of the mathematical sciences. Thus, volumes in this series are suitable for both students and researchers in a variety of interdisciplinary fields, such as: mathematics as it applies to engineering; physical chemistry and material sciences; environmental, health, behavioral and life sciences; nanotechnology and robotics; computational and data sciences; signal/image processing and machine learning; finance, economics, operations research, and game theory.

The series originated from the weekly yearlong STEAM-H Lecture series at Virginia State University featuring world-class experts in a dynamic forum. Contributions reflected the most recent advances in scientific knowledge and were delivered in a standardized, self-contained and pedagogically-oriented manner to a multidisciplinary audience of faculty and students with the objective of fostering student interest and participation in the STEAM-H disciplines as well as fostering interdisciplinary collaborative research. The series strongly advocates multidisciplinary collaboration with the goal to generate new interdisciplinary holistic approaches, instruments and models, including new knowledge, and to transcend scientific boundaries.

More information about this series at <http://www.springer.com/series/15560>

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Advanced Research in Naval Engineering

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Preface

The multidisciplinary STEAM-H series (Science, Technology, Engineering, Agriculture, Mathematics, and Health) brings together leading researchers to present their work in the perspective to advance their specific fields and in a way to generate a genuine interdisciplinary interaction transcending disciplinary boundaries. All chapters therein were carefully edited and peer-reviewed; they are reasonably self-contained and pedagogically exposed for a multidisciplinary readership.

Contributions are by invitation only and reflect the most recent advances delivered in a high standard, self-contained way. The goals of the series are as follows:

1. To enhance multidisciplinary understanding between the disciplines by showing how some new advances in a particular discipline can be of interest to the other discipline, or how different disciplines contribute to a better understanding of a relevant issue at the interface of mathematics and the sciences.
2. To promote the spirit of inquiry so characteristic of mathematics for the advances of the natural, physical, and behavioral sciences by featuring leading experts and outstanding presenters.
3. To encourage diversity in the readers' background and expertise, while at the same time structurally fostering genuine interdisciplinary interactions and networking.

Current disciplinary boundaries do not encourage effective interactions between scientists; researchers from different fields usually occupy different buildings, publish in journals specific to their field, and attend different scientific meetings. Existing scientific meetings usually fall into either small gatherings specializing on specific questions, targeting specific and small group of scientists already aware of each other's work and potentially collaborating, or large meetings covering a wide field and targeting a diverse group of scientists but usually not allowing specific interactions to develop due to their large size and a crowded program. Traditional departmental seminars are becoming so technical as to be largely inaccessible to anyone who did not coauthor the research being presented. Here contributors focus

on how to make their work intelligible and accessible to a diverse audience, which in the process enforces mastery of their own field of expertise.

This volume, as the previous ones, strongly advocates multidisciplinary with the goal to generate new interdisciplinary approaches, instruments, and models including new knowledge, transcending scientific boundaries to adopt a more holistic approach. For instance, it should be acknowledged, following Nobel laureate and president of the UK's Royal Society of Chemistry, Professor Sir Harry Kroto, "that the traditional chemistry, physics, biology departmentalised university infrastructures—which are now clearly out-of-date and a serious hindrance to progress—must be replaced by new ones which actively foster the synergy inherent in multidisciplinary." The National Institutes of Health and the Howard Hughes Medical Institute have strongly recommended that undergraduate biology education should incorporate mathematics, physics, chemistry, computer science, and engineering until "interdisciplinary thinking and work become second nature." Young physicists and chemists are encouraged to think about the opportunities waiting for them at the interface with the life sciences. Mathematics is playing an ever more important role in the physical and life sciences, engineering, and technology, blurring the boundaries between scientific disciplines.

The series is to be a reference of choice for established interdisciplinary scientists and mathematicians and a source of inspiration for a broad spectrum of researchers and research students, graduates, and postdoctoral fellows; the shared emphasis of these carefully selected and refereed contributed chapters is on important methods, research directions, and applications of analysis including within and beyond mathematics. As such, the volume promotes mathematical sciences, physical and life sciences, engineering, and technology education, as well as interdisciplinary, industrial, and academic genuine cooperation.

Toward such goals, the following chapters are featured in the current volume.

The chapter "Impedance of Pistons on a Two-Layer Medium with Inviscid Homogeneous Flow" by Scott Hassan uses an integral transform technique to develop a general solution for the impedance of two-dimensional pistons acting on a two-layer medium.

In the chapter "Acoustics of a Mixed Porosity Felt Airfoil," Aren Hellum presents experimental results to understand the relationship between wing porosity and noise reduction as a function of flow Reynolds number.

In the chapter "Generalizing the Butterfly Structure of the FFT," John Polcari develops the underlying structure of the fast Fourier transform (FFT) well described by a pattern of "butterfly" operations in a more general context of a decomposition applicable to any arbitrary complex unitary matrix.

The chapter "Development of an Aft Boundary Condition for a Horizontally Towed Flexible Cylinder" by Anthony A. Ruffa uses the method of characteristics to develop an aft boundary condition for the linear transverse dynamics of a towed neutrally buoyant flexible cylinder, extending a previous approach to more general numerical methods.

In the chapter "Tracking with Deterministic Batch Trackers," Steven Schoenecker develops two deterministic non-Bayesian batch trackers—the

Maximum Likelihood Probabilistic Data Association Tracker (ML-PDA) and the Maximum Likelihood Probabilistic Multi-Hypothesis Tracker (ML-PMHT), assuming a target with some unknown deterministic motion corrupted by measurement noise.

In chapter “Moving Horizons Estimation for Wheelchair Trajectory Repeatability in the Home” by Steven B. Skaar shows an advantage of Moving Horizons Estimation in contrast with the previously tested Extended Kalman Filter in the context of achieving a useful form of teach/repeat for wheelchairs of severely disabled veterans within their homes.

In the chapter “Exact Solutions to the Spline Equations,” Anthony A. Ruffa and Bourama Toni develop the exact solutions to the cubic spline equations for the case of equal knot spacing, exhibiting an oscillatory response in the region of a discontinuity as a consequence of the row structure of the resulting tridiagonal Toeplitz system.

The chapter “Distributed Membership Games for Planning Sensor Networks” by Thomas Wettergen and Michael Traweek investigates the management of sensor networks organized into distinct groups that share data to improve performance, in particular, for systems where changes in individual sensors’ group membership may improve performance.

In chapter “Statistical Models of Inertial Sensors and Integral Error Bounds,” [Richard] Vaccaro and Ahmed Zaki consider the random components that are useful for modeling modern tactical grade MEMS sensors with the purpose of deriving formulas for bounding errors in the first and second integrals of the sensor output from the additive noise and random drift components that corrupt a sensor signal.

The chapter “Developing Efficient Random Flight Searches in Bounded Domains” by Thomas Wettergen develops a new method for computing the parameters defining an efficient random flight for searchers that are constrained to search in a bounded domain, using concepts from observations of animal foraging behavior to define a random search plan that provides an optimally efficient search in terms of coverage relative to the constraints of random motion in the bounded domain.

The book as a whole certainly enhances the overall objective of the series, that is, to foster the readership interest and enthusiasm in the STEAM-H disciplines (Science, Technology, Engineering, Agriculture, Mathematics, and Health), stimulate graduate and undergraduate research, and generate collaboration among researchers on a genuine interdisciplinary basis.

The STEAM-H series is hosted at Howard University, Washington DC, USA, an area that is socially, economically, intellectually very dynamic and home to some of the most important research centers in the USA. This series, by now well established and published by Springer, a world-renowned publisher, is expected to become a national and international reference in interdisciplinary education and research.

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