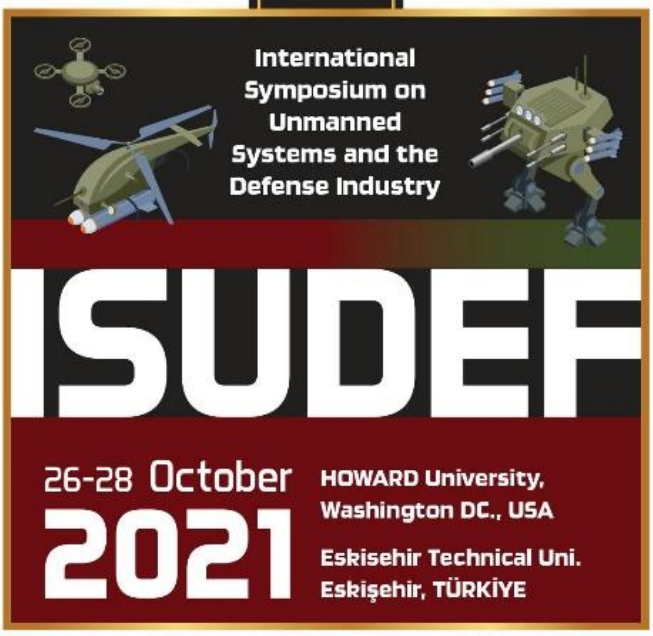

ABSTRACT BOOK

Editors

T. Hikmet Karakoç - Nadir Yılmaz - Ali Haydar Ercan - Alper Dalkıran

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International Symposium on Unmanned Systems and The Defense Industry 2021

ISUDEF'21 Abstract Book

International Sustainable Aviation and Energy Research Society

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Prof.Dr. T. Hikmet Karakoç
(Symposium Founding Chair)

Prof. Dr. Nadir Yılmaz
(Symposium Chair)

Message from the Symposium and Course Chairs

It is a great pleasure to invite you to the International Symposium on Unmanned Systems and the Defense Industry (ISUDEF), which will be held in a Hybrid Mode on October 26-28, 2021.

Unmanned systems are one of the fastest growing and widely developing technologies in the world, offering a number of possibilities for a variety of research fields, including the defense industry. As we are in an era in which there is continuous progress in unmanned systems and homeland defense, we would like to invite researchers, scientists, engineers, practitioners, policymakers, and students to the International Symposium on Unmanned Systems and the Defense Industry to exchange information, present new technologies and developments, and discuss the future direction, strategies, and key priorities moving forward.

ISUDEF, an international, multi-disciplinary symposium, aims to address current topics on unmanned systems and the defense industry in such broad areas as aerial, naval and land applications; avionics; and radar systems & air defense. Specifically, researchers may wish to present their solutions and insights on such topics as platform designs, AI integration, robotics, and autonomous systems to provide innovative solutions to the challenges facing the homeland defense industry, along with civilian applications.

ISUDEF will include several keynote presentations, specialized sessions, workshops, and oral & poster presentation sessions from participants on the different subjects submitted. We look forward to welcoming you to this remarkable event in October 2021.

Sincerely,

Hikmet Karakoç (Symposium Founding Chair) & Nadir Yilmaz (Symposium Chair)

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Adrian Bejan, Duke University, USA

Nancy Leveson, Massachusetts Institute of Technology, USA

Abd Rahim Abu Talib, Universiti Putra Malaysia, Malaysia

Felix J. Yanovsky, National Aviation University (NAU), Kyiv, Ukraine

Danda Rawat, Howard University, USA

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Hyung Bae, Howard University, USA

Keely Griffith, Association for Unmanned Vehicle Systems International (AUVSI), USA

Michael Hatfield, University of Alaska, USA

Soledad Le Clainche Martinez, Universidad Politécnica de Madrid (UPM), School of Aeronautics, Spain

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Dávid Sziroczák, Budapest University of Technology and Economics, Hungary

Ranjan Vepa, Queen Mary University of London, UK

Special Session

Gaby Waldman-Fried

Workshop

Sharan Asundi

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KS01
Predicting Evolution: Airplanes and Helicopters

Adrian Bejan, J.A. Jones Distinguished Professor

Duke University

Abstract: Evolution is the phenomenon of change after change in a discernible direction in time. It is everywhere and unites all of nature and science: bio and non-bio, human made and not human made. The lecture shows how to predict evolution from the physics covered by the constructal law: given freedom, all movement (flow) exhibits the tendency to evolve into configurations that provide greater access. Topics include animal locomotion, airplanes, helicopters, organ size, body size, economies of scale, sustainability, population size, and hierarchy. The doctrine of evolutionary (constructal) design teaches how to predict evolution in general, and how to fast-forward technology evolution. To predict is 'theory', the ability to imagine, to see with the eyes of the mind, to have original ideas. It is the opposite of 'empiricism' such as copying what exists (biomimicry, technology theft, reverse engineering, plagiarism). The lecture is based on the books:

Freedom and Evolution, 2020.

The Physics of Life, 2016

Design in Nature, 2012

KS02
Numerical Analysis of Propeller-Wing interaction in a UAV with Distributed Electric Propulsion

Ramesh K. Agarwal, William palm Professor of Engineering

Washington University in St. Louis

Abstract: As battery and electric motor technology continues to advance rapidly, propeller-driven electric UAV/aircraft are likely to become a significant part of the aviation market in the near future. One proposed design configuration for electric UAV involves using large, wing-tip mounted propellers to actively cancel wingtip vortices; a method called active wingtip vortex cancellation (AWVC). By reclaiming part of the kinetic energy that would otherwise be lost to tip vortex formation, drag is decreased. in addition, the induced span-wise flow and up-wash from the propeller causes the span-wise lift distribution to remain more uniform at the wingtips, thus increasing the lift. Previous wind tunnel testing of this configuration has shown a significant increase in lift and decrease in drag, particularly in low-aspect-ratio configurations. in this paper the wind tunnel UAV configuration is simulated by employing the tools of Computational Fluid Dynamics (CFD) in the ANSYS Fluent software. Several test cases are computed using 3D, transient, viscous, sliding mesh computational approach for the solution of Reynolds-Averaged Navier-Stokes (RANS) equations with SST k-ω turbulence model. CFD results match the wind tunnel data within approximately 1%, validating the CFD approach. For the wind-tunnel configuration, CFD results show that 18.1% increase in lift and 5.1% increase in net thrust is possible solely through the phenomenon of AWVC.

KS03
A More Powerful Approach to Engineering Safer Systems

Professor Nancy Leveson

Aeronautics and Astronautics, MIT

Abstract: With the increasing complexity and use of software in systems today, the traditional hazard analysis methods are becoming less and less useful. A paradigm change is needed to design safety into today's systems because the assumptions about causation underlying the traditional methods no longer hold. Specifically, accidents are increasingly caused by interactions among system components and system design and requirements flaw rather than component failures. in this talk, I will describe the paradigm change and the advantages it provides, including increased safety and decreased cost. The new tools to be described are now being used in thousands of projects in all industries and most countries, including defense.

KS04
Development and Applications of Unmanned Aircraft System industry in Malaysia

Professor Ir. Ts. Dr. Abd. Rahim Abu Talib

Universiti Putra Malaysia

Abstract: Globally, there is a growing demand on the usage of unmanned aircraft system (UAS) or drone technology. Drone has been used in many applications such as shipping delivery, disaster management, precision farming, search & rescue, law enforcement, etc. This keynote address will describe the development and applications of drone industry in Malaysia. Activities related to drone flying has started more than 20 years ago in Malaysia without any specific rules or regulation. Now, the UAS or drone flight activities are currently bound to Civil Aviation Regulation 2016. The Civil Aviation Authority of Malaysia (CAAM) has set standard authorization to fly for UAS to operate in Malaysia. There are specific regulations have been issued for government agencies to conduct adhoc UAS operations, agriculture UAS operations and special UAS project activities. Future development of UAS or drone technology with extended operation duration, ability to carry heavier payload, and controlled at a longer distance enable the usage on many other applications for the benefits of mankind.

KS05
Methods for Retrieving information About Remote Objects from Received Signals

Felix J. Yanovsky, Prof., DSc, PhD, IEEE Life Fellow

National Aviation University of Ukraine

Abstract: At first, a brief overview of research directions in ERMIT department at NAU that are related with the Symposium topic is considered. Then, we focus on the proposed and researched recently the coherent-polarimetric method for the remote sensing. This method synergistically combines and generalizes two approaches, which were initially introduced separately and used in radar meteorology. These are Doppler and polarimetric approaches. Doppler radars with polarimetric potential (dual polarization) are produced nowadays and operated in practice, but their strong potential is not used enough. The problem is that it is not clear, what is the appropriate way of sounding waveform transmission and especially complex signal processing on receive to reach really effective and qualitatively new results. We try to solve this problem. For this purpose, the theoretical study, math modeling, and computer simulation are done. New combined parameters are proposed. The comparison of the developed models with measurement results is done. The results show considerable improvement of detection and estimation turbulence intensity in the troposphere that is important to provide flight safety. Moreover, we also show that this approach is rather general and has great potential for detection, estimation and recognition of various objects both natural and artificial origin.

KS06
Securing Unmanned Aerial Vehicular Networks

Danda Rawat

Howard University, USA

Abstract: Unmanned Aerial Vehicular s (UAVs) network (UAV network) is an emerging networking technology for civilian and military applications. in the UAV Network, confidentiality and security are always major concerns to protect the UAV network and applications it supports. Thus, it is critical to identify and authenticate UAVs before they begin to communicate with other UAVs in the network. Different security solutions have been proposed to secure UAV networks. Traditional security solutions are not applicable to UAV networks as UAV network topology changes quickly as UAVs fly, UAV network needs least possible delay for communications and secure communications, UAVs are resource constrained (in terms of battery life, storage, and computing power) and multitude of cyber-attacks are easy to launch in the UAV network. Thus, security techniques will have to provide better security with confidentiality and least delay in resource constrained devices. This keynote aims to present design, development, and evaluation the lightweight security engineering approaches to secure UAV networks and communications. We will cover modified Elliptic Curve Cryptography (ECC) for UAV security as well as lightweight blockchain with sharding for UAV network in the internet of Battlefield-Things.

IS01
Leveraging Unmanned Systems to Solve the Next 50 Years' Challenges

Keely Griffith, Director of industry Education

Association for Unmanned Vehicle Systems international

Abstract: Over the last 50 years, unmanned systems have evolved to primary tools relied on by the U.S. Department of Defense and civilian defense agencies to maintain competitive advantage worldwide – on the ground, in the air, and at sea. in a new era of strategic competition and in the next half-century beyond, meaningful cross-industry collaboration and significant capital investments will be critical to accelerating advancements in the innovation and integration of autonomous systems. This session will discuss existing initiatives that support collaboration and then dive into the most up-to-date analysis of government spending on unmanned systems in all domains, including information about Fiscal Year 2022 budget legislation.

IS02
Resilient Exploration in Underground Spaces

Sebastian Scherer, Associate Research Professor

Carnegie Mellon University

Abstract: Subterranean robot exploration is difficult with many mobility, communications, and navigation challenges that require an approach with a diverse set of systems, and reliable autonomy. While prior work has demonstrated partial successes in addressing the problem, here we convey a comprehensive approach to address the problem of subterranean exploration in a wide range of tunnel, urban, and cave environments. Our approach is driven by the themes of resiliency and modularity, and we show examples of how these themes influence the design of the different modules. We convey lessons learned in designing and testing a resilient system for subterranean exploration that can generalize to a large range of operating conditions, and potential improvements for the future.

IS03
The Future of Unmanned Aerial Vehicles: Autonomy, Morphing & Biomimicry

Dr Ranjan Vepa

School of Engineering & Materials Science Queen Mary, University of London

Abstract: This talk will focus on three main areas of future developments of Unmanned Aerial Vehicles (UAVs): the essential differences between automatic control systems and autonomous control systems, morphing airfoils and wings and about biomimetic approaches to control and what we can learn from the remarkable skills developed by members of the animal world. in this the talk, the evolution of control systems from automatic control systems to autonomous control systems will be discussed and surveyed. This will be followed by an outline of the basic ingredients of autonomous control systems. The manner in which UAVs can benefit from morphing of airfoils and wings, and the role biomimicry can play in the development of future UAVs will also be discussed.

The talk will be concluded with an assessment of how UAVS are evolving, how morphing could change their general structure and the evolution of morphing wingtips, morphing or folding wings and folding/unfolding propeller-rotors. Humanities aim to make them greener than ever can benefit from our knowledge of how birds do it; we could learn from the birds to take-off, fly and land.

IS04
Deep learning and data-driven Reduced Order Models based on physical principles

Assoc. Prof. Soledad Le Clainche

Universidad Politécnica de Madrid,Spain

Abstract: Modelling turbulent flows solving the engineering problem mentioned, is a highly complex task that requires a large amount of computational resources. The alternative is developing Reduced order models (ROMs) using (among others): (i) modal decompositions (i.e., singular value decomposition – SVD, higher order dynamic mode decomposition - HODMD), (ii) clustering based methods (i.e. principal component analysis - PCA and local PCA [3]) and (iii) machine learning tools.

The main goal of this work is applying these techniques to solve several engineering problems with applications in aerospace engineering, presenting new strategies to develop efficient and accurate ROMs. More specifically, HODMD is used to identify the main patterns and to develop a ROM in an axisymmetric, time varying, non-premixed co-flow flame and, PCA and LPCA are applied to develop a ROM in a synthetic jet. Finally, machine learning tools (artificial neural networks) are combined with modal decompositions (SVD) to develop a novel and efficient ROM.

IS05
Tomographic Emission Spectroscopy for the Characterization of Solid Propellant Plumes

Dr. Yudaya Sivathanu, Technical Director

En'Urga inc.

Abstract: Solid propellants have been used extensively for fueling rockets from the early 13th century to the present day. The main advantages of solid propellants include their simplicity, reliability, and storability. However, they are more challenging to control and less efficient than liquid propellants. This talk focuses on understanding the combustion process by studying the burning plumes of solid propellants using fan-beam emission tomography. Spectrally resolved radiation emission measurements were obtained at multiple view angles from a burning monopropellant plume. These measurements were deconvoluted using the Maximum Likelihood Estimation method in conjunction with a linearized form of the Radiative Transfer Equation. Spatially resolved temperatures, gas concentrations, and particulate volume fractions were obtained from various burning propellant plumes. The results indicate that tomographic emission spectroscopy is a reliable method for obtaining the structure of burning monopropellant plumes.

IS06
Aerospace Programs on a Budget

Dr Michael Hatfield, Assoc Professor of Electrical Engineering, CEM/ECE; Associate Director of Education, GI/ACUASI

University of Alaska Fairbanks (UAF) College of Engineering & Mines (CEM); UAF Geophysical institute (GI) Alaska Center for Unmanned Aircraft Systems integration (ACUASI)

Abstract: Aerospace projects and programs have long captivated the imagination of people from around the world. Today we see a resurgence of interest in space programs with a focus on expanding our reach and long-term presence into our own solar system and beyond.

Aerospace engineering continues to be a popular choice for many students looking to apply a broad set of technical and management skills to exciting and challenging real world multidisciplinary projects. However, implementing such programs can prove problematic for many middle and smaller sized schools. Significant barriers to a formal aerospace program include limited faculty, financial resources, and facilities. in addition, the number of students capable of taking aerospace courses (in addition to their current established majors) limits possible enrolment in classes.

Yet, by providing modest opportunities in aerospace courses (aeronautics, unmanned aircraft, space systems) and programs, our students can still gain meaningful education and experience which can open doors for their future … and simultaneously build the aerospace program at the host school.

This presentation summarizes the emergent aerospace engineering program which has been implemented, to date, at the University of Alaska Fairbanks and touches on its possible futures.

IS07
UAS Enabled Weather Prediction System Prototype Development

Dr. David Sziroczák, MRAeS, CEng

Budapest University of Technology and Economics, Department of Aeronautics and Naval Architecture

Abstract: Today, more accurate weather prediction methods are constrained by the lack of real-time measured data from the planetary boundary layer (PBL), where the most, complex, atmosphere-ground interactions take place. Should data be available, novel, AI based algorithms could significantly increase the accuracy of short-term weather prediction capabilities.

This research project proposes the use of drones for data collection in the PBL. The drone network would increase the temporal and spatial data collection capabilities of today and could provide real-time, accurate, high-resolution information for weather prediction algorithms. The first step towards the implementation of such system is the development of a system prototype, capable of providing sufficient data while at the same time enabling rapid and efficient evaluation of the system components and operational proof of concepts.

This presentation is aimed at highlighting the research work performed so far during the system prototype development. Topics deal with the system components, such as the proposed UAS solutions, ground supporting infrastructure, communication technologies, and the concept of operations. The presentation also considers the predicted utility of such system discussing the expected benefits of improved weather predictions, primarily from a road user's point of view.

IS08
Fiber Optic Multi-Parameter Sensing for 3D Printed Pressure Vessel

Hyung Bae, Assistant Professor

Howard University

Abstract: Fiber optic sensors have been widely researched and used for their small size, inertness to electromagnetic interference, high bandwidth, and high sensitivity. Fiber optic sensors can be a good candidate for embedded sensors for 3D printed parts due to their small form factor. in this presentation, the feasibility of embedded fiber optic sensors for pressure and temperature measurement with 3D printing application. Simple optical fiber is attached to a 3D printed pressure vessel for pressure and temperature sensing. For simultaneous sensing of pressure and temperature, two cleaved optical fibers are attached to the printed part forming two discrete Fabry-Perot cavities. The sensitivities of the two sensors have been carefully designed to ensure a good sensitivity of the multi-parameter sensing. Calibration results of the two sensors are demonstrated in terms of sensitivity, linearity, and multi-parameter sensing capability. The sensor design can be useful for various sensing applications that involve 3D printed parts.

SSS1
Lighter, Faster, Stronger, Cheaper: How Generative Design is Transforming Design & Manufacturing

Gaby Waldman-Fried

Autodesk, inc.

Abstract: in this session, learn how innovative industry leaders Airbus, Honda, and Claudius Peters use generative design to reduce product development time, cut material cost, and improve product performance. Discover how you can incorporate generative design concepts in your classroom, and how it can be used in project-based learning to teach skills that students need for success in engineering careers.

001
inference of Civil infrastructure Vibrations Using Unmanned Aerial Vehicles

Abeer Jazzar[1] and Utku Kale[1]

[1] *Department of Aeronautics and Naval Architecture, Faculty of Transportation Engineering and Vehicle Engineering, Budapest University of Technology and Economics, Budapest, Hungary*

Abstract: Extracting vibration features of civil infrastructure enables authorities to identify structural safety and integrity, as well as preparedness for hazardous events such as earthquakes. Unmanned aerial vehicle (UAV) systems are used as mobile sensors to measure vibrations and deformations of civil infrastructure. Compared with the conventional structural health monitoring systems, UAVs provide essential advantages such as remoteness, mobility, automation, and scalability in contrast with stationary and permanent vibration sensing systems. in this study, the possible use of sensor technology to detect civil infrastructure vibration with the help of UAV sensors, particularly bridge infrastructure was evaluated. The method is an invasive sensing technology that makes use of embedded accelerometer data from smartphones and UAVs which is used for bridge acceleration response measurement. This method relies on high landing accuracy and coupling with the structural surface under extreme conditions.

Keywords: structural health monitoring, unmanned aerial vehicle, sensors, accelerometer, finite element model.

002
Electrical System Design for Very Light Aircraft

Merve Aluç[1] and Guven Komurgoz[1]

[1]*Department of Electrical Engineering, Istanbul Technical University, Istanbul, Turkey*

Abstract: in this study, electrical system design of the first very light aircraft being built in Turkey are presented. An electrical system was designed for a very light aircraft (VLA) with a single motor. in any action to be taken on the subject such as system architectures to be created, selection of electrical equipment and layout of these equipment, selection of suitable cable, connectors and lights etc. the EASA CS-VLA Standard was applied. The design process includes the selection of electrical systems and equipment according to the selected motor, the construction of the system architecture, the electrical load analysis, the selection of the battery as a result of load analysis, the examination of cable standards and the determination of the necessary cables and connectors and the transfer of the system to the drawing programs. At the end of the design process, the determined electrical equipment will be placed in the aircraft.

Keywords: Light aircraft, electric system, certification, EASA, VLA.

005
A Test-Bed for Attitude Determination and Control System of Nanosatellite

Aykut Kutlu[1], Demet Cilden-Guler[2] and Chingiz Hajiyev[3]

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Abstract: in order to ensure a reliable verification of attitude and control systems for nanosatellites, a test platform is developed. It is used to improve and implement the test scenarios of the sensors, actuators and algorithms. Magnetometer, accelerometer and gyroscope are used as attitude sensors to estimate the state of the satellite. As the primary attitude control actuator, three reaction wheels are used in each axis. The test setup is composed of the main octagonal table, balancing blocks, adapters for installation of equipment, adapters including anodized coating for corrosion protection. in order to manage balancing, the coarse balance blocks are placed in four corners and the precise balancing blocks are placed on each axis. The platform has a wireless monitoring system for online analysis and a power distribution unit. A computer is used to determine attitude determination and control tasks in a distributed control mechanism. Several scenarios are tested and analyzed in the traditional and nontraditional Kalman-type filters for attitude estimation of the satellite and magnetometer calibration purposes.

Keywords: Attitude Determination, Sensor Calibration, Small Satellite, Test Platform.

007
Satellite Formation Flight Via Thrusters and PID Control Approaches

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Abstract: This article is focused to control of relative satellite vector estimations with various Kalman filter (KF) and Proportional-integral-Derivative (PID) approaches. The identical 3U target and follower satellites orbits and initial conditions are simulated according with desired formation geometry limitations. in this study, target and follower satellites states are determined as derived simulation data. Position states due to Earth-centered inertial (ECI) reference frame were obtained by Keplerian orbital parameters and Global Positioning System (GPS) receiver via the Pseudo-ranging model. The various satellites thruster's scenario is analyzed with various relative state estimation which using Kalman filters. The novel methods which satellites and relative orbit estimation are determined via two stages, are inputted to the control section of follower satellites within formation flight of satellites architecture.

Keywords: Pseudo-ranging model, Relative Navigation, PID control, Satellite, Formation flight, GPS, Cluster Satellites.

009
Adaptive Kalman Filter Based Sensor Fault Detection, Isolation and Accommodation For B-747 Aircraft

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Abstract: Sensor fault detection, isolation and accommodation via Adaptive Kalman Filter (AKF) algorithm are applied to the lateral dynamics of Boeing-747 aircraft in this study. The flight dynamic model of Boeing-747 aircraft in steady state flight condition is presented and investigated. in nominal case, the Optimal Linear Kalman Filter (OLKF) gives fine estimation values. However, when there is malfunction on the measurement channels, the accuracy of the filter estimations become poor and the filter becomes unreliable. Two faulty scenarios are investigated. The first scenario comprises the single sensor fault and the second is a simultaneous double sensor fault. The fault detection algorithm detects the fault and isolation process performs via calculating and comparing the statistics of sample and theoretical error variances to distinguish the faulty sensor. Lastly, fault accommodation process is presented in the study as implemented by Adaptive Kalman filter algorithm and demonstrate very efficient, firm and reliable performance on behalf of enhancing the estimation values of the filter.

Keywords: Sensor fault detection, state estimation, flight control system, Optimal linear Kalman Filter, Adaptive Kalman Filter, state space model.

010
Stem Opportunities in Flight Testing Sunlight Reflector Ultralights

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Abstract: The Glitter Belt architecture uses swarms of autonomous, ultralight, high altitude reflector vehicles to measure atmospheric and surface properties and any effects of solar reflection, and then to scale up and reduce Global Warming. This paper considers the Western Hemisphere part of the architecture. The flight test process invites global participation, particularly from STEM students interested in small satellites and autonomous aerial vehicles. Conceptual design, scale model construction and initial low-risk testing, and issues in autonomous rendezvous, and technical areas for STEM participation are summarized.

Keywords: Glitter Belt, conceptual design, meteorology, swarm guidance, broadband astronomy.

011
Modeling and Simulation of Vertical Landing Dynamics of An Aircraft Based on A Model System

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Abstract: in this study, to develop a mathematical model for a short take off and vertical landing (STOVL) aircraft dynamics a model system which resembles such aircraft dynamics was studied. The proposed model system uses the thrust of axial fans to hover the whole system in the air. The dynamic equation s of the model system are derived and a reaction force model is also proposed for a stable landing condition. A simulation model is built and tested for some initial values of the variables and results were evaluated.

Keywords: vertical landing, STOVL model, reaction force model, dynamic simulation.

012
Examination of Supercapacitors in Terms of Sustainability in Aviation

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Abstract: The development in the aviation industry progresses depending on the development in propulsion systems. Propulsion systems have changed and developed over the years according to needs. in recent years, efforts have been made to replace traditional propulsion systems with more environmentally friendly alternatives. For this reason, electric propulsion systems have gained popularity in recent years. Although batteries and fuel cells already exist among devices that store electrical energy, these devices have some limitations. Supercapacitor technology is a new and promising energy storage technology. in this paper, supercapacitors with their aerospace-friendly and environmentally friendly properties are discussed.

Keywords: Aviation, energy, energy storage components, sustainability, battery, supercapacitors.

013
Improving the Risk Matrix

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Abstract: A Risk Matrix is a widely used tool to assess risk during project development by combining severity and likelihood of undesired events. Unfortunately, risk matrices have some major limitations, particularly with likelihood assessment. This paper describes a new method for creating a risk matrix to assess safety that uses a hazard analysis technique called System-Theoretic Process Analysis (STPA) in the assessment of hazard likelihood. The approach uses the causal scenarios derived from STPA to identify potential risks, along with a measure of mitigation effectiveness as a proxy for likelihood. By combining the strengths of STPA and traditional risk assessment methods, decision-makers will be better equipped to determine the risk level associated with their projects. The new risk assessment method is demonstrated on the development concept of a complex Future Rotary Wing Aircraft (FRWA) system and can be applied in any industry that uses a risk matrix to assess risk.

Keywords: Risk Matrix, System Safety, Systems Engineering, STPA.

014
Wind Energy Conversion for Stratospheric Balloon in Real Environment

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Abstract: It is crucial to solve the energy problem of stratospheric balloon to operate at high altitude for years. Wind energy can be a power source for long endurance stratospheric balloons by using high altitude wind profile. in this study, the wind energy conversion unit has been integrated to the station keeping high altitude stratospheric balloon system to predict the output power of unit in real environment. The result has been compared with the energy demand of propulsion unit to keep the balloon flight coordinates over the flight station. To simulate the balloon system, one of the Turkey's cities was chosen as a launch station and simulation has been applied into this city's atmospheric conditions including real wind data. Results show that wind energy conversion can yield a significant amount of energy to compensate energy demand of stratospheric balloon units such as propulsion.

Keywords: Stratospheric balloon, high altitude, wind energy, energy conversion, real environment.

015
The Artificial Immune System Paradigm for Generalized Unmanned Aerial System Monitoring and Control

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Abstract: Monitoring and control of dynamic systems must address their operation for maximum safety and performance. This means that the dynamic system is expected to maintain a desirable or acceptable level of performance in completing a mission under both normal and abnormal operational conditions. These abnormal conditions include off-design situations, excessive and unpredictable environmental conditions, adverse interaction with external agents, and subsystem faults and failures. This paper presents the envisioned general development process of an integrated and comprehensive methodology for monitoring and control of an autonomous unmanned aerial system inspired by the beneficial properties of the biological immune system. This includes outlining for each phase of the abnormal condition monitoring and control process the biological sources of inspiration and the implementation methods with their potential benefits and drawbacks.

Keywords: Monitoring, Control, Artificial intelligence, Immune Paradigm.

017
Nonlinear Six-Degree-of-Freedom Flight Modelling of a Single-Propeller Airplane

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Abstract: A mathematical model based on the solution of nonlinear aircraft equation of motion for six-degree-of-freedom flight was developed by using MATLAB programming. This mathematical model was adopted for evaluating the flight motion of single-propeller airplane. The aerodynamic data for the flight model was obtained from wind tunnel tests of power-off and stick-fixed 1/12 scale model of the airplane. The propulsion data, on the other hand, was obtained from two engines used within a flight envelope defined by altitude and airspeed. Linear interpolations were performed to evaluate the input data available in look up tables. The damping derivatives needed for the flight model were obtained from empirical USAF DATCOM methods. Airplane equation of motion was solved numerically at equilibrium condition for cruising velocity and altitude. Time history variations of all twelve state variables show instantaneous motion of airplane. The procedure described in this paper should be useful for the mission evaluation of such a propeller airplane during its preliminary design.

Keywords: 6-DOF flight modelling, propeller airplane, wind tunnel testing.

018
Transonic Airfoil Development for An Unmanned Air System

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Abstract: The process of developing a new energy efficient 16% thick airfoil for an unmanned air system operating at transonic speeds is presented. The airfoil specifications included a range of Reynolds number per foot from 1.7 million to 2.5 million and Mach number from 0.4 to 0.8. Shape optimization in geometry and inverse design modules of the MSES program were initially used for a preliminary design of the 16% thick airfoil. The MSES/LINDOP program was then used to obtain the final airfoil shape, optimizing the performance of the initial airfoil with an objective of minimizing drag coefficient for 7 design points with conflicting requirements in Reynolds and Mach number. The optimization produces an upward shift of drag bucket in the direction of higher lift coefficient. This shift is also seen on the location of transition producing an increase in the extent of laminar flow.

Keywords: airfoil optimization, airfoil design, transonic airfoils.

019
Optimization of Energy Efficiency According to Freud's Disk Theory Depending on Propell Pitch Angles

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Abstract: Propeller systems are systems that are used extensively in many areas, especially in ships, airplanes, air conditioning and wind turbines. Unmanned Aerial Vehicles, which are produced and used intensively nowadays, are also one of the most important areas where propeller systems are used. Thanks to the propeller system, Unmanned Aerial Vehicles can hover in the air and move. It is of great importance that the propellers are designed in a stable, efficient and reliable manner. in this study, drone propellers are optimized in terms of energy efficiency by considering Freud's Disc Theory. For the optimization process, a new mathematical model, which is used for the first time in the literature, is proposed and the efficiency of the proposed model is analyzed by comparing it with the simulation algorithm and real propeller values. As a result of the analysis study, it has been determined that an improvement of 11.84% compared to the real propeller data and 11.39% compared to the simulation results has been achieved in terms of energy efficiency. It is estimated that high efficiency can be achieved by applying the proposed solution approach to other propeller systems.

Keywords: Propeller design, Unmanned Aerial Vehicles, Optimization, Mathematical Modelling, Simulation.

020
Marketing of innovative Transportation Options: Urban Air Mobility

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Abstract: Throughout the history of civilization, transportation has been an important issue for humanity. in the past, while transportation by road, sea and train was essential, aviation has gained importance in the last century and has increased its share compared to others. Accelerating digitalization, especially in electric and autonomous vehicles that have self-travel and parking capabilities, with industry 4.0 has begun to affect and transform the transportation sector, mainly road and air transportation. These affect not only vehicles but also people's consumption preferences. For this reason, innovative steps should be taken in marketing as well, and safety-oriented strategies should be determined to eliminate consumer concerns, especially for autonomous aircraft (UAM). From this perspective, the main goal of this study is to offer various suggestions in terms of 'marketing' for industry professionals by highlighting consumer attitudes and behaviors towards innovative technologies not only in aviation but in in all modes of transportation.

Keywords: transportation, innovation, marketing, consumer, urban air mobility.

021
Detection of Unmanned Air Vehicles Using Multi-Camera Architectures

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Abstract: This paper presents a study on the feasibility of using multi-camera architectures based on monocular depth estimation strategies based on RGB images to improve the depth camera results, as well as to explore triangulation algorithms for the localization of Unmanned Air Vehicles (UAV). Preliminary results show that there is a benefit in using monocular depth estimation to complement the measurements of a depth camera for UAV obstacle detection, specifically when it comes to filling in the gaps in the depth map provided by the depth camera due to the obstacles being out of range.

Keywords: UAV detection, Sense and avoid, Obstacle detection.

023
Concept Design and Analysis for A Fixed-Wing Unmanned Aerial Vehicle to Perform Surveillance and Mapping Missions

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Abstract: Unmanned aerial vehicles have important position for both civil and military applications today. Fixed-wing unmanned aerial vehicles have an important place in the literature. in this study, the design stages of military and high altitude unmanned aerial vehicles were examined, and a scaled model was produced to perform ground tests and flight tests. For airfoil selection, 2D analyzes were made using the XFLR5 program. Speed and aerodynamic analyzes of unmanned aerial vehicle were performed by modeling a CFD code. As a result, the parameters required for observation, locating, and mapping have been determined. A successful model has been developed in terms of stable and aerodynamic flight.

Keywords: UAV, XFLR5, CFD, Flight Performance.

027
Flow Patterns in Double Planar Synthetic Jets

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Abstract: Synthetic jets are devices with high relevance due to its several industrial applications. For instance, their application as an actuator for active flow control of the boundary layer is very useful for improving the efficiency in aircrafts. This work studies the main flow physics in several types of synthetic jets, at different Reynolds number, using a data-driven method, higher order dynamic mode decomposition (HODMD). The cases studied are: a single active jet, two jets moving synchronously and asynchronously with phase shift between them of π and $\pi/2$ radians. The flow structures reveal the interaction between the two jets. The flow is found symmetric at low Reynolds number and asymmetric at high Reynolds number. HODMD extracts the main flow patterns with two aims: finding the mechanism triggering the symmetry breaking and to generate a reduced order model, which is interesting for the temporal prediction of the flow, reducing the computational time in the numerical simulations.

Keywords: planar synthetic jets, flow patterns, HODMD.

029
Coordinated Path Following for Multi-Agent Fixed-Wing Aircraft

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Abstract: This paper addresses the problem of coordinated path following for fixed-wing Unmanned Aerial Vehicles (UAVs) for a fixed altitude set-point. This problem is decomposed into two components: path following by commanding the attitude of the UAV, and synchronization of their respective along-path parameters. in relation to the path following problem, two different algorithms are considered. in the first, the path is decomposed into a concatenation of straight-lines where the controller is linearization-based. in the second, a non-linear curved path following controller is considered. For the synchronization, a proportional-integral coordination control law is considered for a communication topology with integral connectivity.

Keywords: coordinated path following, coordination control, path following, unmanned aerial vehicles, fixed-wing.

030
Submersible Seaplanes as the Path to Hybrid Flying and Diving Craft

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Abstract: A survey of novel hybrid unmanned aquatic–aerial vehicles in 2015 proposed the term 'AquaUAV' and overviewed developments in both seaplane UAVs and a new class of submersible UAVs that can dive. The submersible developments by Beihang and Nanchang Hangkong universities a decade ago have led to morphing and copter AquaUAVs. An … university research team have conceptually designed a submersible seaplane that merges the maturity of the seaplane class with covert underwater insertion, travel and recovery. The reconnaissance design inserts from underwater emplacement, surfaces, can fly in ground effect, keeps station on the sea surface while recharging, travels and wait for collection underwater. The design minimizes doppler and infra-red signatures to evade the surface-wave and backscatter radar systems and cube-satellite arrays typical in contested maritime areas. Five critical enabling technologies are overviewed, showing how they enable the design. The university is hoping for sponsorship for prototype testing.

Keywords: aquatic unmanned aerial vehicle, submersible seaplane, wing in-ground effect, syntactic foam, computational fluid dynamics, solar recharge.

032
Onboard Trajectory Coordination of Multiple Unmanned Air Vehicles

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Abstract: The increasing diversity of Autonomous Air Vehicles (AAV) and their application has created an increased need for effective aircraft trajectory coordination within airspaces. Here a method to coordinate a flight formation of multiple Unmanned Aerial Vehicles (UAVs) using onboard command and control is introduced. The proposed system has been verified in simulation and validated in flight. The results show that it is possible to control a fleet of multi-rotor aircraft using equipment present onboard the aircraft. Areas of improvement to increase accuracy and reliability of the system have also been proposed.

Keywords: UAV, Multi-Rotor, Multi-Agent, Flight Formation, Coordination, Control.

033
in-Flight Nonlinear System Identification for UAS Adaptive Control

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Abstract: Fast aircraft prototyping, fault detection, morphing surfaces and real-time generation of dynamic models are just some of the advantages of a model identification adaptive controller. The research presented in this paper investigates a proposed control architecture and validates the novel data-driven algorithm SINDy to be used for online system identification of a UAS. The reported simulation results explore the effects and the limits of short training time and sensor noise on the identified model fitness.

Keywords: Adaptive control, data-driven model, multisine perturbation, model identification adaptive controller.

034
The Architecture of a Modular UAV with Additively Manufactured Frame: Preliminary Flight and Performance Evaluations

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Abstract: This work explores an Unmanned Aerial Vehicle (UAV) with a customizable configuration. Its architecture follows the application scenario, thus granting it fits the required performances. Tricopter, quadcopter, hexacopter, and octocopter are all the possible configurations this UAV can be adapted to. The customization is achieved with eight individual components; several setups arise when they are assembled in different ways and numbers. The core houses the standard avionics; those to be repeated find place in plug-and-play arms. A further chance of customizability is given by the Fused Filament Fabrication (FFF), the additive manufacturing technology used to produce the structural parts of the frame. Finally, the paper proposes the performance simulation of four different scenarios, implementing non-custom avionics and highlighting how they modify from one setup to another. Flight time, payload capabilities, maximum speed, efficiency, and thrust-to-weight ratio are the key parameters guiding to fit the UAV to the mission profile.

Keywords: UAV; drone; multirotor; additive manufacturing; flight performances.

035
Drone Simulation, Mapping and Navigation Via ROS

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Abstract: in recent years, simulation environments with robust physics engines, high-quality graphics and user-friendly interfaces allow researchers to validate their work in simulation environments before real test environments. in this study, a ROS based mapping and navigation of a real drone model in three-dimensional simulation environment Gazebo is described. The mapping process is carried out using the Gmapping algorithm. The purpose of this study is to evaluate the drone's mapping, location and navigation in an unknown environment.

Keywords: ROS, Gazebo, mapping, navigation, drone.

036
Hierarchical Adaptive Fault-Tolerant Model Predictive Control of a Quadrotor

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Abstract: This paper proposes an adaptive fault-tolerant model predictive control design for trajectory tracking of a quadrotor subject to unexpected actuator faults. The proposed control adopts a hierarchical structure where the dual-loop and dual-time-scale attitude control and position control are developed successively. The attitude control regulates the attitude rapidly, while the position control achieves fault-tolerant tracking by combining Lyapunov-based model predictive control and adaptive parameter estimation. Closed-loop stability is proven and the control performance is substantiated by simulations.

Keywords: quadrotor, model predictive control, fault-tolerant control.

037
Higher-Order Dynamic Mode Decomposition to Model Reacting Flows

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Abstract: in this work we analyse an axisymmetric, time varying, non-premixed laminar co-flow flame. To this aim, a data driven algorithm (higher order dynamic mode decomposition) has been used to identify the main patterns leading the flow dynamics and modelling the turbulent combustion. The results show that this complex turbulent flow can be modelled using a reduced number of modes identified by the method, which represent the flow physics. These modes can be used to reconstruct the original solution. This flow reconstruction represents a reduced order model that can be used to model the main flow dynamics at a reduced computational time. Modelling turbulent combustion using methods based on physical principles, such as the one presented in this work, could be used to generate several databases in a fast and efficient manner, bringing new possibilities to improve the efficiency in combustion systems in aircraft.

Keywords: Reacting flows, HODMD.

038
Fault Tolerant Estimation of Relative Motion of Satellites in Cluster

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Abstract: This paper is devoted Global Positioning System (GPS) based cluster Satellite architecture localization which used for Pseudo-ranging model. The relative satellite state estimations are detected and estimated by fault tolerant Kalman filters via measurement of actual distance between 4 GPS satellites and target satellite. The Keplarian equations and orbit elements are used for target and follower satellites dynamic models. J2 orbit perturbation is considered within the relative states estimation stage via covariance matrices of target and follower satellites' localization stages. The novel aproach is fault tolerant relative satellite state estimations which designed according to 2 version. One of them is reconfiguration fault tolerant cluster satellite localization and the other one is adaptively fault tolerant cluster satellite localization. The Extented Kalman Filter (EKF) used for target and follower satellites orbital state vector estimations and detection of GPS measurement errors. The Reconfigurable version and the adaptive version of fault tolerant localization architecture eliminate the GPS measurement errors during estimating relative satellites position and velocity vectors.

Keywords: Relative satellite localization, GPS, Fault Tolerant Kalman Filter, Adaptive Kalman Fİlter, Orbital localization, Cluster Satellite architecture.

039
Trajectory tracking control of an unmanned ground vehicle based on Fractional Order Terminal Sliding Mode Controller

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Abstract: in this paper, fractional order terminal sliding mode control (FOTSMC) method, which is a hybrid control approach, is used to improve the trajectory tracking control performance of an unmanned ground vehicle (UGV). First of all, a kinematic controller design has been carried out to estimate the linear and angular velocities that will stabilize the vehicle asymptotically. Then, FOTSMC, which is a hybrid control method that combines the advantages of fractional control and terminal sliding mode control methods, is proposed to perform vehicle reference velocities tracking. in addition, terminal sliding mode control (TSMC) and sliding mode control (SMC) methods are used for trajectory tracking control of the same vehicle to demonstrate the performance of the proposed controller. Simulation results show that the proposed controller performs trajectory tracking with smaller error and lower amplitude chattering compared to TSMC and SMC.

Keywords: Unmanned ground vehicle, kinematic control, fractional order, terminal sliding mode control.

040
Nonlinear Control of Multi-Quadrotor Flight Formations

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Abstract: The design of a controller based on classical methods to control flight formation of multi-UAV quadrotors is presented. A leader-follower methodology is implemented where the leader has some predefined trajectory and a follower is controlled in order to track the leader keeping a constant displacement in its reference frame. The formation control solution is done in two steps: first, by considering only the motion at constant height, and second, a three-dimensional motion was considered. in both cases, the nonlinear control laws are derived based on Lyapunov stability and the backstepping method.

Keywords: UAV, leader-follower, Lyapunov stability, backstepping.

041
Dynamic Modeling of Main Landing Gear of a High Altitude Long Endurance UAV

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Abstract: Main landing gear of a high altitude long endurance UAV was modeled as a mass-spring-damper system in this study. Landing gear components including the oleo-pneumatic shock strut, tire, and wheel were included in the constructed model in the study. An oleo-pneumatic shock absorber with fixed orifice area was used in the model and dynamic behavior of the system was investigated. A representative input data set for UAV specifications and oleo-pneumatic shock absorber characteristics were collected from literature to form the input data set, and dynamic model was solved with using computer software. Three main cases were run in accordance with the CS-25 certification requirements which are at 1.83, 3.05, 3.7 m/s (6,10,12 fps) descent velocities and lift equals to weight condition. Within the constraints, the results are satisfactory and can be used as a baseline configuration to be optimized in future research.

Keywords: Aircraft landing gear, shock absorber, system modeling, UAV systems.

043
GNSS Aided Satellite Localization by Using Various Kalman Filters

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Abstract: This paper is devoted comparison of the satellite position and velocity states estimation with the use of Traditional Extended, Extended with linear measurements and Newton Raphson aided Extended Kalman Filters. in this study, a Low-Earth orbiting satellite position and velocity states are estimated by using the above filters. A global navigation satellite system (GNSS) receiver is modeled using a pseudo-range approach. Obtained results were compared and discussed. An attempt was made to determine the best method for estimating the satellite's position. The accuracy of the estimates was shown for each estimation approach.

Keywords: Satellite position estimation, Kalman Filter.

044
Thermal study of cylindrical lithium-ion battery at different discharge rates

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Abstract: This study aims to simulate a commercially available 26650 lithium-ion battery temperature. The multi-scale multi-dimensional NTGK model was used to simulate battery temperature. The highest maximum battery temperature was 346.110 K obtained at 3.0C-rate while the lowest maximum battery temperature of 311.934 K was exhibited at 1.0C-rate. The highest average battery temperature of 345.164 K and the lowest average battery temperature of 311.627 K were obtained at 3C-rate and 1C-rate, respectively. However, the results demonstrated that the temperature rise was more pronounced for the maximum battery temperature for all implemented C-rates. The results also showed that the C-rate should be carefully changed by monitoring the maximum battery temperature. The implemented battery thermal model can be used to improve battery thermal management systems in real-life applications.

Keywords: thermal management, lithium-ion battery, maximum battery temperature, discharge, C-rate.

045
The Effect of Control Cylinder Placed at Different Angles in Front of a Heated Cylinder on Heat Transfer

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Abstract: Controlling the flow structure on objects using different control techniques has been a wide field of study for researchers for many years. in this study, the temperature distribution around the heated cylinder was investigated in two different Reynolds numbers (Re=1400 and Re=2700) when a 25mm diameter flow control cylinder is placed in the upstream region of a heated cylinder in a water channel at L/D=2 position and at an angle of 21°. As a result of the study, it was determined that the 21° angled positioning worsened the heat transfer compared to the fixed (0°) positioning of the control cylinder in the upstream region of the heated cylinder for each Re number examined within the scope of the study. The straight control cylinder in the L/D=2 position produced better results than the cylinder in the 21° angled position.

Keywords: Flow control, Heated cylinder, Heat transfer, Nusselt number.

047
Aerodynamic Shape Optimization of the Morphing Leading Edge for the UAS-S45 Winglet

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Abstract: This paper presents an aerodynamic optimization for a Morphing Leading Edge (MLE) winglet of a well-known UAV, the UAS-S45. The optimization algorithm is integrated with the modified Class Shape Transformation (CST) parameterization method, and had the aim to enhance aerodynamic performance by minimizing drag and maximizing aerodynamic endurance at the cruise flight condition. The optimization scheme was carried out with in-house MATLAB code, and by employing the Vortex Lattice Method (VLM) to calculate the aerodynamic properties of the morphing leading-edge winglet. This study presents the optimization technique and compares winglet geometries results by demonstrating that changing the winglet geometry in flight can enhance aircraft performance while lowering drag, therefore the fuel consumption. The optimized airfoils have shown a significant improvement in the overall aerodynamic performance by up to 8.55% drag reduction and 10.20% increase in aerodynamic endurance, as compared to the reference airfoil. Therefore, the results indicate the importance of leading-edge morphing in enhancing the aerodynamic efficiency of the UAS-S45 airfoil.

Keywords: Morphing Winglet, Optimization, Particle Swarm Optimization, Class Shape Transformation, Aerodynamic Performance.

050
Applications of Drones in the Field of Health and Future Perspectives

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Abstract: Drones can gather real-time data cost-effectively to deliver payloads and have initiated the rapid evolution of many industrial, commercial, and recreational applications. The advancement of Unmanned Aerial Vehicle (UAV) technology in industrial processes and communication and networking technologies has increased their use in civil, business, and social applications. Drones offer various exciting opportunities; delivery of medical and laboratory supplies, blood products, including biopsy for emergency surgeries, is just a starting point. Drones can evolve medical care as well as propel advancement in the health industry. The use of an automated external defibrillator (AED) before emergency medical services (EMS) arrival can increase 30-day survival in out-of-hospital cardiac arrest (OHCA) significantly. Drones or UAVs can fly with high velocity and potentially transport devices such as AEDs to the site of OHCAs. This article provides a comprehensive review of current and future drone applications in health to empower and inspire more aggressive investigation.

Keywords: Drone, UAV, Cardiac arrest, Defibrillation, AED, Drone transportation, Healthcare.

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Comparison of 5th Generation Fighters: Evaluation of Trends in Military Aviation

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Abstract: Nations attach great importance to their defense in order to ensure their survival against internal and external threats. The only defense force that can respond in the fastest and most effective way against possible threats is the air force. The power of the air force, which has such an important place in the country's defense, is based mainly on fighters. For these reasons, the vision of purchasing or manufacturing fighter jets in line with the strategic plans and future goals of the countries in defense is of great importance. in this study, a detailed comparison of the 5th generation fighters that have already been produced has been made. The comparison is made into a decision problem structure and solved with AHP, one of the multi-criteria decision-making methods. The result was the Sukhoi SU-57 as the optimum fighter aircraft. in addition, new trends and aims in fighters were examined. Trends and aims will guide countries and cooperations to be included in the new era of fighters.

Keywords: Air force, Fighter jets, Multi-Criteria Decision-Making, Analytic Hierarchy Process.

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Comparison of Kalman Filter Types in Orientation of UGV with Using inertial Navigation System

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Abstract: in the literature, in applications based on inertial state estimation, there is no determinative study on which criteria to choose Kalman Filter and its derivatives The purpose of this article is to determine which filter is more efficient by comparing the performance of the inertial Measurement Unit (IMU) which is planned to be used in Unmanned Ground Vehicles (UGV) position detection applications. in this simulated study, the real position value provided by the accelerometer and gyroscope data obtained for the UGV in the 3-dimensional space plane from the IMU and the position values estimated by the Extended Kalman Filter (EKF) and the Extended information Filter (EIF) were compared. It has been observed that the Extended information Filter can detect position with less error in position estimation.

Keywords: Kalman Filtering, Extended Kalman Filtering, Extended information Filtering, Orientation, IMU, UGV.