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## Journal Information:

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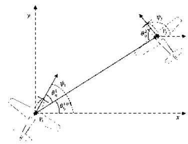
# Section Aerospace Science and Engineering

## Featured Papers

DOI:10.3390/app10165613

### Path Planning and Real-Time Collision Avoidance Based on the Essential Visibility Graph

*Authors: Luciano Blasi , Egidio D'Amato, Massimiliano Mattei and Immacolata Notaro*



Abstract: This paper deals with a novel procedure to generate optimum flight paths for multiple unmanned aircraft in the presence of obstacles and/or no-fly zones. A real-time collision avoidance algorithm solving the optimization problem as a minimum cost piecewise linear path search within the so-called Essential Visibility Graph (EVG) is first developed. Then, a re-planning procedure updating the EVG over a selected prediction time interval is proposed, accounting for the presence of multiple flying vehicles or movable obstacles. The use of Dubins curves allows obtaining smooth paths, compliant with flight mechanics constraints. In view of possible future applications in hybrid scenarios where both manned and unmanned aircraft share the airspace, visual flight rules compliant with International Civil Aviation Organization (ICAO) Annex II Right of Way were implemented. An extensive campaign of numerical simulations was carried out to test the effectiveness of the proposed technique by setting different operational scenarios of increasing complexity. Results show that the algorithm is always able to identify trajectories compliant with ICAO rules for avoiding collisions and assuring a minimum safety distance as well. Furthermore, the low computational burden suggests that the proposed procedure can be considered a promising approach for real-time applications.

DOI:10.3390/app10238633

### Performance Analysis of Multi-Spindle Drilling of Al2024 with TiN and TiCN Coated Drills Using Experimental and Artificial Neural Networks Technique

*Authors: Muhammad Aamir, Majid Tolouei-Rad, Ana Vafadar,
Muhammad Nouman Amjad Raja and Khaled Giasin*


Abstract: Multi-spindle drilling simultaneously produces multiple holes to save time and increase productivity. The assessment of hole quality is important in any drilling process and is influenced by characteristics of the cutting tool, drilling parameters and machine capacity. This study investigates the drilling performance of uncoated carbide, and coated carbide (TiN and TiCN) drills when machining Al2024 aluminium alloy. Thrust force and characteristics of hole quality, such as the presence of burrs and surface roughness, were evaluated. The results show that the uncoated carbide drills performed better than the TiN and TiCN coated tools at low spindle speeds, while TiCN coated drills produced better hole quality at higher spindle speeds. The TiN coated drills gave the highest thrust force and poorest hole quality when compared with the uncoated carbide and TiCN coated carbide drills. Additionally, a multi-layer perceptron neural network model was developed, which could be useful for industries and manufacturing engineers for predicting the surface roughness in multi-hole simultaneous drilling processes.

DOI:10.3390/app11093995

**Unmanned Aerial Traffic Management System Architecture for U-Space In-Flight Services**

*Authors: Carlos Capitán, Héctor Pérez-León, Jesús Capitán, Ángel Castaño and Aníbal Ollero*

Abstract: This paper presents a software architecture for *Unmanned aerial system Traffic Management* (UTM). The work is framed within the U-space ecosystem, which is the European initiative for UTM in the civil airspace. We propose a system that focuses on providing the required services for automated decision-making during real-time threat management and conflict resolution, which is the main gap in current UTM solutions. Nonetheless, our software architecture follows an open-source design that is modular and flexible enough to accommodate additional U-space services in future developments. In its current implementation, our UTM solution is capable of tracking the aerial operations and monitoring the airspace in real time, in order to perform in-flight emergency management and tactical deconfliction. We show experimental results in order to demonstrate the UTM system working in a realistic simulation setup. For that, we performed our tests with the UTM system and the operators of the aerial aircraft located at remote locations with the consequent communication issues, and we showcased that the system was capable of managing in real time the conflicting events in two different use cases.

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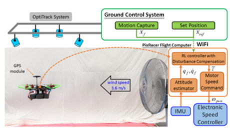
DOI:10.3390/app11073257

**Robust Quadrotor Control through Reinforcement Learning with Disturbance Compensation**

*Authors: Chen-Huan Pi, Wei-Yuan Ye and Stone Cheng*




Abstract: In this paper, a novel control strategy is presented for reinforcement learning with disturbance compensation to solve the problem of quadrotor positioning under external disturbance. The proposed control scheme applies a trained neural-network-based reinforcement learning agent to control the quadrotor, and its output is directly mapped to four actuators in an end-to-end manner. The proposed control scheme constructs a disturbance observer to estimate the external forces exerted on the three axes of the quadrotor, such as wind gusts in an outdoor environment. By introducing an interference compensator into the neural network control agent, the tracking accuracy and robustness were significantly increased in indoor and outdoor experiments. The experimental results indicate that the proposed control strategy is highly robust to external disturbances. In the experiments, compensation improved control accuracy and reduced positioning error by 75%. To the best of our knowledge, this study is the first to achieve quadrotor positioning control through low-level reinforcement learning by using a global positioning system in an outdoor environment.

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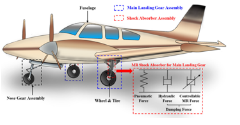
DOI:10.3390/app11177895

**A New Design Model of an MR Shock Absorber for Aircraft Landing Gear Systems Considering Major and Minor Pressure Losses: Experimental Validation**

*Authors: Byung-Hyuk Kang, Jai-Hyuk Hwang and Seung-Bok Choi*




Abstract: This work presents a novel design model of a magnetorheological (MR) fluid-based shock absorber (MR shock absorber in short) that can be applied to an aircraft landing gear system. When an external force acts on an MR shock absorber, pressure loss occurs at the flow path while resisting the fluid flow. During the flow motion, two pressure losses occur: the major loss, which is proportional to the flow rate, and the minor loss, which is proportional to the square of the flow rate. In general, when an MR shock absorber is designed for low stroke velocity systems such as an automotive suspension system, the consideration of the major loss only for the design model is well satisfied by experimental results. However, when an MR shock absorber is applied to dynamic systems that require high stroke velocity, such as aircraft landing gear systems, the minor loss effect becomes significant to the pressure drop. In this work, a new design model for an MR shock absorber, considering both the major and minor pressure losses, is proposed. After formulating a mathematical design model, a prototype of an MR shock absorber is manufactured based on the design parameters of a lightweight aircraft landing gear system. After establishing a drop test for the MR shock absorber, the results of the pressure drop versus stroke/stroke velocity are investigated at different impact energies. It is shown from comparative evaluation that the proposed design model agrees with the experiment much better than the model that considers only the major pressure loss.

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