Arkansas Tech University

Department of Mechanical Engineering

Final Report

Faculty Professional Development Grant, 2018

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A. Summary

This final report presents the outcomes of a Professional Development Grant to fund registration, travel, lodging and meals during a trip to the 2018 Multidisciplinary Analysis and Optimization Conference from 25 to 29 June 2018 in Atlanta, Georgia. The conference was organized by the American Institute of Aeronautics and Astronautics (AIAA).

The grant was approved in support of my attendance to present a peer-reviewed conference paper, chair two conference sessions, attend the AIAA Multidisciplinary Design Optimization meeting as a technical committee and serve as a judge to select the best paper and presentation awards. The face page of my published paper[1] in the AIAA conference proceeding is included at the end of this final report in Appendix I.

B. Restatement of the Research Problem

The AIAA Aviation Conference is an annual gathering of more than 4,000 scientist to present the latest research and development in the area of Aerospace Engineering (https://aviation.aiaa.org/). Through the financial support provided by this grant, I had the opportunity to present my latest research findings, exchange ideas with other researcher in my field, and develop relationships with multiple research and development organization in the field of Aerospace Engineering.

C. Brief Review of the Professional Enhancement Opportunity

The support from the professional development grant at Arkansas Tech University allowed me to carry out the trip to Atlanta, GA, present my accepted research paper, and perform as the chair for two of their sessions in Aeroelastic and Aero-Structures Optimization II, and Design Optimization of Complex Systems.

The grant also allowed me to attend the AIAA Multidisciplinary Design Optimization technical committee that happened at the same time and place of the conference. Since I am a technical committee, attendance of these meetings is mandatory for the members on a regular basis. AIAA technical committees are worldwide experts in their fields to help develop,

1 https://arc.aiaa.org/doi/10.2514/6.2018-3421, Retrieved on October 1, 2018.

support, and administer AIAA products and services, including conferences, publications, awards, and student design contests.

D. Summary of Findings and Outcomes

Oral presentation of my research work resulted in several discussions with other researcher in the field and potential collaborative research work among us. I also received invitations to join as a technical reviewer for NASA proposals. Face to face interaction with governmental research agencies and industrial sector has also increased the likelihood of doing collaborative research work including our undergraduate and graduate students.

Attendance, conference presentation, chairing two scientific sessions, and participating in the technical committee meeting enhance the visibility of Arkansas Tech University. Sharing my experience at this capacity is an important venue to publicize Arkansas Tech University and showcase its faculty. This grant also provided me the opportunity to further develop my professional network, and learn about the latest research findings. This allows me to expand and update my knowledge, and share it with my students at Arkansas Tech University. Continuation of this research in the form of senior design projects, and undergraduate research topics is also among the ways the results of this research will be disseminated.

E. Conclusion and Recommendations

Meeting new scholars is one of the greatest benefits of attending a conference. During this conference, I had the opportunity to make several meaningful professional connections to develop my network. Presenting my research in the conference also helped me to improve and extend the scope of my work by getting feedback from the experts in the field. Attending this international conference gave me the chance to listen to different points of view and learn new ideas and trends in my field. Therefore, I would like to express my sincere thanks to the members of the Professional Development Committee, Academic Affairs and the Office of Sponsored Research and University Initiatives at Arkansas Tech University for funding this proposal.

APPENDIX I

2018 Multidisciplinary Analysis and Optimization Conference
A New Statistical Approach to Enhance the Performance of Model-Free Optimal Controls Algorithms
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A New Statistical Approach to Enhance the Performance of Model-Free Optimal Controls Algorithms

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2018 Multidisciplinary Analysis and Optimization Conference Atlanta, Georgia

A New Statistical Approach to Enhance the Performance of Model-Free Optimal Control Algorithms

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This paper presents a new statistical approach to enhance the performance of Extremum Seeking Control algorithm. Extremum seeking controls is a model-free optimization algorithm that uses dither and demodulation signals to obtain the derivative information of an input for directional search. To improve the performance and stability of the algorithm, it is needed to simplify the input signal to the system since unsteadiness in the input signal causes the algorithm to be less efficient and fail. Time-averaging and non-statistical interpolation schemes of the input change the statistical characteristics of the signal, and they are of limited help. In this research, we propose a more accurate and representative extension of the algorithm based on the Probability Density Function to preserve the statistical characteristic of the original signal. The results show that the generated signal using an interpolation based on the Probability Density Function enhances the performance of extremum seeking control algorithm in finding the optimal states of wind energy systems.

I. Introduction

Many engineering structures operate under unsteady and high-fluctuating environments. These include; aircraft wings, wind turbine rotors, ship propellers and helicopter blades.[1–5] Time domain simulations are performed to represent the behavior of these complex systems, combined with dedicated control algorithms such as predictive, fuzzy, and model-free to optimize their performance.[6–8]

A stochastic signal is frequently experienced as an input to the control system to optimize a given performance index. Model-based control algorithms can accommodate this disturbance in a variety of ways,[9,10] but model-free control algorithms know little about the system under study and frequently fail to achieve the desired performance.

Extremum seeking controls (ESC) is an example of such a model-free controls algorithm recently used to optimize the performance of several engineering systems.[11,12] ESC is an adaptive algorithm that extracts online the gradient of the function of interest using a pair of dither and demodulation signals and proper filtering with respect to a stochastic input signal.[13,14] This gradient is then used to optimize the performance index of the system with respect to one or multiple inputs.

The use of ESC for wind energy system's performance optimization is relatively new. Johnson[15] demonstrated an adaptive torque-gain algorithm to optimize the energy output of wind turbines. The 3 hours adaptation period resulted in a very slow convergence time of about 40 hours, but the algorithm showed

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