

# **59th Israel Annual Conference on Aerospace Sciences 2019**

Tel-Aviv and Haifa, Israel  
6-7 March 2019

Volume 1 of 2

ISBN: 978-1-5108-8278-2

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2019) by Faculty of Aerospace Engineering, Technion - Israel Institute of Technology  
All rights reserved.

Printed by Curran Associates, Inc. (2019)

For permission requests, please contact Faculty of Aerospace Engineering, Technion - Israel Institute of Technology at the address below.

Faculty of Aerospace Engineering  
Technion - Israel Institute of Technology  
Department of Aerospace Technology  
Haifa 32000  
Israel

Phone: (04) 829-2260  
Fax: (04) 829-2030

[aerospace.technion.ac.il/](http://aerospace.technion.ac.il/)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## VOLUME 1

<b>Innovation Beyond the Horizon.....</b>	1
<i>Amiram Appelbaum</i>	
<b>The Beauty of Turbulence and Transitions in Reactive Flows .....</b>	2
<i>Elaine Oran</i>	
<b>Industrial Shape Optimization Applications Using Adjoints and HPC: A 25-Year Perspective .....</b>	3
<i>Juan J. Alonso</i>	
<b>Scientific Applications of Global Navigation Satellite Systems.....</b>	4
<i>Penina Axelrad</i>	
<b>Advanced Low Cost Launching System Design - a System Engineering Approach .....</b>	5
<i>Itshak Glaser, Agnes Cohen, Asaf Hargash</i>	
<b>Rafazon - Simulation and Optimization of a Quadcopters Fleet for Real-Time Delivery .....</b>	25
<i>Tomer Rokita, Chana Ross</i>	
<b>Area Coverage - a Swarm Based Approach .....</b>	35
<i>Ori Rappel, Joseph Z. Ben-Asher</i>	
<b>Investigation of Mobile Robot Time Optimal Trajectories under State Dependent Constraints.....</b>	56
<i>Polina Khmelniker, Elon Rimon, Joseph Z. Ben-Asher</i>	
<b>Defender Assisted Evasion Maneuvers .....</b>	69
<i>Roger Anderson, Meir Pachter, Robert Murphrey</i>	
<b>Augmented Proportional Navigation Guidance with Cooperative Collision Avoidance .....</b>	75
<i>Bhargav Jha, Ronny Tsalik, Martin Weiss, Tal Shima</i>	
<b>A Generic Guidance Design Method Based on Minimum Quadratic Guidance Effort.....</b>	92
<i>Martin Weiss, Tal Shima</i>	
<b>Least-Square Filtering of Homing Sensor Data with Bounded Measurement Errors .....</b>	108
<i>Martin Weiss, Tal Shima, Ilan Rusnak</i>	
<b>Impact Angle Guidance Using MinMax Approach.....</b>	120
<i>Sergey Rubinsky, Shaul Gutman</i>	
<b>Optimization of Satellite Constellations in Low Earth Orbit for Regional Positioning.....</b>	142
<i>Tomer Shtark, Pini Gurfil</i>	
<b>Performance Evaluation of a Regional Navigation Satellite System in Low Earth Orbit .....</b>	164
<i>Tomer Shtark, Pini Gurfil</i>	
<b>Comparison of Two Nonlinear Filters for Orbit Determination Using Angles-Only Data.....</b>	183
<i>Mark L. Psiaki</i>	
<b>A Novel Constrained Quaternion Filter.....</b>	202
<i>Daniel Choukroun, Uri Tamir</i>	
<b>SpaceIL Mission to the Moon: Navigation Approach for the Landing .....</b>	219
<i>Agnes Levy, Ariel Rubanenko, Aviv Priel, Itzik Gazit</i>	
<b>High-Order Thermal Effects in Oscillatory Couette Flow of a Rarefied Gas.....</b>	236
<i>Yaron Ben-Ami, Avshalom Manela</i>	
<b>Spinning to Noise: Broadband Propeller Acoustics .....</b>	255
<i>Jonathan Silver</i>	
<b>Subsonic Jet Noise Predictions .....</b>	274
<i>Michael Weidenfeld</i>	
<b>Collaborative Investigation of 3-Dseparation on Low Aspect Ratio Finite Span Wings .....</b>	283
<i>Shelby Hayostek, Miki Amitay, Kai Zhang, Taira Kunihiko, Wei He, Anton Burtsev, Vassilis Theofilis</i>	
<b>Nanoswimmers in the ERF Environment .....</b>	302
<i>Jacob Nagler</i>	
<b>Investigation of ABS-Paraffin Based 3D Printed Hybrid Rocket Fuels.....</b>	312
<i>Jacob Bresler, Benny Natan</i>	
<b>Investigation of the Influence of Graphite Additives on the Fuel Regression Rate in Hybrid Propulsion .....</b>	327
<i>Silky Elanjickal, Francisco Sá, Alon Gany</i>	
<b>Electromechanical System for Solid Rocket Motor Thrust Modulation.....</b>	338
<i>Yossi Zamir, David Albagli, Alon Gany, Michael Safron</i>	
<b>Post-Firing Analysis of Solid Rocket Motor Internal Insulation Using 3D Scanning &amp; Modeling Technique .....</b>	347
<i>Ramin Shilav</i>	

<b>Development of Numerical Modeling Methods and Experimental Capabilities for Carbon and EPDM Erosion Prediction for Solid Rocket Motors .....</b>	356
<i>Yonadav Sudman, Michal Oren, Avital Kigli, Oren Peles, Dmitri Gandler, Hod Wirzberger</i>	
<b>Technion Aerial Systems 2018 Development of an Autonomous Unmanned Aerial System for AUVSI SUAS Competition.....</b>	379
<i>Janna Bruner, Imri Tzror, Daniel Joseph, Sigalit Greenberg, Oz Grinfeld-Faru, Sergey Shulman, Tom Smadar, Gil Danan, Ron Soesan, Osher Shukrun, Alon Shay, Gil Tohar, Noam Meir, Simone Di Porto, Omer Shamir, Avraham Barel, Tsoof Joels, Bar Liani, Gabriel Luden, Matan Zur, Shahar Sarfaty, Aviram Daniel, Ron Gilad, Omer Wilmowski, Maria Machulsky, Tamar Peretz, Nitz An, Idan Eizenberg, Zvi Zvi Herscovici, Kfir Reuven, Dror Artzi, Yevgeni Gutnik, Johanan Erez, Lior Zivan, Hovav Gazit</i>	
<b>A New Modified Diesel Cycle for Small Aircraft Operating at High Altitude Conditions - a Numerical Simulation .....</b>	397
<i>Kadmiel Karsenty, Eran Sher</i>	
<b>DriveSat - Vacuum Arc Thruster &amp; Hard Disc Drive Reaction Wheel Satellite - 2018 Student Project .....</b>	410
<i>Tal Alperovitz, Yevgenii Sdvijkov, Itai Norber, Daniel Leiberman, Aviv Malhi, Nadav Levy, Jacob Herscovitz</i>	
<b>FireFly - Autonomous Drone Swarm.....</b>	434
<i>Meir Nemirovsky, Arik Yavnai, Liran Alfandari, Liraz Mudrik, Daniel Markovich, Nir Ben Baruch, Dana Vaisler</i>	
<b>Formula Technion Aerodynamics Team 2018.....</b>	439
<i>Yael Haslavsky, Alex Shtainman, Eli Goldenshluger, Yedidya Shlomo Cohen, Ilya Barbul, Natali Rozin, Lilachr Rafailov Lilach, Daniel Daniel Nahman</i>	
<b>Vito - Long Distance Drone.....</b>	465
<i>Ofir Klimovitsky, Nathaniel Dreilich, Yuval Ipenberg, Limor Jacob, Netanel Magor, Jonathan Mazor, Matan Yitzhak, Isaac Kadushin</i>	
<b>Flutter Mechanisms Characterization Using Distributed Aeroelastic Energy Analysis.....</b>	473
<i>Yaara Karniel, Daniel Kariv, Michael Iovnovich</i>	
<b>Effect of External Stores Aerodynamics on Analytic Fighter Aircraft Flutter Predictions: Evaluation of a Superposition Modeling Approach .....</b>	491
<i>Michael Iovnovich</i>	
<b>Kriging-Based Gust Response Analysis Methodology at High Angles of Attack .....</b>	513
<i>Wrik Mallik, Daniella Raveh</i>	
<b>Dynamic Gust Response of Very Flexible Aircraft Using Segmental Modes.....</b>	525
<i>Favel Gov, Moti Karpel</i>	
<b>A General Attainable-Set Model Predictive Control Scheme .....</b>	558
<i>Rui Gomes, Fernando Lobo Pereira</i>	
<b>Estimation-Based Guidance and Its Use in a Staggered-Engagement Stochastic Cooperative Interception.....</b>	571
<i>Liraz Mudrik, Yaakov Oshman</i>	
<b>Performance Analysis of a Preview-Control-Based Terrain-Following Approach .....</b>	584
<i>Arseny Livshitz, Moshe Idan</i>	
<b>Motion Planning of Thrust Vectored Airship Using Spherical Expansion Based Algorithm with Adaptive Fuzzy Control .....</b>	601
<i>Amardeep Mishra, Vrushabh Zinage</i>	
<b>Control of Turbulent Separation from an Inclined Cylinder of Finite Aspect Ratio, Thus Affecting Its Yaw .....</b>	621
<i>Harshad Kalyankar, Lutz Taubert, Israel Wygnanski</i>	
<b>Active Flow Control Implementation for Helicopter External Stores Support System Drag Reduction .....</b>	631
<i>Ofek Drori, Avi Seifert</i>	
<b>Control of Aerodynamic Loads on Rotorcraft Blades Using Trailing Edge Fluidic Actuation.....</b>	641
<i>Yuehan Tan, Ari Glezer, Ryan Patterson, Peretz Friedmann</i>	
<b>Take-Off Performance Enhancement Via Stall Control of a Full-Scale Aircraft Tail.....</b>	656
<i>David Hasin, David Greenblatt, David Keisar</i>	
<b>3D Printing in China's Aerospace Industries .....</b>	667
<i>Xiaodong Niu</i>	
<b>In-Situ Monitoring of Joint Integrity for Condition Based Monitoring of Avionic Components .....</b>	675
<i>Craig Lopatin</i>	

## VOLUME 2

<b>Transport Aircraft Human Errors Quantification .....</b>	693
<i>Ilan Berlowitz</i>	
<b>TITANS - Technion Institute of Technology AutoNomous Submarine Design Report .....</b>	787
<i>Dor Tamour, Kadmiel Karsenty, Felix Kharakh, Ofek Oiknine, Yoav Bar David, Ran Levy, Arie Zhakov, Guy Kagan</i>	
<b>Project Front Viewer .....</b>	792
<i>Alon Naor, Ivan Zaporozhets, Neta Yaari, Nofar Galmudi, Nuriel Taran, Oded Naveh</i>	
<b>The Role of Established Space Industry in New Space Environment .....</b>	805
<i>Opher Doron</i>	
<b>Very Flexible Aircraft: Performance Promises and Aeroelastic Challenges .....</b>	806
<i>Carlos Cesnik</i>	
<b>Aviation's Third Revolution: Challenges and Opportunities .....</b>	807
<i>Susan X. Yang</i>	
<b>Flash Boiling Fuel Atomization: Theoretical Criteria .....</b>	808
<i>Yahav Moshkovich, Yeshayahou Levy, Eran Sher</i>	
<b>On the Operation of a Generic Vaporizer under Steady-State Conditions.....</b>	812
<i>Yeshayahou Levy, Vladimir Erenburg, Valery Sherbaum, Igor Gaissinski, Vitaly Ovcharenko, Ori Kam</i>	
<b>Polydisperse Spray Stagnation Point Ignition: Analytical and Numerical Studies .....</b>	837
<i>J. Barry Greenberg, Gershon Katz</i>	
<b>Evolution of Spherical Flame through a Mist of Water-In-Fuel Droplets .....</b>	855
<i>J. Barry Greenberg, Noam Weinberg</i>	
<b>Experimental Study of the Transonic Flow of a Jet-Fighter Weapon Bay with a Store Model .....</b>	869
<i>Hadar Ben-Gida, Lior Poplingher, Yoel Goldman, Motti Adar</i>	
<b>The Stationary Leading-Edge Vortex Over a High Aspect Ratio Wing.....</b>	885
<i>Hadar Ben-Gida, Roi Gurka, Daniel Weihs</i>	
<b>Validation of the Extensions Implemented to the Simple Analytical Model for Waverider Design .....</b>	896
<i>Dan Igra</i>	
<b>A New Aerodynamic Model of Horizontal Axis Wind Turbines .....</b>	918
<i>Valentin Ognev, Aviv Rosen</i>	
<b>Aerodynamic Design and Evaluation of a Type of Hypersonic Long-Range Civil Vehicle .....</b>	943
<i>Zhansen Qian</i>	
<b>GMM Development : Challenges and Successes .....</b>	957
<i>Oran Zeldin, Carmit Heller, Agnes Cohen</i>	
<b>Modeling Flight Test Unexpected Phenomena with the Use of Neural Networks .....</b>	958
<i>Natan Grinfeld, Agnes Cohen, Isaac Yaesh</i>	
<b>SpaceIL - Landing the First Israeli Spacecraft on the Moon.....</b>	966
<i>Ido Antaby</i>	
<b>A Novel Approach for an Autonomous Weighing System through Fuselage Interface Loads.....</b>	967
<i>Oren Shachar, Jonathan Balter, Ron Bar-On, Meir Ben-Ari</i>	
<b>Conformal Airborne Early Warning System for the Italian Air Force (IT-CAEW) Program .....</b>	994
<i>Addie Melumad</i>	
<b>Determination of a towed body configuration with a dynamical-aerodynamical simulation .....</b>	995
<i>Pavel Pevzner, Michal Vahab-Dalal , Shlomo Djerassi</i>	
<b>Introducing Incremental eXpectation to Belief Space Planning .....</b>	996
<i>Elad I. Farhi, Vadim Indelman</i>	
<b>A Projected Lloyd's Algorithm for Coverage Control Problems.....</b>	1008
<i>Yoav Palti, Daniel Zelazo</i>	
<b>Control Under Constraints of Tethered UAVs via Interpolating Control .....</b>	1023
<i>Tal Glick, Shai Arogeti</i>	
<b>Formations Using Finite-Time Heterogeneous Cyclic Pursuit.....</b>	1035
<i>Dwaipayan Mukherjee, Shashi Ranjan Kumar</i>	
<b>Comparative Performance of Two Methods for Visual Terrain Assisted Navigation .....</b>	1053
<i>Hector P. Rotstein, Ehud Rivlin, Amir Geva</i>	
<b>Navigation and Ionosphere Characterization Using High-Frequency Signals - Models, Solution Concepts, and a Performance Analysis.....</b>	1067
<i>Yoav Baumgarten, Mark L. Psiaki</i>	
<b>Enhanced Estimation of Position Aided INS Utilizing Trajectory History.....</b>	1095
<i>Itzik Klein, Yeshaya Lipman, Eliav Vaknin</i>	
<b>Aiding a Low-cost Navigation System by Flight-direction Data .....</b>	1109
<i>Shmuel Boyarski, Carmit Heller, Eldar Wiesen, Agnes Cohen</i>	

<b>Velocity Aided Leveling Loop utilizing Low Cost Inertial Measurement Unit .....</b>	1118
<i>Irina Avital, Isaac Yaesh, Adrian-Mihail Stoica</i>	
<b>Long-wave magnetomechanical instabilities in -fiber-reinforced magnetoactive composites .....</b>	1129
<i>Artemii Goshkoderia, Stephan Rudykh</i>	
<b>Examination of Algorithms for Prediction of Very High Cycle Fatigue Life .....</b>	1153
<i>Yael Buinovich, Tom Binyamin</i>	
<b>Numerical Investigation of the Effect of Secondary Bending in Hard-Point Joints .....</b>	1170
<i>Orel Magidish, Yuval Freed, Dvir Elmalich, Alon Mayo, Lior Sagi-Machines</i>	
<b>Widespread Fatigue Damage Assessment - What Can Possibly Go Wrong? .....</b>	1185
<i>Yuval Freed</i>	
<b>Weibull or Log-Normal Distributions to Characterize Fatigue Life Scatter - Are We Closer to a Solution? .....</b>	1194
<i>Abraham Brot</i>	
<b>Exploration of Spark Discharge Characteristics for Ignition of Scramjet Engines .....</b>	1204
<i>Joseph Lefkowitz, Timothy Ombrello, Stephen Hammack, Campbell Carter, Kenneth Busby</i>	
<b>Theoretical Performance of Water-Augmented Underwater Rocket.....</b>	1212
<i>Nachum Eisen, Alon Gan</i>	
<b>Evaluation of Fuels and Oxidizers for Pulse Detonation Rocket Engines.....</b>	1221
<i>Flavio Siles, Hertzl Kadosh, Tal Schwartz, Dan Michaels</i>	
<b>Hybrid RANS/LES Simulation of Combustion in a Model Scramjet.....</b>	1227
<i>Mark Wasserman, Yuval Levy, Elaad Mograbi</i>	
<b>Detached-Eddy Simulations of the Transonic Flow of a Jet-Fighter Weapon Bay with a Store Model .....</b>	1246
<i>Hadar Ben-Gida, Lior Poplingher, Motti Adar</i>	
<b>Hybrid Simulations of Various Levels for the Prediction of Flared Afterbodies Drag.....</b>	1264
<i>Eran Arad</i>	
<b>Drag Reduction Control in Turbulent Channel by Spanwise Traveling Wave of Wall Blowing and Suction .....</b>	1280
<i>Yi Huang</i>	
<b>Smoothing of Linear Scalar Systems with Cauchy Distributed Noises .....</b>	1300
<i>Moshe Idan, Jason L. Speyer</i>	
<b>Issues in Design and Selection of State Dependent Coefficient Form for Efficient Estimation .....</b>	1310
<i>Ilan Rusnak, Liat Peled-Eitan</i>	
<b>An Improved Algorithm for Universal Sensor Registration .....</b>	1336
<i>Daniel Sigalov, Aharon Gal, Boaz Vigdor</i>	
<b>Optimal State Estimation of Maneuvering Target with Limited Acceleration.....</b>	1351
<i>Ilan Rusnak</i>	
<b>Spacecraft Attitude Dynamics During Orbit Correction Maneuvers under Multi-Tank Sloshing Disturbances.....</b>	1370
<i>Noam Leiter</i>	
<b>Liquid Lithium-Hydrogen Rocket Engine with Regeneration of Components .....</b>	1397
<i>Lev Blumkin</i>	
<b>A Scenario Based On-board Software and Testing Environment for Satellites .....</b>	1407
<i>Michael Bar-Sinai, Achiya Elyasaf, Aviran Sadon, Gera Weiss</i>	
<b>Rendezvous Maneuver of Satellites Using Solar Radiation Pressure .....</b>	1420
<i>David Mishne</i>	
<b>Dynamic Response of an Elastic Aircraft to Store Ejection .....</b>	1436
<i>Daniel Kariv, Daniella Raveh</i>	
<b>Modal Rotations: A Modal-Based Method for Large Structural Deformations .....</b>	1456
<i>Ariel Drachinsky, Daniella Raveh</i>	
<b>Aeroservoelastic Stability Analysis, Tests and Design Aspects Using Parametric Flutter Margins .....</b>	1471
<i>Federico Roizner, Moti Karpel</i>	
<b>Author Index</b>	