

Air Transport

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VoIP 记录与监听技术及应用

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摘要: VOIP 录音技术作为下一代地空语音通信技术, 采用会话的方式, 通过 IP 网络, 直接将语音信号传输至本地或远端录音服务器, 可实时监听, 也可随时随地提取回放, 方便快捷。采用 VOIP 录音方式, 避免了录音数据提取对通信的影响, 跨越地域和通信线路的限制, 使集中统一进行录音和监听成为可能。我单位密切关注该项技术的发展, 研制出 VOIP 录音设备, 设计出目前地空通信未完全 IP 化的过渡阶段利用 VOIP 录音技术进行录音和监听的方案。通过在沈阳地区进行录音测试验证, 效果良好, 为实际工程应用提供参考。

关键词: VoIP; 地空通信; 录音技术

The Technology and Application of VoIP Recording and Monitoring

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Abstract:

VoIP recording technology, as the next generation of ground-to-air voice communication technology, directly transmits voice signals to local or remote recording servers through IP networks in a conversational manner, which can monitor in real time and extract playback anytime, anywhere, and is convenient and fast. By adopting VoIP recording mode, the influence of recording data extraction on communication is avoided, and the restrictions of regions and communication links are crossed, making centralized and unified recording and monitoring possible. We closely followed the development of this technology, developed VoIP recording equipment, and designed a plan to use VoIP recording technology for recording and monitoring in the transitional phase of the current ground-to-air communication that is not fully IP - based. Through the recording test in Shenyang area, the effect is good and provides a reference for practical engineering application.

keywords: VOIP; G/A communication; recording technology

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民航 KU 波段卫星监控信号引接分析及意义

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摘要: 现阶段民航东北空管传输系统多采用“两地一空”模式,即地面两中继保障,而 KU 卫星提供空管线路的空中保障。传统地面传输设备的监控可以引接到区管中心,但民航通信卫星网所负责的外台站 KU 卫星设备长期以来没能将其监控信号引接回区管,导致我们无法对相应节点的运行状态进行监控,本文主要对锦州、朝阳、通辽、西乌四个台站 KU 卫星监控信号引接回区管进行分析,最终实现了对这四个台站 KU 卫星的监控。

关键词: KU 卫星; 监控; 改造与建设

Analysis and Significance of Guidance of Satellite Monitoring Signal in KU Band of Civil Aviation

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Abstract:

At present, the air traffic control transmission system of civil aviation in Northeast China mostly adopts the mode of "two places and one air", i.e. ground two relay support, while KU satellite provides air traffic control line support. The monitoring of traditional ground transmission equipment can be directed to the district management center, but the KU satellite equipment of the station in charge of the Civil Aviation Communication Satellite Network has not been able to direct its monitoring signal back to the district management for a long time, which makes it impossible for us to monitor the operation status of the corresponding nodes. This paper mainly focuses on Jinzhou, Chaoyang, Tongliao and Xiwu stations. The KU satellite monitoring signal is transferred back to the zone tube for analysis, and finally the monitoring of the four KU satellites is realized.

keywords: KU satellite; monitoring; transformation and construction

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FA36 网络优化及完善分析

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摘要: 雷达信号以及甚高频业务作为管制员指挥航班的重要手段,在民航空管系统的日常工作中发挥着极大的作用。本文主要以 FA36 网络组建和维护过程中发生隐患为依据,以现用的 FA36 网络现状为基础,现业务传输情况虽基本稳定,但从通信行业发展的角度和安全隐患排查的角度,民航东北地区雷达信号的传输还存在不足,需要优化布局。再此基础上详细阐述对民航雷达和甚高频网络建设和改造方案,从而建立一个高速的、安全高效的局域交换网,以满足空管雷达和甚高频遥控台信号信号传输的需求。

关键词: 局域网; 改造与建设; 雷达; 甚高频

Analysis and Optimization of FA36 Network

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Abstract:

Radar signal and VHF service, as the important means for controllers to command flights, play a great role in the daily work of civil aviation air traffic control system. This paper is mainly based on the hidden dangers in the process of FA36 network establishment and maintenance, and on the basis of the current situation of FA36 network. Although the service transmission situation is basically stable, from the perspective of communication industry development and security risk investigation, the transmission of radar signals in the northeastern region of civil aviation still has shortcomings, and needs to optimize the layout. On this basis, this paper elaborates on the construction and transformation of Civil Aviation Radar and VHF network, so as to establish a high-speed, safe and efficient local area switching network to meet the requirements of signal transmission of air traffic control radar and VHF remote control station.

keywords: LAN; renovation and construction; radar; VHF

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Blind Estimation of Spreading Sequence in Aperiodic Long-Code DSSS Signal

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Abstract: In non-cooperative system, the estimation of direct sequence spread spectrum (DSSS) signals has to be done in a blind manner. The technique of spreading sequence estimation is mature for Short-Code DSSS (SC-DSSS). However, the blind estimation technique of spread spectrum sequence for aperiodic Long-Code DSSS (LC-DSSS) is always flawed as the signal periodicity was destroyed. In this paper, the Coefficient of Similarity (CS) was used to reconstruct the periodicity of LC-DSSS signal. Then, the spreading sequence can be estimated using eigen-value decomposition (EVD). Simulation experiments show that the proposed algorithm can effectively estimate the spreading sequence of LC-DSSS signals for low signal-to-noise ratio (SNR) case.

Key words: direct; sequence; spread; spectrum (DSSS); aperiodicity; similarity analysis; measure function

基于临空飞艇的新型台风追踪探测方法与系统

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摘要: 台风是世界上最严重的自然灾害之一, 危害巨大, 每年频发, 不仅会导致人员的伤亡, 还会造成财产的损失, 因而台风的预报尤为关键。目前国内外对台风预警的研究中, 地基仪器和地基仪器的探测都存在局限性。为了能够对台风进行全过程、多要素的精细观测, 本文提出了基于临空飞艇的新型空基台风追踪探测方法与系统, 临空飞艇具备长时驻空、广域覆盖、持续追踪的特点, 能够对台风进行大区域、全天候的直接观测。之后, 本文介绍了系统组成与工作流程, 该系统能够真实地逼近实际台风的数字化状态并反演, 从而有效提升防灾减灾能力, 减少经济损失和人员伤亡。

关键词: 临空飞艇; 台风追踪探测; 全过程多要素; 数字化台风

A New Method and System for Typhoon Tracking Reconnaissance Using Near-Space Airship

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Abstract:

Typhoon is one of the most serious natural disasters in the world. It occurs frequently every year with major hazard. It not only leads to casualties but also loss of property. Therefore, the forecast of typhoon is especially important. At present, the research on typhoon forewarning at home and abroad has limitations using space-based and ground-based instruments for reconnaissance. In order to be capable of realizing the whole-process and multi-element fine observation of typhoon, we propose a new air-based typhoon tracking reconnaissance method and system using the near-space airship. The airship can realize wide-range and all-weather observation directly on typhoon, with the characteristics of long-term remaining, wide-area coverage and continuous tracking. Then, we explain the implementation steps and system components. The system can truly approximate the digital state of the actual typhoon and invert. Thereby, the ability of disaster prevention and mitigation will be effectively improved. And economic losses and casualties will be reduced.

keywords: Near-space; airship; typhoon; tracking; reconnaissance; whole-process and multi-element; digitized typhoon

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基于相控面阵天线的无人机柔性波束覆盖

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摘要: 无人机在未来的空地网络中将发挥越来越重要的作用, 由于无人机的移动性, 其作业的目标区域会频繁地改变, 因此需要采用灵活的波束赋形技术。得益于较小的硬件尺寸低功耗, 基于相控面阵天线的毫米波波束赋形可以应用到无人机通信系统当中, 从而实现对目标区域的柔性覆盖。为了实现这一目标, 本文首先对目标区域进行坐标变换, 得到了该区域的最小矩形包络。之后, 通过采用子阵列方法获得了覆盖该包络区域的波束。仿真结果表明, 本文所提出了方法能够对任意形状大小的目标区域实现灵活的波束覆盖, 并且使得波束增益主要集中在目标区域。

关键词: 无人机; 毫米波; 相控面阵天线; 波束赋形; 柔性覆盖

Flexible Beam Coverage for UAV with Phased Planar Array

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Abstract:

Unmanned aerial vehicle (UAV) plays an important role in the future air-to-ground networks. Due to the mobility, the target coverage area of a UAV may change frequently, which requires flexible beamforming. Thus, millimeter-wave beamforming with a phased-array is preferred in UAV communications due to the small size and power efficiency. In this paper, we explore 3D beamforming for mmWave UAV communications with a phased uniform planar array. To realize a flexible coverage, we first take the coordinate transformation of a target area and obtain a minimum rectangular which can cover the target area. Then, we use the sub-array technique to design a wide beam to cover the rectangular. Simulation results show that the proposed approach can achieve flexible beam coverage for any type of target area, and the beamforming gain is mainly concentrated in the target coverage area.

keywords: UAV; mmWave; phased planar array; beamforming; flexible coverage

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基于网络编码的航空自组网组播路由协议研究

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摘要: 航空自组网是移动自组网在航空通信领域的应用。航空自组网是一种直接使用机载数据链在飞机之间进行通信的无中心自组织的多跳网络。相比于传统航空通信利用地面中继与卫星中继的方法, 降低了使用成本与实时业务传输的传播时延。但由于航空自组网其高动态性, 网络节点分布稀疏的特点, 导致信道质量不稳定, 传输丢包率较大。针对航空自组网的特点, 提出了一种基于网络编码的组播路由协议用于降低丢包率并减少传播时延。

关键词: 航空自组网; 网络编码; 组播技术

Research on Multicast Routing Protocol of Aeronautical Ad Hoc Network Based on Network Coding

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Abstract:

The aeronautical ad hoc network is the application of mobile ad hoc networks in the field of aeronautical communications. The aeronautical ad hoc network is a non-central self-organizing multi-hop network that communicates directly between aircraft using an airborne data link. Compared with traditional aeronautical communication, the method of using ground relay and satellite relay reduces the cost of use and the propagation delay of real-time service transmission. However, due to the high dynamics of the aeronautical ad hoc network and the sparse distribution of network nodes, the channel quality is unstable and the transmission loss rate is large. Aiming at the characteristics of avionics network, a multicast routing protocol based on network coding is proposed to reduce the packet loss rate and reduce the propagation delay.

keywords: aeronautical ad hoc network; network coding; multicast technology

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导航增强自组网协同定位优化方法

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摘要: 导航增强自组网由北斗导航卫星、通信卫星、临近空间浮空器、地面伪卫星等组成,旨在利用浮空器平台作为额外的通信中继点和导航源,协同实现空地一体化导航增强。本文聚焦于临近空间导航应用的探索,研究卫星与浮空器平台的协同定位,通过浮空器平台的信号转发来实现区域导航增强,提高卫星信号较弱地区用户的定位精度,起到应急导航定位的作用。文章首先介绍了导航增强自组网模型,分析了浮空器平台和卫星之间的可见性及约束条件。然后阐述了协同定位的工作原理和定位精度评价指标 DOP。最后进行了仿真实验,结果表明本文提出的协同定位方法能够在仿真场景下保证一定的定位精度。

关键词: 临近空间; 导航增强; 协同定位

A Cooperative Positioning Optimization Method of Navigation Augmentation Network

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Abstract:

The Navigation Augmentation Network consists of Beidou navigation satellites, communication satellites, near-space aerostats, ground pseudolites, etc. The aerostat platform is used as an additional communication relay point and navigation source to achieve the Space-Air-Ground Navigation Augmentation. This paper focuses on the exploration of near-space navigation applications by studying the cooperative positioning of satellites and aerostat platforms. Regional navigation enhancement is achieved through signal forwarding of aerostat platform, thus improving the positioning accuracy of users with weak satellite signals, which could play a significant role in emergency navigation positioning. Firstly, the navigation enhanced network model is introduced, while the visibility and constraints between aerostat platforms and satellites are analyzed. Then the principle of co-location and the dilution of precision(DOP) as evaluation index are presented. Finally, the simulation experiment is performed and the results show the collaborative positioning method proposed in this paper could guarantee certain positioning accuracy in the simulation scenario.

keywords: Near-space; Navigation Augmentation; Cooperative Positioning

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地基增强系统的电离层梯度检测方法研究与验证

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摘要: 地基增强系统 (GBAS) 作为目前精密进近技术的前进方向之一, 具有灵敏度高、改正精度高、设备利用率高、成本低等优点。但由于电离层梯度现象的存在, 极大地限制了定位精度的进一步提升, 无法达到期望的三类精密进近等级。本文将基于电离层梯度的特点, 研究短基线电离层梯度检测方法, 通过将其运用到实际检测条件下, 对其各项性能进行分析, 明确其优势以及存在的问题, 为更进一步提高其性能提供指导。

关键词: 地基增强系统; 电离层梯度; 短基线电离层检测

Research and Verification of Ionospheric Gradient Detection Method for Ground-Based Augmentation System

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Abstract:

As one of the forward directions of the current precision approach technology, the ground-based augmentation system (GBAS) has high sensitivity, high correction accuracy, high equipment utilization rate and low cost. However, due to the existence of the ionospheric gradient phenomenon, the positioning accuracy is greatly limited, and the expected three types of precision approach levels cannot be achieved. In this paper, based on the characteristics of ionospheric gradient, the short-baseline ionospheric gradient detection method is studied. By applying it to the actual detection conditions, its performance is analyzed to clarify its advantages and existing problems, to further improve its performance.

keywords: Ground-based augmentation system; ionosphere gradient; short baseline ionosphere detection

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GNSS 性能监测与评估系统监测站选址分析

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摘要: 全球卫星导航系统 (GNSS) 作为我国民航管新技术的核心, 对 GNSS 元素性能进行监测显得极为重要, 为此, 中国民航立项 GNSS 性能监测与评估工程。本文通过分析 GNSS 性能监测与评估系统对地面监测站建设的要求, 包括监测站的覆盖性能、均匀度、几何构型和建设投入, 提出了最优监测站分布模型, 利用遗传算法对模型求解, 得到最优的监测站选址方案, 为监测站的建设提供了参考。

关键词: 监测站; 最优分布; 遗传算法

GNSS Performance Monitoring and Evaluation System Monitoring Station Location Analysis

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Abstract:

Global Navigation Satellite System (GNSS) is the core of new air traffic control technology in China's Civil Aviation. It is extremely important to monitor the performance of GNSS elements. For this purpose, Civil Aviation of China has established a GNSS performance monitoring and evaluation project. This paper analyzes the requirements of the GNSS performance monitoring and evaluation system for the construction of ground monitoring stations, including the coverage performance, uniformity, geometric configuration and construction investment of the monitoring station, then puts forwards the model of optimal monitoring station distribution and the model is solved by genetic algorithm. The optimal monitoring station location plan from the model provides a reference for the construction of the monitoring station.

keywords: monitoring stations; optimal distribution; genetic algorithm

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简析 M 型下滑天线的近场监控天线定位

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摘要: 下滑天线的外场监控信号只靠一个近场监控天线 (NFM), 对 M 型下滑天线具有天线多, 孔径大的特点, 所以空间的镜像信号合成复杂, 研究近场空间信号具有重要意义。从天线结构出发, 讨论了近场情况下的信号分布, 根据天线路径差来分析不同距离下的信号分布, 找出理想监控距离, 并得出监控天线的高度。讨论理想监控距离下的信号特征, 与远场比较。最后分析殊情况下: 上坡地形和偏置安装的监控设置。

关键词: 近场监控; 相位差; 偏置安装

Analysis on Near Field Monitor Location of M-array System

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Abstract:

The near field monitor is the only field monitor for glide path antenna. The characteristic of M-array system is more antennas and larger size, so the space signal synthesis is more complex. It is for great importance to research space signal in near field. From the aspect of antenna structure, the distribution of signals in near field had been discussed. The ideal monitor height and distance had been achieved according to route error of different antennas. The ideal signal characteristic had also been discussed and compared with the circumstance in far field. Analyzed the special situations that forward slope and bias installation at last.

keywords: near field monitor; phase error; bias installation

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基于空间相关性的民航旅客量预测算法

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摘要: 民航旅客量预测的准确性直接决定航空公司的收益, 是民航领域重要的研究课题之一。针对民航航线网络中各机场的空间关系及相互影响情况, 本文建立了一个基于通航城市的空间关系的旅客量预测模型, 采用深度卷积神经网络捕捉民航旅客量的时序和空间信息, 采用三次指数平滑模型捕捉民航旅客量时间序列的季节等周期性信息、长期趋势信息及时序信息, 采用全连接网络对上述两个模型进行融合。将本文提出的模型, 应用于 30 个典型的民航城市构成的航线网络的未来一年的月度旅客量预测中, 取得了很好的实验结果。

关键词: 民航旅客量预测; 卷积神经网络; 三次指数平滑

Forecasting Civil Aviation Passenger Based on Spatial Relation

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Abstract:

Abstract:The accuracy of forecasting civil aviation passenger is the key for revenue of airline company, which is an important topic in civil aviation research. To solve the spatial relation of airports in civil aviation airline network, an algorithm based on spatial information of cities is proposed for forecasting civil aviation passenger. The algorithm model the sequential and spatial information by convolutional neural network, and the sequential information contained of periodicity information such as season and long-term trend information by triple exponential smoothing model. The algorithm is applied in the experiment of forecasting civil aviation passengers in the next year by month of civil aviation composed by 30 cities, and achieve good performance.

keywords: civil aviation passenger forecast; convolutional neural network; triple exponential smoothing

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基于卷积神经网络的机场场景人群计数和密度估计方法

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摘要: 鉴于人群计数与其密度估计问题在机场等密集人群频繁聚集的场景中对安全管理、突发问题预警和情报收集等应用的重要作用, 该问题目前受到了越来越多的关注。人群计数与密度估计是一项十分具有挑战性的任务, 因为人在视觉图像中尺寸变化很大, 且密集情况下会面临严重的遮挡问题和特征不明显的问题。当前方法大多依赖于多分支卷积神经网络结构提取多尺度特征, 但会引入大量冗余的参数和计算。因此本文提出一种由残差融合模块、金字塔形池化模块和子像素模块组成的, 不依赖于多分支结构的卷积神经网络结构, 在很少的参数冗余的条件下实现了优异的人群计数和密度估计性能, 以用于机场等密集人群聚集场景的人群计数与密度估计问题。

关键词: 机场安全; 人群计数; 密度估计

Crowd Counting and Density Estimation Method Based on Convolutional Neural Network for Airport Scene

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Abstract:

Crowd counting and density estimation have received more and more attention due to their widespread applications in safety management, emergency warning and intelligence gathering in scenes where crowds gathering frequently such as airports. However, crowd counting and density estimation is a very challenging task because of the great variation in size of people and the severe occlusion problems and insignificant features in crowding scenes. Most current methods adopt multi-branch convolutional neural network structures to extract multi-scale features, but introduce a large number of redundant parameters and computations. Therefore, in this paper, we proposes a novel convolutional neural network architecture consisting of the residual fusion module, the pyramid pooling module and the sub-pixel convolutional module to achieve excellent performance for crowd counting and density estimation without the multi-branch architecture. Our method can be easily used in crowd gathering scenes such as airports.

keywords: airport security; crowd counting; density estimation

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空基视角下铁轨目标的分割与提取

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摘要: 中国铁路工业十分发达, 铁路总里程位居世界第二, 高速铁路总里程位居世界第一。它们为我国经济和社会发展做出了重要贡献。因此, 我们也迫切的需要建立一个高效的监视体系来确保铁路运行安全。但是, 我国现有的铁路巡检还主要依赖铁路工人人力检查, 效率较低。在本文中, 我们提出运用无人机, 结合计算机视觉的相关技术, 实现从空中对地面的空基自主巡检。但是, 传统的视觉方法只能从图形层面区分不同物体, 无法结合工程意义给出更高级的判断。因此, 我们提出, 应当首先分割并提取图像中最重要的部分, 也即铁轨区域。这样, 结合巡检中物体识别的结果, 才能判断某物体是否对铁轨造成威胁。为此, 我们利用卷积神经网络模型, 并在采集的空基数据库上进行实验验证。结果显示, 我们能够将铁轨区域较准确的识别出来。

关键词: 铁轨; 监视; 空基

Segmentation and Extraction of Railway in Images from Air-Based Perspective

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Abstract:

Railway industry is very developed in China, with the second longest length of railways and the longest length of high speed rail in the world. They make a great contribution to Chinese economic and social development. Therefore, we urgently need an effective supervision system to ensure the safety of railway. However, railway inspection mainly relies on manpower in China, which means the low efficiency. In this paper, we propose a method utilizing UAV (Unmanned Aerial Vehicle), combined with computer vision technology. It can automatically surveil the railway from air. However, traditional detection method can only distinguish different object according to their visual difference. It can't judge whether the object will threaten the safety of railway. Therefore, we believe we should segment the most important part in the image first, namely railway region. So that we can figure out the safety situation of railway, based on the result of object detection and semantic segmentation. In order to verify the effect of our method, we utilize the CNNs (Convolutional Neural Network) to operate experiments on the dataset. The results show we can precisely distinguish the railway region in the image.

keywords: railway track; inspection; Air-based

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点云数据的深度学习处理方法

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摘要: 随着自动驾驶的快速发展, 对环境感知的要求也越来越高。作为自动驾驶汽车最重要的传感器之一, 激光雷达可以通过扫描周围环境得到点云数据。使用合适的方法处理点云数据, 我们可以获得目标物体的种类、距离、方位等。因此, 点云数据的处理成为了自动驾驶行业的一大热点。深度学习在图像上的巨大成功给我们启发, 近年来业内提出了很多基于深度学习的点云处理方法, 如多视角投影、体素化网格等等, 但有着各方面的缺陷。PointNet的提出开拓了全新的处理点云的方法, 即直接在点云上应用深度学习模型, 并解决了点云数据的无序性、无结构性的问题。但是其应用的最大池化对称函数舍弃了太多信息, 在实际应用时方差较大。针对该问题, 本文提出了新的解决点云数据无序性和保证空间变化不变性的方法。在解决无序性问题时, 用全局最大池化和全局平均池化分别处理每一维的点云数据, 然后将得到的两个向量串联得到全局特征。在保证空间变化不变性的同时, 对学习转换矩阵的特征提取中, 也引入了全局最大池化和全局平均池化方法, 以得到与数据集更加匹配的转换矩阵。实验证明, 本文的方法有效地提高了分类结果的平均准确率, 并减小了准确率方差。

关键词: 自动驾驶; 点云数据; 深度学习

Deep Learning Processing Method for Point Cloud Data

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Abstract:

With the rapid development of autonomous driving, the requirements for environmental awareness are getting higher and higher. As one of the most important sensors for autonomous vehicles, Lidar can get point cloud data by scanning the surrounding environment. Using the appropriate method to process point cloud data, we can obtain the type, distance, orientation, etc. of the target object. Therefore, the processing of point cloud data has become a hot spot in the autopilot industry. The great success of deep learning in images has inspired us. In recent years, many point cloud processing methods using deep learning model have been proposed in the industry, such as multi-view projection, voxel grid, etc., but have various defects. PointNet has opened up a new way to deal with point clouds, which is to apply the deep learning model directly on the point cloud, and solve the problem of disorder and non-structurality of point cloud data. However, the maxpooling symmetric function of its application discards too much information, and the variance is large in practical applications. Aiming at solving this problem, this paper proposes a new method to solve the disorder of point cloud data and ensure the invariance of spatial variation. When solving the disorder problem, the global maxpooling and the global average pooling are used to process the point cloud data of each dimension separately, and then

the obtained two vectors are connected in series to obtain global features. While ensuring the spatial variation invariance, the global maximum pooling and global average pooling methods are also introduced in the feature extraction of the learning transformation matrix to obtain a transformation matrix that more closely matches the dataset. Experiments show that the proposed method effectively improves the average accuracy of classification results and reduces the accuracy variance.

keywords: autonomous driving; point cloud; deep learning

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Anomaly Detection in Railway Surveillance Images

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Abstract: Vision surveillance is an essential and important technique for railway security. In this paper, we propose an unsupervised cluster-based low-rank matrix model for anomaly detection in railway surveillance frame images. To avoid annotating the anomalous objects which are not unpredictable, we propose to detect anomaly by reconstructing the normal railway in reverse mode. In our approach, we focus on railway regions as region of interest (ROI) for vision surveillance. Therefore, line segment detection is the beginning point to pick up the railway ROIs. On one railway ROI region, considering the alternation of gravel and sleeper areas, the vertical pixel segments to the rail edge are clustered into two categories. For each cluster, all pixel segments in no matter gravel or sleeper area have a strong linear correlation, which can be represented by each other, so the normal railway pixel segments can be reconstructed via a low-rank matrix completion problem. Subtracting the reconstructed pixel segments from the original ones, the sparse anomaly is located. Experimental results show that our unsupervised method outperforms many supervised methods to detect the railway anomaly in both common objects and occasional objects.

Key words: Anomaly detection; railway image; clustering; low-rank matrix

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Carriers' Entry Patterns Under EU-US Open Skies Agreement

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Abstract: This paper investigates route entry patterns of carriers in the context of the EU-US open skies agreement (OSA). A carrier's dominance in market share and existing presence at both endpoint airports have positive impacts on route entry. Competitors' presence at both endpoint airports and route concentration are two significant deterrents of entry. The role of London Heathrow and the establishment of joint ventures within international alliances also show significant impacts, although the effects vary across different markets. Separating transatlantic markets into "new" versus "existing" markets helps disentangling the complex relationships between the OSA and route entry.

Key words: Entry patterns; EU-US open skies agreement; Market competition; Panel data analysis

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民航空管大数据处理平台架构研究

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摘要: 随着新一代信息技术和航空业的发展, 空管运行产生的业务数据呈爆炸性增长, 依托大数据存储和处理技术, 构建空管大数据处理平台, 能更有效支撑管制运行、现场指挥、流量控制、冲突预测、空域入侵、应急救援等各项空管业务。结合目前国内外民航空管领域大数据技术的应用现状, 梳理空管运行的业务需求及数据类别, 设计并搭建空管大数据处理平台整体架构; 对大数据处理基础对的名称节点、数据节点进行功能设计, 并对大数据平台数据批处理计算、流处理计算等计算需求进行研究, 针对不同的数据处理方式, 提供具体的处理方法; 分析表明研究成果有助于提高我国民航空管运行效率, 为民航空管大数据处理平台提供支撑。

关键词: 民航空管; 大数据处理; 平台架构

Research on Big Data Analysis Platform Architecture of Air Traffic Control

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Abstract:

With the development of the new generation of information technology and aviation industry, the business data generated by air traffic control is exploding. Relying on big data storage and processing technology, the air traffic control big data processing platform can be built to more effectively support the control operation, on-site command and traffic. Control, conflict prediction, airspace intrusion, emergency rescue and other air traffic management services. Combining the current application status of big data technology in civil aviation industry at home and abroad, combing the business requirements and data categories of air traffic control, designing and constructing the overall structure of the air traffic control big data processing platform; the name node and data node for the big data processing base pair Carry out functional design, and study the computational requirements of data batch processing and stream processing calculation of big data platform, and provide specific processing methods for different data processing methods; analysis shows that the research results can improve the efficiency of our national aviation management To provide support for the civil aviation data big data processing platform.

keywords: civil aviation management; big data analysis; platform architecture

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车路协同自动驾驶技术在民航机场的应用

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摘要: 本文通过分析民航机场飞行区内围绕航空器的保障车辆, 包括廊桥车、飞机拖车、行李装运车、除冰和清雪车、员工通勤车、维护车和乘客摆渡车以及无动力设备的工作场景, 结合物联网技术、三维可视化技术、智能决策系统、专家决策、人工智能、深度学习、智能网联以及移动通信等先进技术, 针对航班生产作业过程, 探讨民航机场飞行区保障车辆引入基于车路协同自动驾驶技术的实现方式, 通过对民航机场空侧车辆典型应用场景的分析和阐述, 切实提高机场航班运行生产效率、提升机场旅客服务水平、增强机场核心竞争力。

关键词: 民航机场; 车路协同; 自动驾驶; 空车车辆; V2X

The Application of Vehicle-Road Cooperative Autopilot Technology in Civil Aviation Airport

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Abstract:

This paper analyses the working scenes of the support vehicles in the flight area of civil aviation airport, which include jet bridges, aircraft tugs, shuttles, baggage, de-icing and snow clearing, employee buses, maintenance vehicles and passenger shuttles and as well as powerless equipment, and combines Internet of Things technology, Three-dimensional visualization technology, intelligent decision-making system, expert decision-making system, etc. Aiming at the process of flight production and operation, this paper discusses how to introduce vehicle-road cooperative autopilot technology into civil aviation airport flight area support vehicles. Through the analysis and elaboration of typical application scenarios of air-side vehicles in civil aviation airport, it can effectively improve the efficiency of airport flight operation, enhance the level of airport passenger service and enhance the core competition of airport.

keywords: Civil Aviation Airport; Road-Vehicle Cooperation; Autonomous Driving Technology; Airside Vehicle; V2X

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碳排放约束对空中交通流量管理的影响分析及对策研究

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摘要: 随着低碳经济时代的到来, 航空业将逐步发生深刻的改变。本文对碳排放约束给空中交通流量管理带来的影响及对策进行了研究。首先在市场化碳排放约束的基础上建立了相应的航班飞行成本模型, 并据此分析了航空公司在空中交通流量管理过程中的决策偏好变化。然后分析了航空公司决策偏好变化给空中交通流量管理系统带来的影响, 分析结果表明, 碳排放约束将导致空中交通流量管理系统总延误增大, 周转能力降低。最后针对碳排放约束给空中交通流量管理系统带来的负面影响提出了3点应对建议, 并构建算例做了进一步的验证说明。

关键词: 碳排放约束; 空中交通流量管理; 地面等待; 改航; 空域管理

Influence of Carbon Emission Restriction on Air Traffic Flow Management and its Countermeasures

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Abstract:

With the arrival of low-carbon economy era, aviation industry will gradually take place profound changes. In this paper, the influence of carbon emission constraints on air traffic flow management and the countermeasures are studied. Firstly, based on the restriction of market-oriented carbon emissions, the corresponding flight cost model is established, and the change of decision preference of airlines in the process of air traffic flow management is analyzed. Then the influence of the change of airline decision preference on the performance index of air traffic flow management system is analyzed. The results show that carbon emission constraint will lead to the increase of total delay and decrease of turnover capacity of air traffic flow management system. Finally, three suggestions are put forward for the negative impact of carbon emission constraints on the air traffic flow management system, and a further verification example is given.

keywords: carbon emission constraints; air traffic flow management; ground holding; reroute; airspace management

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基于 LSTM 的民航客运量预测方法

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摘要: 民航客运量作为航空运输的重要指标, 受到城镇居民消费水平、第三产业、经济政策等众多因素的影响, 是一种复杂的非线性时间序列。本文结合长短期记忆模型(Long Short Term Memory), 提出了一种基于 LSTM 循环神经网络的民航客运量预测方法。LSTM 作为循环神经网络的基本单元, 能够从时间序列历史数据中提取数据特征, 挖掘数据序列内在关联性。本文针对民航客运量历史数据, 通过建立多级 LSTM 神经网络, 对未来一段时间内民航客运量进行预测。该方法能够利用 LSTM 神经元的记忆特性, 从客运量历史数据中查找和构建特征空间, 提取客运量时间序列的非线性特性。通过对网络进行训练学习和超参数优化, 使模型能够对民航客运数据进行高精度的拟合以及对未来运输高峰的精准预测。该方法有效避免了传统方法中影响民航客运量多种因素之间的不确定性, 同时具有较强的鲁棒性和广泛的实用性。本文将该模型与 ARIMA 模型、BP 网络模型进行了对比, 结果表明, LSTM 模型预测方法能够有效提高民航客运量的预测精度和预测稳定性。

关键词: 民航客运量; 时间序列预测; 长短期记忆模型

Prediction of Civil Aviation Passenger Traffic Volume Based on LSTM

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Abstract:

The volume of passengers is an important index of civil aviation transport. It is a complicated nonlinear time series concerned with gross domestic product, tertiary industry, urban consumption level and many other factors. Based on the LSTM (Long Short Term Memory) model, the method was put out in forecasting the future passenger scale. It first took the history data of civil aviation into preprocessing by Standardization and a sliding window, and then through training LSTM neural network, a feature space was built from the original data sequence. This method in forecasting the future passenger scale can avoid the uncertain factors that lie in the traditional methods and extract the nonlinear features of the time series. Compared with the ARIMA model and BP network, the results show that the LSTM method can improve the prediction of civil aviation passenger scale effectively.

keywords: civil aviation passenger traffic volume; time series prediction; LSTM

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空中交通系统自组织临界特性辨识

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摘要: 为了从宏观与全局的视角揭示空中交通系统的航班延误、航班取消的内在动力学机理, 分析了空中交通系统自组织临界性。首先, 基于空中交通系统的广延耗散性、航班延误与航班取消的规模—频度的幂律特性以及其 Hurst 指数, 辨识空中交通系统具有自组织临界性。然后依据 Hurst 指数大小分析系统的航班延误、航班取消在自组织临界状态下的时间长程相关性与演化规律; 依据幂律特性直线的斜率判断航班延误、航班取消的管理水平。研究表明国内的空中交通系统具有自组织临界性; 航班延误、航班取消具有长程相关性; 系统的航班延误的管理水平优于航班取消; 系统的航班延误、航班取消分别向负向、正向演变。

关键词: 空中交通系统; 广延耗散性; 长程相关性; Hurst 指数; 自组织临界性

Identification of the Self-Organized Criticality Characteristics of Air Traffic System

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Abstract:

In order to reveal the air traffic system's flight delay and the intrinsic dynamic mechanism of flight cancellation from macroscopic and global perspectives, the self-organization criticality of air traffic system is analyzed. First, based on the system's extend dissipative structure, flight delays, flight cancellations, the scale-frequency power-law characteristics and Hurst index of air traffic systems is used to identify the Self-organized critical in air traffic system. Then based on the size of the Hurst exponent, the system's flight delays and long-range correlations and evolution rules of flight cancellation under self-organized critical conditions are analyzed. Based on the slope of the power law characteristic line, the management of flight delays and flight cancellations is determined. Research shows that domestic air traffic systems have self-organized criticality; Flight delays, flight cancellations is long-range relevance; The system's flight delay management level is better than flight cancellation; The system's flight delays and flight cancellations are evolving negatively and positively by respective.

keywords: air traffic system; extend dissipative characteristics; long-range correlation; Hurst index; self-organized criticality

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基于 SIS 的时变机场网络延误传播模型

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摘要: 从宏观角度分析机场网络延误传播机理, 基于复杂网络 SIS 传染病模型建立了延误传播模型。从机场网络延误传播的时变性和与 SIS 传染病模型的相似性入手, 以机场为节点, 定义了其在机场网络延误传播过程里存在的不同状态, 依据节点状态间的转变机理, 建立机场网络延误传播动力学模型, 并根据航班时刻规划航班流运输路径。以全国 153 个机场为例, 采集航班延误数据, 进行模型仿真并分析实验参数。结果表明: 机场网络延误节点的延误影响范围有限, 且网络对延误的传播能力具有一定的抑制性, 很少出现全网的崩溃现象; 该模型具有有效性和实用性, 可以较好的仿真实际延误的传播过程。

关键词: 航空运输; 空中延误; SIS 模型; 机场网络; 传播模型; 时变网络

Time-Varying Airport Network Delay Propagation Model Based on SIS

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Abstract:

Analysis of the mechanism of airport network delay propagation from a macro perspective. A delay propagation model was established based on the complex network SIS infectious disease model. Starting from the similarity between the time-varying airport network delay propagation and the SIS infectious disease model, the airports are built as nodes to establish a network. Defines the different states of airport nodes in the process of airport network delay propagation. Establishing airport network delay propagation dynamics model based on the transition mechanism between node states. And plan flight flow path based on flight schedule. Taking 153 airports nationwide as an example, collecting flight delay data, performing model simulation and analyzing experimental parameters. The results show that the delay of the airport network is limited. The network will inhibit the propagation of delays and will not cause the collapse of the entire network. The model is effective and practical, and can simulate the actual delay of the propagation process.

keywords: Air transport; Air delay; SIS model; airport network; propagation model; time varying network

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基于 MIT 的多扇区流量控制模型研究

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摘要: 通过综合考虑交通管制和航空公司运行两个方面, 研究了在恶劣天气下多个扇区容量发生动态变化时的流量控制问题。提出了以扇区动态容量作为主要约束条件, 航班总延误成本和扇区流量稳定为优化目标, 基于尾随间隔 (MIT) 的多扇区流量控制模型, 并采用带精英策略的 NSGA-II 算法求解。以某大型城市区域管制中心 3 个扇区为例进行了仿真分析。结果表明: 利用该流量控制模型不仅能够缓解扇区拥堵, 还可以让决策者选择一个最优的 MIT 限制值, 既可以保证各个扇区的流量稳定减轻管制员工作负荷也可以控制航班的延误总成本, 并验证了所建模型具有有效性与实用性。

关键词: 尾随间隔

Research on Multi Sector Flow Control Model Based on MIT

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Abstract:

Considering both traffic control and airline operation, this paper studies the flow control problem when capacity of multiple sectors changes dynamically in severe weather. A multi-sector flow control model based on trailing interval (MIT) is proposed, with sector dynamic capacity as the main constraint, the cost of total aircraft delay and the stability of sector flow as the optimization objective, and solved by NSGA-II algorithm with elitist strategy. In a regional control center 3 sector as an example for simulation analysis. The results indicate that the flow control model can not only alleviate sector congestion, but also enable decision makers to choose an optimal MIT limit value. It can not only ensure the flow stability of each sector and reduce the workload to controllers, but also control the total cost of flight delays, and verify that the model is effective and practical.

keywords: trailing interval

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基于天气影响的离场航班延误分析及预测

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摘要: 恶劣天气影响航班正常运行, 科学地评估天气对机场离场航班的影响是准确预测和管理航班延误的前提。本文采用空中交通管理机场性能天气算法(ATMAP 算法)对机场的航空例行天气报告进行量化, 建立了天气对离场航班延误影响的评估模型和算法。我们以上海浦东国际机场为例, 分析了恶劣天气的发生时间、严重程度以及持续时间对离场航班运行的影响, 并基于天气因素构建了随机森林模型, 对航班运行进行预测, 为及时采取有效措施缓解航班延误提供依据。

关键词: 机场天气; 独立离场延误; 延误预测; ATMAP 算法

Analysis and Prediction of Departure Flight Delay Based on Weather Impact

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Abstract:

Severe weather affects the normal operation of the flight. Scientifically assessing the impact of weather on airport departure flights is a prerequisite for accurately predicting and managing flight delays. In this paper, the air traffic management airport performance weather algorithm (ATMAP algorithm) is used to quantify the airport's routine weather report, and an assessment model and algorithm for the impact of weather on flight delays is established. Taking Shanghai Pudong International Airport as an example, we analyze the impact of the occurrence time, severity and duration of bad weather on the operation of departure flights. Finally, we build a random forest model based on weather factors to predict flight operations, which provides a basis for timely and effective measures to mitigate flight delays.

keywords: Airport weather; independent departure delay; delay prediction; ATMAP algorithm

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基于交互式多模型的短期 4D 航迹预测

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摘要: 本文研究的主要目的是通过采集 ADS-B 等空地数据链实时下传的航器状态数据 (高度、航向、地速和垂直速度), 建立航空器的飞行状态转换及观测方程, 进而利用交互式多模算法 (IMM) 让不同的运动模式匹配航空器不同的运动状态, 动态校正航空器初始航迹预测值, 并展开无观测数据条件下的 4D 航迹外推。仿真实验表明, 该算法收敛速度较快, 航迹预测精度较高, 能够有效的追踪航空器的实时运动状况。

关键词: 多模式交互; 4D 航迹; 动态预测

Short Term 4D Trajectory Prediction Based on Interactive Multi-Models

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Abstract:

The main purpose of this paper is to establish the flight state transformation and observation equation of an aircraft by collecting the real-time state data (altitude, heading, ground speed and vertical velocity) downloaded from ADS-B and other air-ground data links, then to make use of interactive multi-model algorithm (IMM) to match different motion states with various models, so as to dynamically correct the previous predicted flight trajectory and 4D trajectory extrapolation without observational data is also developed. Simulation results show that algorithm has the faster convergence speed and higher trajectory prediction accuracy, and can effectively track the real-time motion status.

keywords: Interactive Multi-models; 4D Trajectory; Dynamic Prediction

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Airport Surface Moving Target Tracking and Prediction Based on Improved Interacting Multiple Model Algorithm

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Abstract: To avoid the inherent defects of current airport surface surveillance systems, a distributed non-cooperative surface surveillance scheme based on geomagnetic sensor technology is proposed in this paper. Furthermore, a surface target tracking algorithm based on improved interacting multiple models (I-IMM) is presented for use when the target is perceptible. In this algorithm, the weighted sum of the mean values of the residual errors, which is used to reconstruct the model probabilistic likelihood function, and the Markov model transition probability are updated using posterior information. When a target is imperceptible, its trajectory can be predicted by the target identified motion model and the adaptive model transition probability. Simulation results show that the I-IMM algorithm can be used efficiently together with an observed small sample of velocity information for target tracking and trajectory prediction. Compared with the IMM and RMIMM algorithms, the frequency of model switching and the rate of model identification were increased during the imperceptible period, and target prediction error was greatly reduced.

Key words: airport surface surveillance; geomagnetic sensor network; improved interacting multiple models; target trajectory tracking and prediction

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中国空中交通管理区域划分研究

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摘要: 近年来我国航旅需求的不断增加, 空中交通管理的运行效率却在下降。因此, 一系列有效的空管改革措施势在必行。本文在整合我国民航航班历史飞行数据的基础上, 利用综合有效性指标确定模糊 C 均值聚类方法的最佳聚类数后, 将最佳聚类数与我国民航航班经纬度数据输入模糊 C 均值聚类算法获取聚类结果, 依据聚类结果利用聚类边界识别方法对我国空中交通活动进行了区域划分。实验结果明确了将我国空中交通管理区域重新划分为华北、华南和西北三大区域的划分思路, 可为未来空管改革提供参考借鉴。

关键词: 航空运输; 空中交通区域划分; 模糊 C 均值聚类; 空中交通管理; 综合有效性指标; 聚类边界识别

The Research on Chinese Air Traffic Subarea Division

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Abstract:

In recent years, with the increasing demand for air travel in China, the operational efficiency of air traffic management is declining. Therefore, a series of effective air traffic control reform measures are imperative. On the basis of integrating the historical flight data of Chinese civil aviation flights, after using comprehensive validity index to determine the optimal clustering number of the fuzzy C-means clustering, the optimal clustering number and longitude and latitude data of Chinese civil aviation flights are input into the fuzzy C-means clustering algorithm to obtain the clustering results. Based on the clustering results, the clustering boundary recognition method is applied to Chinese air traffic subarea division. The experimental results clarify the idea of dividing the Chinese air traffic management subarea into three parts: the North China, South China and Northwest China, which can provide reference for future air traffic control reform.

keywords: air transportation; air traffic subarea division; fuzzy C-means clustering; air traffic control; comprehensive validity index; clustering boundary recognition

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Design and Optimization Methods of Vertical Profiles for Continuous Climb Operation

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Abstract: Continuous Climb Operation (CCO) can save fuel consumption, reduce the pollute emission and alleviate the noise impact. The design and optimization methods of the vertical profiles were proposed in this paper to facilitate the implementation of CCO. Taking the characteristics of Vertical Navigation (VNAV) function within Flight Management System into consideration, the design method of the vertical profiles for CCO was presented based on Base of Aircraft DATA (BADA) and four-dimensional trajectory prediction techniques. In allusion to the optimization method of the vertical profiles for CCO, it was described as an aircraft trajectory optimization problem through multiple-phase optimal control theory. Gauss pseudo-spectral method was introduced to transform the optimal control problem into a nonlinear programming problem. Such a nonlinear programming problem could be addressed by sequential quadratic programming algorithm to realize the vertical profile optimization for CCO. To verify the performance of the proposed design and optimization methods of the vertical profiles for CCO, the flight simulator test and computer simulation were respectively carried out for the CCO procedure of YIN departures in the Guangzhou Baiyun International Airport by using A320 aircraft. The simulation results indicate that vertical profiles for CCO calculated by the proposed VNAV-based design method are in accordance with the profiles from the flight simulator test. Also, the flight time for CCO obtained from the proposed optimization method with the target of minimum time is reduced by 6.8%, and the fuel consumption with the objective of minimum fuel is saved by 7.0%. So, the proposed design and optimization methods of the vertical profiles for CCO in this paper can contribute to achieving the goal of green flight.

Key words: air transportation; trajectory optimization; continuous climb operation; multiple-phase optimal control; Gauss pseudo-spectral method

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日常气象条件下管型航路空间柔性化方法研究

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摘要: 为了探索空中交通管型航路柔性化的特征, 支持航空器的高效、绿色飞行, 结合日常气象条件对管型航路的空间布局进行优化, 提出了绿色管型航路的优化方法。首先, 分析了日常条件下影响管型航路的气象因素, 并将管型航路空间柔性化转换成搜索最优路径的问题; 接着, 综合考虑航空器的燃油、时间、CO₂ 排放和凝结尾生成多个目标, 引入成本系数, 建立结合气象的管型航路优化模型; 最后, 选取广州白云机场-北京首都机场间的管型航路为基础进行实验, 根据模型特点, 采用遗传算法求解。实验结果表明所提优化策略可降低管型航路内的飞行成本和对飞行对环境的影响, 优化后的管型航路中, 6 个小时内的 8 架航空器共计减少飞行成本 9113 元。

关键词: 管型航路; 温室效应; 凝结尾; 飞行成本; 航路优化

Research on Flexible Configuration Method for Flow Corridor Under Daily Meteorological Conditions

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Abstract:

In order to study the characteristics of flexibility in corridors, and to support the efficient and environmental flight, the layout of the corridor was optimized in combination with the daily meteorological factors. Firstly, the influencing factors considered in the optimization of the corridor were analyzed, and the special flexibility of the corridor was converted into the search for the optimal path. Secondly, taking into account the flight fuel, time, CO₂ emissions and contrail, the corridor optimization model combined with meteorology is established with introducing cost factors,. Finally, the corridor between Guangzhou Baiyun airport and Beijing Capital airport was selected and solved by genetic algorithm. The results show that the flight cost and environmental impact in the corridor are reduced with the proposed optimization method. In the optimized corridor, the total cost of 8 aircrafts is reduced by 9113 yuan within 8 hours.

keywords: flow corridor; greenhouse effect; contrail; flight cost; route optimization

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基于复杂网络的航空公司航线网络特征分析

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摘要: 为提升航空公司竞争力、完善和优化航线网络, 研究航司现运行航线网特征成为必然。运用复杂网络理论从航空公司角度构建航线网络模型, 以我国三大航空公司(国航、南航、东航)为例计算平均度、平均路径长度、聚集系数等基础特征指标, 以及度中心度、紧密中心度、中间中心度等中心性特征指标。结果表明: 三大航线网络密度较小; 均具有小世界网络特性和无标度特性; 国航与东航网络中心性差异较大, 其中南航航线网络联系最紧密, 国航航线网络聚集性最好, 中心化现象明显, 东航网络通达性较好; 在节点选择性失效状态下, 三大网络连通性呈现急剧下降趋势, 少数机场对航线网络连通性起到关键作用。

关键词: 航线网络; 特征指标; 中心性; 连通性; 实证分析

Analysis of Characteristics of Airline Route Network Based on Complex Network

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Abstract:

In order to improve the competitiveness of airlines, improve and optimize the route network, it is inevitable to study the characteristics of the airline's current route network. The complex network theory is used to construct the route network model from the perspective of airlines. The three major airlines (Air China, China Southern Airlines, China Eastern Airlines) are used as examples to calculate basic characteristics such as average degree, average path length and aggregation coefficient, as well as degree centrality and close center. Central characteristic indicators such as degree and intermediate center degree. The results show that the network density of the three major routes is relatively small; both have small-world network characteristics and scale-free characteristics; the centrality of Air China and Eastern Airlines routes is very different, and the network of China Southern Airlines is the closest, and the network of Air China routes is the best. The centralization phenomenon is obvious, and the accessibility of the Eastern Airlines network is good. Under the selective failure state of the nodes, the three major network connectivity shows a sharp downward trend, and a few airports play a key role in the connectivity of the route network.

keywords: route network; characteristic index; centrality; connectivity; empirical analysis

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基于模糊综合评价的空域扇区拥挤程度识别方法

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摘要: 为了科学合理的对空域扇区的拥挤程度进行识别, 本文利用模糊综合评价方法作为对空域扇区拥挤程度评价的主要方法, 从多角度分析对空域扇区拥挤程度产生影响的因素, 提取拥挤评价指标, 建立空域扇区拥挤评价指标体系。利用层次分析法确定各评价指标的权重大小。借鉴地面交通拥挤划分的方法确定空域扇区的拥挤类别。最后利用百分位法确定各评价指标所属的拥挤类别, 确定模糊评价中的隶属度矩阵, 与权重向量进行模糊合成, 最终得出了各扇区在每个时间段的拥挤等级。实验证明, 模糊综合评价方法能够科学合理的对空域扇区的拥挤程度进行动态识别, 区分不同扇区在不同时间段的拥挤程度, 与扇区实际运行状态相符。该结论可为空域规划和管理提供参考意见。

关键词: 扇区拥挤程度; 指标体系; 层次分析; 模糊综合评价

Dynamic Recognition Method of Congestion Degree of Airspace Sector Based on Fuzzy Comprehensive Evaluation

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Abstract:

In order to scientifically and reasonably dynamic recognize the congestion degree of airspace sector, this paper uses fuzzy comprehensive evaluation method as the main method to evaluate the congestion degree of airspace sector, and analyzes the factors that affect the congestion degree of airspace sector from multiple angles, and extracts indexes for congestion evaluation and establishes an index system for congestion evaluation of airspace sector. The analytic hierarchy process is used to determine the weight of each evaluation index. The congestion classification of airspace sector is determined by referring to the method of terrestrial traffic congestion. Finally, the percentile method is used to determine the congestion category which each evaluation index belongs to, and the membership grade matrix in fuzzy evaluation is determined and fuzzy synthesized with the weight vector. Finally, the congestion level of each sector in each time period is obtained. The experiment proves that the fuzzy comprehensive evaluation method can scientifically and reasonably dynamic recognize the congestion degree of the airspace sector, and distinguish the congestion degree of different sectors in different time periods, which is consistent with the actual running state of the sector. These conclusion can provide a reference for airspace planning and management.

keywords: congestion degree of sector; indicator system; analytic hierarchy process; fuzzy comprehensive evaluation

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基于离散优化的安全绩效指标预警规则设计方法

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摘要: 安全管理体系作为一种数据驱动的安全管理模式, 强调所有的管理行为都应该有运行数据作为参考依据。安全绩效管理作为评价安全管理体系建设有效性的重要手段, 更离不开运行数据的支持。目前, 在安全绩效管理过程中用于指导预警规则设计的标准偏差原则在实际操作层面只能依靠管理人员主观经验, 因而既有可能导致管理资源的浪费, 也有可能致指标无法及时预警。本文利用离散优化思想提出了一种设计预警规则的方法, 该方法以降低安全管理成本、维持可接受的安全裕度作为优化目标, 以指标的历史运行水平作为约束条件, 通过对约束条件的求解得到目标的最优解, 并以此作为确定预警规则的依据。通过在航空公司应用该方法对指标开展实际监控, 验证了方法的适用性。

关键词: 安全管理体系; 安全绩效管理; 预警规则; 离散优化

A Way of Establishing Safety Trigger Rules in Safety Performance Management Using Discrete Optimization

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Abstract:

As a data-driven management mechanism, the safety management system (SMS) emphasizes that all safety decisions should be made based on safety data, in which the safety performance management (SPM) is considered of great importance to evaluate the effectiveness of SMS. The standard deviation principle (STDEVP) is recommended by the International Civil Aviation Organization (ICAO) to establish the criteria value that serves to trigger an evaluation, decision, adjustment or remedial action related to the particular SPI. However, a specific operational guidance on how to determine reasonable safety trigger rules based on the criteria value is yet to offer. This paper proposes a way of setting safety trigger rules based on STDEVP using discrete optimization. The objective of optimization is reducing the cost of safety management while maintaining an acceptable safety margin, and constraint conditions are based on historical data of the operation. The minimum requirements of safety trigger rules can be determined by solving the constraint conditions to get the optimal solution of the optimization goal, which will serve as the objective reference. The applicability of the method is verified by applying it to monitor the SPIs in airline companies.

keywords: Safety Management System; Safety Performance Management; Safety Trigger Rules; Discrete Optimization

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面向应用型人才的交通运输特色专业人才的培养研究

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摘要: 本文主要考虑交通运输专业的发展方向及民航业内对交通运输人才的要求, 结合多年的教学组织管理经验及高等学校应用型培养人才的特点, 分析总结出交通运输特色专业培养存在的问题及改革重点, 希望通过此能对业内人士对交通运输人才的培养提供一定的参考价值。

关键词: 应用型人才; 人才培养改革; 双重型人才

Research on the Training of Specialists with Transport Characteristics for Applied Talents

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Abstract:

In this paper, we consider professional direction and the development of civil aviation transportation industry in the demand for transportation talents, combined with years of experience in teaching organization and management and the characteristics of applied talents training of institutions of higher learning, analysis summed up the characteristics of professional training transportation problems and reform focus, hope that through this to the cultivation of the personage inside course of study to transport personnel to provide the certain reference value.

keywords: Application-oriented talents; Talent training reform; Dual talent

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RECAT 尾流间隔标准下对 REICH 碰撞风险模型的改进

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摘要: 加强安全评估是完善空中交通管理的关键, 在现行的 RECAT 尾流间隔标准下, 为了将碰撞风险的评估进行优化, 对 REICH 碰撞风险模型做出改进。因为圆锥体的形状更接近于飞机外形, 所以把 REICH 碰撞模型中的长方体碰撞模板改成圆锥体碰撞模板, 用重型机空客 A330-200 的数据做算例分析。计算出的纵向碰撞概率要比纵向碰撞的安全目标等级小, 经过验证, 其结论是合理的, 符合国际民航组织相关标准, 但是该模型存在不便于计算垂向及侧向碰撞概率的问题, 因此圆锥体碰撞模板仅能够为在 RECAT 尾流间隔标准下的安全评估提供参考。

关键词: RECAT; 尾流间隔; REICH 模型; 模型改进; 碰撞风险

Improvement of REICH Collision Risk Model Under RECAT Wake Separation Standard

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Abstract:

Strengthening the safety assessment is the key to improving air traffic management. Under the current RECAT wake separation standard, in order to optimize the collision risk assessment, the REICH collision risk model is improved. Because the shape of the cone is closer to the shape of the aircraft, the rectangular collision template in the REICH collision model is changed into a cone collision template, and the data of the heavy aircraft Airbus A330-200 is used as an example. The calculated longitudinal collision probability is smaller than the safety target level of the longitudinal collision. After verification, the conclusion is reasonable and conforms to the relevant ICAO standards. However, the model has problems in calculating the probability of vertical and lateral collisions. The cone collision template can only provide a reference for safety assessment under the RECAT wake spacing criteria.

keywords: RECAT; wake separation; REICH model; model improvement; collision risk

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侧风影响下的近距平行跑道进近尾流间隔研究

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摘要: 飞机尾流被视为影响机场流量和飞行安全的一个重要因素。实际运行过程中, 在保证飞机安全的前提下结合环境因素适当缩减前后机之间的间隔成为提升机场容量的最佳途径。因此, 本文在考虑大气环境中的侧风对飞机尾流运动特性影响的基础上对飞机尾流的耗散情况进行建模, 结合近距平行跑道的运行规定, 对飞机在使用近距平行跑道进近时的尾流间隔进行研究。最后通过仿真实验得出在特定侧风环境影响下的安全尾流间隔, 为具体运行环境下的航空器尾流间隔缩减提供参考。

关键词: 尾流间隔; 侧风影响; 近距平行跑道

Study on Separation of Wake Vortex Under the Influence of Crosswind During Approach at Closely-Spaced Parallel Runways

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Abstract:

Aircraft wake vortex is seen as an important factor affecting airport flow and aircraft safety. In the actual operation, it is the best way to improve the capacity of the airport by appropriately reducing the separation in combination with environmental factors under the premise of ensuring flight safety between the front and rear aircraft. Therefore, the dissipation of the aircraft wake vortex is modeled based on the influence of the crosswind in the atmospheric environment on the wake characteristics of the aircraft in this paper. Then, combined with the operational regulations of the close parallel runway to study the wake separation when aircraft is approaching. Finally, the safety wake separation under the influence of the specific crosswind environment is obtained through the simulation experiment, which provides a reference for the aircraft wake vortex separation reduction in the specific operating environment.

keywords: wake vortex separation; crosswind effect; closely-spaced parallel runway

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航空公司突发事件应急恢复机理分析与研究

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摘要: 近年来航空公司时常发生突发事件, 对航空公司整体运营造成极大的影响。航空公司在发生了突发事件后, 有效及时的处理和恢复会减少航空公司的损失。利用航班网络中各节点的承载量、容量以及恢复概率等指标研究在应急恢复条件下航班网络级联失效模型, 分析所选取指标与航班网络节点的抗毁性和航班网络崩溃速度之间的关联性。

关键词: 应急恢复; 级联效应; 航班网络

Research on Airline Flight Emergency Recovery Model

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Abstract:

In recent years, many emergencies have occurred in various airlines, which has a great impact on the whole operation of airlines. Airlines in the event of an emergency, effective and timely handling will reduce the airline's losses. This paper mainly studies the large-scale cascade failure of flight network under the condition of emergency recovery by using the load capacity, capacity, recovery probability and other indexes of the nodes in the flight network, and the correlation between these indexes and the damage resistance and the crash speed of the flight network.

keywords: emergency recovery; cascade failure; flight network

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民航公共突发事件应急管理体系研究：以突发地震为例

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摘要：文章以地震为突发事件的研究类型，分析公共突发事件（地震）应急管理的基本需求，运用应急管理的“4R模型”，构建以“分析预防”、“应急决策”、“应急响应”、“恢复重建”为四个主要阶段的应急管理体系及其实施框架，开展对应急决策系统五个特性的研究，从不同部门的不同职责出发寻求满足多部门联动应急管理体系的设计方法，构建较为完备的民航应急管理评价体系。文章实现了民航应急管理从起始至结束评价的一整套体系搭建，扩展了应对突发事件的研究思路，如首次将“不确定性”研究引入应急决策的“动态”、“多目标”、“协同”三大传统评价体系等，丰富了以地震为例的突发事件应急管理体系设计方法，为以地震为例的民航突发事件应急管理系统的综合性能评估提供了较为系统的解决方案。

关键词：突发事件；应急管理；应急决策；应急；应急响应

Research on Emergency Management System of Emergency Incident Based on Earthquake

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Abstract:

Taking earthquake as the research type of emergencies, this paper analyses the basic needs of emergency management of public emergencies (earthquakes). At the same time, using the "4R model" of emergency management, this thesis constructs the emergency management system and its implementation framework with "analysis and prevention", "emergency decision-making", "emergency response" and "recovery and reconstruction" as the four main stages. At the same time, this thesis studies the five characteristics of emergency decision-making system, seeks to meet the design method of multi-department emergency management system from the different responsibilities of different departments, and constructs a relatively complete civil aviation emergency management evaluation system. Moreover, this thesis realizes a whole system of civil aviation emergency management evaluation from the beginning to the end, and expands the research ideas of dealing with emergencies. For example, this paper firstly introduces the "uncertainty" research into the three traditional evaluation systems of "dynamic", "multi-objective" and "synergy" in emergency decision-making, enriches the design method of emergency management system taking earthquake as an example, and provides a more systematic solution for the comprehensive performance evaluation of civil aviation emergency management system by taking earthquake as an example.

keywords:emergency; emergency management; emergency decision-making; emergency response

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公务机融资租赁方案的经济性分析

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摘要:我国公务航空产业的快速增长得益于公务机融资租赁的发展,现有公务机机队中90%以上的飞机采用融资租赁方式进行引进。本文分析了公务机融资方案涉及的要素配置,建立了函数连续性的租赁合同要素分析模型,结合实际案例研究各要素的效益敏感性,有针对性的提出公务机融资方案设计的要素配置建议。

关键词: 公务航空; 融资租赁; 租赁成本; 经济性分析

Research on the Economical Analysis of Business Jet Financial Leasing

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(Civil Aviation Management of China)

Abstract:

In this paper, the importance of the work style related to the general aviation safety is present. Furthermore the current status and challenges are analyzed. In addition, some suggestions are also delivered.

keywords: Business Aviation; financial leasing; leasing cost; economical analysis

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基于工作作风建设的通用航空安全发展研究

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摘要: 本文阐述了工作作风对于通航安全工作重要性, 分析了通航工作作风建设的现状和挑战, 并就如何加强作风建设提出了意见建议。

关键词: 通用航空; 安全管理; 工作作风建设

Research on the Construction of Work Style in General Aviation Safety Management

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Abstract:

In this paper, the importance of the work style related to the general aviation safety is present. Furthermore the current status and challenges are analyzed. In addition, some suggestions are also delivered.

keywords: General aviation; safety management; work style construction

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基于无线信道的高速公路无人机监控系统研究

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摘要: 高速公路无人机监控是目前高速公路监控、移动执法、应急指挥等行业应用的热点应用, 然而高速公路 4G 网络覆盖相较于城区信号不是特别稳定导致各级监控中心接收到的图像质量难以满足监控管理和应急指挥的需求, 本文提出了基于无线信道的高速公路无人机视频监控模式, 将图像质量评价引入监控模式, 根据图像质量和缓冲区具体情况, 实时调整视频编码的分辨率、帧率, 以保证图像质量和视频流的稳定传输, 以满足高速公路各级监控中心在监控管理和应急指挥时视频监控尽量不出现中断、卡顿和大量噪点的现象, 系统测试结果表明在使用 4G 网络的情况下, 该系统可以较好地适用无线网络不稳定的情况, 能够较好地满足高速公路远程监控需求。

关键词: 4G 网络; 无线信号; 图像质量; 分辨率; 帧率

Research on UAV Monitoring System Based on Wireless Channel

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Abstract:

Expressway unmanned aerial vehicle (UAV) monitoring is the expressway monitoring, mobile law enforcement, emergency command and other industries the hot application, however, expressway 4G coverage compared with urban signal not very stable in all levels of the monitoring center receives the image quality is difficult to meet the needs of monitoring management and emergency command, UAV is proposed in this paper, based on the wireless channel expressway video monitoring mode, introduce the image quality evaluation to monitor mode, according to the image quality and the specific situation of the buffer, real-time adjustment for the resolution of the video coding, frame rate, to ensure the quality of the image and the stability of the video stream transmission, in order to meet the expressway monitoring center at all levels in monitoring management and emergency command video monitoring as far as possible without interruptions and noise, the system test results show that in the case of using 4 g networks, the system can be well used wireless network is not stable, can well meet the demand of remote monitoring of the expressway.

keywords: 4G network; wireless signal; image quality; resolution; frame rate

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基于人工蜂群算法的无人机群三维编队重构方法

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摘要: 为了应对复杂的环境, 无人机编队需要快速实现编队重构。通过将控制输入近似分段线性化的方式将编队重构问题转化为最优控制问题。但是三维空间的无人机编队重构是一个高维优化问题, 传统生物启发式算法很容易陷入局部最优, 无法快速实现无人机编队重构。本文采用人工蜂群算法对无人机编队重构问题进行求解, 其具有全局搜索、参数较少、收敛速度快等特点, 且不受目标函数是否是线性的限制, 适合解决三维编队重构最优控制问题。

关键词: 无人机; 编队重构; 最优控制; 人工蜂群算法

Three-Dimensional Formation Reconfiguration for Multi-UAVs Based on Artificial Bee Colony Algorithm

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Abstract:

In order to cope with the complex environment, flight formation of multiple UAVs needs to realize the formation reconfiguration as quickly as possible. The formation reconfiguration problem can be transformed into an optimal control problem by approximating piecewise linearization control inputs. However, the formation reconfiguration in 3-D space is a high-dimensional optimization problem, which is hard to solve. Traditional bio-heuristic algorithms are easy to fall into local optimum, which causes failure of formation reconfiguration. In this paper, Artificial Bee Colony (ABC) Algorithm is used to solve the problem of formation reconfiguration. It has the advantages of global search, fewer parameters and faster convergence speed, which is suitable for solving the optimal control of 3-D formation reconfiguration.

keywords: Unmanned Aerial Vehicle (UAV); formation reconfiguration; optimal control; Artificial Bee Colony

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Research on the Accuracy Control of Consumer Unmanned Aerial Vehicle Photogrammetry

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Abstract: With the increasing maturity of consumer uav technology, consumer uav has begun to be applied to the field of photogrammetry. Based on the consumer uav photogrammetry technology, this paper carried out experiments on the control parameters affecting the larger uav photogrammetry model. And obtained the threshold value of the control parameters to ensure the integrity of the aerial photography model. Then the ground control points were uniformly distributed in the experimental field, and the high-precision 3d coordinates of the ground control points were surveyed by differential GPS with correcting the 3d model by control points. Finally, the error statistics method is used to analyze the measurement accuracy of the above results. The experimental results show that the maximum plane error of the obtained data is 23.07mm, the maximum elevation error is 25mm, and the error in the DTM elevation of the built test area is 0.0235m, fully meeting the accuracy requirements. The research shows that the measurement accuracy of the consumer uav in the flight control system can be up to centimeters, which not only provides a flexible and efficient new measurement method for the surveyor, but also a reference for the photogrammetry like that.

Key words: small consumer UAV

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植保无人机高杆密叶作物航空喷洒作业比较研究

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摘要: 高杆密叶作物具有株树高、枝叶密的特点，航空喷洒需求单亩剂量高、受药范围大，一般电动多旋翼无人机风场小、单架次载药量低，不能充分满足高杆密叶作物喷洒需求。2018年，笔者带领两支无人机作业机队（油动六旋翼无人机队、电动六旋翼无人机队）先后在山东某苹果种植公司基地、新疆建设兵团某棉业公司种植基地开展实验作业，针对油动六旋翼、电动六旋翼两种无人机对在苹果、棉花两类高杆密叶作物的航空喷洒效果、经济效益等进行了比较研究，确定了解决高杆密叶作物航空植保喷洒的适用机型—油动多旋翼无人机。

关键词: 无人机；植保无人机；航空喷洒；高杆密叶作物喷洒；油动多旋翼无人机；航空农业；航空林业

Comparative Study on Plant Protection UAS in High Pole and Dense Leaf Crop Aerial Spraying Applications

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Abstract:

Comparative study on plant protection UAS in High pole and dense leaf crop aerial spraying applications.

keywords: crop aerial spraying applications; plant protection UAS

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浅议无人机安全管理

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摘要: 本文论述了无人机的应用现状、存在的问题以及安全监管现状, 并对无人机的安全监管提出了一些建议, 对无人机的安全监管进行了一些有益的探索。

关键词: 无人机; 安全; 监管

Safety Management of Unmanned Aerial Vehicle

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Abstract:

This paper discusses the application status, existing problems and safety supervision status of UAV, and puts forward some suggestions on safety supervision of UAV, and makes some useful exploration on safety supervision of UAV.

keywords: UAV; safety; supervision

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Research on Anti-Drone System Based on Multiple Detection Techniques

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Abstract: In this paper, ADS which can achieve the highest possible POI for drones and effective attacking is presented, the system mix together four detection technologies including radar detection, radio frequency monitoring, video surveillance, acoustic detection and two countering technologies including high-power blocking and induction technique. ADS can realize the effective protection of the key area for civil field all day.

Key words: anti-drone; acoustic detection; radar detection; radio frequency monitoring; video surveillance; countering

我国民用无人机管控体系框架研究

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摘要: 随着我国无人机产业迅速发展, 无人机管控体系研究建设需求迫切。本文分析了国内外无人机管控体系的发展现状, 借鉴国外先进理念和建设经验, 根据我国空情特点和空管政策, 设计提出了全国无人机管控体系框架, 并重点围绕该体系的关键运行支撑——无人机飞行服务站系统功能框架进行了深入探讨, 可为我国无人机管控体系建立、无人机产业化发展提供参考。

关键词: 无人机; 管控; 体系; 飞行服务站

Research on the Framework of Unmanned Aircraft System Traffic Management System in China

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Abstract:

With the rapid development of China's unmanned aircraft system (UAS) industry, the industry has an urgent need for research on UAS traffic management system. This paper analyzes the current situation of the development of UAS traffic management system at home and abroad, and draws lessons from foreign advanced theory and successful experience. According to China's policy of air situation and the characteristics of the air traffic management, We design and propose a set of national civil UAS traffic management system framework, and focused on UAS flight service station system which is the critical operation support of the system. This system framework provides a reference for the establishment of UAS traffic management system and the development of UAS industrialization in China.

keywords: UAS; traffic management; system; flight service station

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基于改进多项式拟合的合作类无人机轨迹实时预测算法

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摘要: 无人机轨迹预测技术是实现无人机空中交通管理的关键技术之一。本文针对合作类无人机轨迹实时预测问题, 提出改进多项式拟合轨迹预测算法。该算法利用现行监管平台中无人机的历史飞行轨迹数据和实时飞行状态数据, 基于动态定权的加权最小二乘法, 采用多个多项式模型组成的模型集对无人机短时飞行轨迹进行并行预测。结合无人机实际飞行数据设计了两个仿真实验, 结果表明, 相比于传统的多项式拟合轨迹预测算法, 本文所提出的改进多项式拟合轨迹预测算法能够匹配无人机飞行过程中不同的飞行模态, 更加准确地把握无人机未来飞行趋势, 对于无人机短时飞行轨迹具有更好的实时预测性能。

关键词: 合作类无人机; 轨迹预测; 多项式拟合; 动态加权

Real-Time Trajectory Prediction Algorithm for Cooperating Unmanned Aircraft Based on Modified Polynomial Fitting

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Abstract:

UA trajectory prediction technology is one of the key technologies to UA traffic management. In this thesis, a modified polynomial fitting trajectory prediction algorithm is proposed for cooperating UA. Based on the historical flight trajectory data and real-time state data in the regulatory platform and the dynamic weighted least squares method, this algorithm uses a model set composed of multiple polynomial models to predict the short-term trajectory of UA in parallel. Two simulation experiments are designed based on the actual flight data of the UA. The results show that compared with the traditional polynomial fitting trajectory prediction algorithm, the modified polynomial fitting trajectory prediction algorithm proposed in this thesis can match the different UA flight modes and accurately grasp the flight trend of the UA. It has a better prediction performance for the short-time trajectory of UA in real-time.

keywords: cooperating UA; trajectory prediction; polynomial fitting; dynamic weighted

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民用无人机空中交通管理体系要素研究和实践

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摘要: 为实现民用无人机的高效管控, 研究了民用无人机空中交通管理体系要素。结合我国民用无人机的运行管理现状, 提出了民用无人机运行的两类空域, 描述了民用无人机空中交通管理的八类功能服务及参与方职能, 设计了民用无人机空中交通管理体系数据流架构, 并提出了民用无人机空中交通管理发展路线。最后以深圳地区民用无人机空中交通管理试点系统——无人驾驶航空器空中交通管理信息服务系统 (UTMISS) 进行案例分析, 阐述了 UTMISS 的适飞空域、系统架构、管理流程、主要功能, 并对系统的发展方向提出建议。

关键词: 民用无人机; 空中交通管理; 要素; UTMISS

Research on the Elements of Air Traffic Management System of Civil Unmanned Aircraft Systems and Practice

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Abstract:

In order to realize the efficient management and control of civil Unmanned Aircraft system (UAS), the elements of civil UAS traffic management is studied. Based on the current situation of civil UAS operation management in China, two kinds of airspace for UAS operation are put forward. Traffic management functions and participant responsibilities of UAS are described. And the data flow architecture of UAS traffic management is defined. Then the development roadmap of air traffic management of civil UAS was proposed. Finally, as a case study of the pilot civil UAS traffic management system in Shenzhen, the UAS Traffic Management Information Service System (UTMISS) is introduced. The suitable airspace, system architecture, management process and main functions of UTMISS are described, and suggestions for the development direction of the system are presented.

keywords: civil unmanned aircraft system; air traffic management; element; UTMISS

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无人机安全风险评估指标及方法研究

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摘要: 随着无人机的井喷式发展, 无人机安全风险问题日益突出。首先, 本文通过分析以往无人机飞行事故致因, 从系统故障率、空中碰撞概率及与保护区相撞概率的角度出发构建了无人机飞行事故率指标, 反映了无人机飞行事故发生的可能性。然后, 根据无人机的尺寸与坠落方式, 区域人口密度与环境遮蔽系数等参数, 构建了无人机坠落覆盖面积和撞击致死率两个指标, 反映了无人机飞行事故发生的严重度。最后, 提出了一种基于 FCM++ 算法的无人机安全风险等级评估方法, 为无人机路径规划与安全管控提供一定的技术支持与理论基础。

关键词: 无人机; 评估指标; 风险评估

Research on the Index and Method of Safety Risk Assessment for Unmanned Aerial Vehicles

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Abstract:

With the increasing development of unmanned aerial vehicles (UAVs), the safety problem of UAV has become increasingly prominent. Firstly, by analyzing the causes of UAV flight accidents, the paper constructs the index of UAV flight accident rate based on system failure rate, the probability of mid-air collision and the probability of collision with protected area, which reflects the possibility of UAV flight accidents. Then, according to the size and descent mode of UAV, population density and shelter factor, the paper constructs two indexes of UAV exposure area and fatality rate, which reflect the severity of UAV flight accidents. Finally, a safety risk assessment method for UAV based on FCM++ algorithm is proposed, which provides some technical support and theoretical basis for UAV path planning and safety management.

keywords: unmanned aerial vehicle; assessment index; risk assessment

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民用无人机融合国家空域系统运行关键技术国内外综述

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摘要: 目前世界各国与组织针对民用无人机融合运行监管的法律规范、运行规章、关键技术等开展了大量研究。在法规方面,国际民航组织、无人系统规则制定联合体、美国、欧洲、中国等在无人机融合监管、运行概念、运行规则、程序标准、人员要求等方面不断完善无人机运行法规标准体系。在无人机融合运行监管系统方面,国内外工业界与主管部门,针对探测与避让、C2、无人机交通管理系统关键技术研发与原型系统测试验证等开展了大量工作,为无人机与民用航空器融合运行提供架构基础,为相关政策制定、关键技术研发和运用提供科学依据。

关键词: 无人机; 国家空域系统; 融合运行

The Review of Key Technologies of Civil UAS Integrated National Airspace System Operation

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Abstract:

At present, countries and organizations around the world have carried out a lot of research on the legal norms, operational rules and key technologies for the integrated operation and supervision of civil UAS. In terms of laws and regulations, the international civil aviation organization (ICAO), JARUS, the United States, Europe, China and other countries have continuously improved the UAS operation laws and standards system in terms of integrated supervision, operation concepts, operation rules, procedure standards and personnel requirements. In the field of UAS integration operation supervision system, research, development and prototype system verification tests are carried out a lot of work in view of the detection and avoidance, C2, UAS traffic management system key technology, which provides a framework for integration operation, and for scientific basis for related policy, key technology research and development.

keywords: UAS; National airspace system; Integration operation

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A Satisficing Conflict Resolution Approach for Multiple UAVs

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Abstract: In this paper, we are concerned with exploring the theoretically and technically research outcomes for the conflict resolution (CR) of multiple unmanned aerial vehicles (UAVs) by using the Internet of Things technologies. We propose a satisficing algorithm to mitigate the CR problem of multiple UAVs. Specifically, we first formulate the CR problem as a game model and design strategies of the game model based on flight characteristics of UAVs. Next, a satisficing game theory is used to mitigate the formulated problem. Furthermore, required time of arrival, which is a new judgment parameter of the strategy utility, is developed to ensure that the whole system can reach a socially acceptable compromise. Simulation results verify the effectiveness and adaptability of the proposed algorithm under complex environments.

Key words: Conflict resolution; satisficing game theory; cooperative control

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基于分层强化学习的无人机路径规划

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摘要: 本文提出了一种分层结构的强化学习算法, 用于解决未知环境中复杂的无人机路径规划问题。仿真计算表明, 所提出的算法能够成功完成复杂环境中的路径规划任务; 与单层深度强化学习网络进行了对比, 结果表明, 该结构在鲁棒性和网络收敛性方面都有较大提升, 能满足实际无人机路径规划问题中, 更多变的环境与更复杂的任务对算法稳定性的要求。

关键词: 分层强化学习

A Hierarchical Reinforcement Learning Approach for Unmanned Aerial Vehicles Path Planning

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Abstract:

In this paper, a hierarchical reinforcement learning algorithm is proposed to solve complex path planning problems in unknown environments. The simulation results show that the proposed algorithm can successfully accomplish the task of UAV path planning in complex environments. Compared with the single-layer deep reinforcement learning network, the results show that the robustness and convergence of the network are improved greatly, so that it can satisfy the requirement of more variable environment and more complex tasks for the stability of the algorithm in the actual UAV path planning problem.

keywords: Hierarchical Reinforcement Learning

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无人机的应用及未来趋势

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摘要: 无人机从瓶盖大小只有几十克到空中预警机、攻击机的几十吨重的体积都包括在内, 说明了无人机的应用广泛, 目前无人机在农业、运输、军事领域、勘探、灾难救援、传染病传播以及传染源的监测等领域都得到了应用, 也为这些项目带来了诸多好处。

关键词: 无人机

The Future of UAV

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Abstract:

the future of UAV.

keywords: uav

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基于混合人工势场与蚁群算法的多飞行器冲突解脱方法

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摘要: 复杂低空空域环境下多飞行器冲突解脱方法可以有效地提供冲突解脱策略, 避免飞行器之间发生危险接近事故或者碰撞, 从而保障空域运行安全。目前飞行器冲突解脱方法主要可以分为集中式和分布式。然而基于人工势场法等分布式方法虽然计算速度快, 但可能会产生不切实际的解; 基于进化算法等集中式方法可靠性高, 但是计算量大, 响应速度较慢, 实时性差。本文结合人工势场法与蚁群算法的优点提出改进混合冲突解脱方法, 首先利用人工势场法迅速得到近似可行的冲突解脱路径, 然后将方案调整、编码得到“权威蚂蚁”, 由“权威蚂蚁”衍生“权威蚁群”, 利用“权威蚁群”始化信息素矩阵, 基于蚁群算法, 求得含有飞行规划约束的解脱方案。并通过与传统的人工势场法与蚁群算法进行比较, 验证了改进算法在时效性和可行性上的优点。

关键词: 冲突解脱; 人工势场法; 蚁群算法

Research on the Conflict Resolution Method Based on the Hybrid Ant Colony Optimization and Artificial Potential Field

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Abstract:

Aircraft conflict resolution method can be divided into centralized method and distributed method. The previously proposed potential field method is able to find trajectories very quickly, however the solutions are often infeasible with large-angle deflection. On the other hand, although heuristic search algorithms, such as ant colony optimization algorithm, can produce high quality solutions in terms of feasibility, long computational time often makes it an infeasible option. Then combining the advantages of artificial potential field and ant colony algorithm an improved algorithm is proposed. By comparing with traditional algorithms, the advantages of the improved algorithm in timeliness and feasibility are verified.

keywords: Conflict resolution; artificial potential field; ant colony optimization

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串置翼太阳能无人机的试飞验证

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摘要: 文章概述了一款串置翼结构的太阳能无人机的总体设计, 气动计算及动力学建模。并完成了串置翼太阳能无人机缩比模型的试飞。通过试飞分析, 结果表明: 该飞机性能可达到满意效果, 为后续太阳能无人机的研制提供了理论依据与实践经验。

关键词: 串置翼; 太阳能无人机; 试飞

Flight Test for a Tandem-Airfoil Solar UAV

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(沈阳航空航天大学)

Abstract:

This paper summarizes the overall design, aerodynamic calculation and dynamic modeling of the tandem wing solar UAV. And completed the test flight of the serial wing solar drone reduction model. Through the test flight analysis, the results show that the performance of the aircraft can achieve satisfactory results, and provide theoretical basis and practical experience for the development of the follow-up solar UAV.

keywords: tandem -airfoil; solar uav; flight test

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植保无人机发展及应用综述

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摘要: 近年来, 无人机事业蓬勃发展, 植保无人机在农业生产中扮演着重要角色。本文分析了国内外植保无人机发展及应用现状, 并提出了目前存在的问题, 并对植保无人机的发展趋势及应用进行了展望。

关键词: 植保无人机; 发展现状; 存在问题; 展望

Summary of Development and Application of Plant Protection Drones

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(沈阳航空航天大学)

Abstract:

In recent years, the drone business has flourished, and plant protection drones play an important role in agricultural production. This paper analyzes the development and application status of plant protection drones at home and abroad, and puts forward the existing problems, and prospects the development trend and application of plant protection drones.

keywords: plant protection drone; development status; existing problems; prospect

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微型无人机发展现状研究综述

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摘要: 微型无人机是基于微机电系统技术, 涉及空气动力学、材料学、结构学等多个领域集成的复杂系统。当前微型无人机大体可分为固定翼微型无人机、旋翼微型无人机和扑翼微型无人机三大类, 对其现有的典型样机进行综述, 并结合微型无人机的起源及其发展历程, 总结了其优越的性能特点和未来发展的方向。

关键词: 微型无人机; 固定翼; 旋翼; 扑翼; 发展

Research Review on the Development Status of Micro UAV

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Abstract:

Micro-unmanned Aerial Vehicle (UAV) is a complex system based on micro-electromechanical system (MEMS) technology, which involves the integration of aerodynamics, materials science, structure science and other fields. At present, micro UAV can be divided into three categories: fixed wing micro UAV, rotor wing micro UAV and flapping wing micro UAV. This paper reviews the existing typical models of micro UAV, and summarizes its superior performance characteristics and future development direction based on the origin and development history of micro UAV.

keywords: Micro UAV; Fixed wing; Rotor; The flapping wing; Development

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单兵便携式无人机

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摘要: 本文针对一种方便携带、可折叠、机箱一体的无人机进行了研究。通过研究固定翼无人机的外形结构、折叠机构、箱子结构以及快速起飞流程, 实现固定翼无人机在 10s 内快速起飞执行任务, 为应对紧急情况和战场环境提供了一种新的机型。

关键词: 可折叠; 机箱一体化; 快速反应

Individual Portable Drone

Wang Hairui, Song Qi, Wang Lu

(沈阳航空航天大学)

Abstract:

This paper studies a drone that is easy to carry, foldable and integrated. By studying the shape and structure of the fixed-wing UAV, folding mechanism, box structure and rapid take-off process, the fixed-wing UAV can take off quickly within 10s, providing a new model for emergency and battlefield environments.

keywords: foldable; chassis integration; rapid response

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值守无人机平台研究现状和发展趋势

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摘要: 随着无人机行业的快速发展, 值守无人机平台的研究和应用方兴未艾。本文在介绍值守无人机平台发展的基础上, 分析了值守无人机平台组成的关键技术, 总结了一些在实际应用中的优缺点, 并展望了其未来发展的方向, 为值守无人机平台的研究和应用提供了理论支撑。

关键词: 无人值守; 无人机; 智能平台

Guardian Drone Platform

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(沈阳航空航天大学)

Abstract:

With the rapid development of the drone industry, the research and application of the duty drone platform is in the ascendant. Based on the development of the duty-held drone platform, this paper analyzes the key technologies of the duty-held drone platform, summarizes some advantages and disadvantages in practical applications, and looks forward to the future development direction. The research and application of the platform provides theoretical support.

keywords: unattended; drone; intelligent platform

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无人机飞行复现仿真系统设计

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摘要: 本文针对故障无人机设计了飞行复现的仿真系统。系统基于 MATLAB 软件对无人机的飞行数据处理和 AC3D 软件构建的无人机三维物理模型在 FlightGear 中实现飞行可视化。实验结果表明系统可复现任意时间段内无人机的飞行轨迹和姿态。系统主要应用于无人机动态测试中坠机的故障分析, 可提高无人机飞行性能, 提高研发效率, 缩短研发周期, 拓宽无人机研究视角。

关键词: 事故复现; 飞行仿真; FlightGear; MATLAB

Simulation System Design of UAV Flight Reproduction

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(沈阳航空航天大学)

Abstract:

In this paper, described a system for the UAV flight replay. The flight data processing was done by MATLAB. The three-dimensional model established by AC3D was imported into FlightGear. This study achieved the flight simulation visualization and replayed the arbitrary time period data of UAV flight trajectory and attitude. This study was used for crash failure analysis in UAV dynamic test, which can improve UAV flight performance, shorten r&d period and improve development efficiency, thereby broadening UAV research perspective.

keywords: flight replay; flight simulation; FlightGear; MATLAB

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基于主成分和系统聚类分析的我国各省市通用航空发展比较研究

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摘要: 作为民用航空的两翼之一, 通用航空是国家综合运输体系的重要组成部分, 但它的发展在我国还处于初级阶段。目前, 所考虑的有关于通用航空发展情况的影响因素过于单一, 大多研究着重于定性分析, 几乎没有针对各省市的多指标定量比较研究。因此, 本文首先在查找相关数据文献的基础上, 选出合适的评价指标, 再利用主成分分析进行指标降维处理, 并利用得到的主成分综合得分 f 将我国各省市通航发展水平进行排名。之后, 本文采用系统聚类分析法, 利用各主成分得分 f_1 与 f_2 , 结果将我国各省市通用航空发展水平分为 4 类, 其分类结果基本符合主成分分析所得出的排名, 从而验证了主成分综合得分排名的合理性。最后, 结合上述所得出的结果, 本文对我国各省市通用航空的发展提出一些合理建议, 以期能够为各省市合理布局通用航空网络奠定理论基础。

关键词: 通用航空; 发展水平; 主成分分析法; 系统聚类分析法

Comparative Study on the Development of General Aviation in China's Provinces and Cities Based on Principal Component and Hierarchical Clustering Analysis

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Abstract:

General Aviation (GA), as one of the “two wings” of Civil Aviation, is an important part of the national comprehensive transport system, but its development is still in the primary stage in China. At present, the factors affecting the development of GA are too simple by other scholars. Most of the research focuses on qualitative analysis, and there is almost no quantitative research on various provinces and municipalities’ comparison. Thus, this paper selects the appropriate evaluation indexes based on the relevant data and paper firstly, and then uses the Principal Components Analysis (PCA) method to reduce the dimension of the indexes, and ranks GA development level in different provinces in China by the composite scores ‘ f ’. After that, this paper uses respective component scores, f_1 and f_2 , to divide the GA development level of various provinces into four categories by the Hierarchical Clustering Analysis method, and these results are basically consistent with the rankings obtained by PCA. Thus, this process verifies that the rank of the principal component score is very reasonable. Finally, in order to lay a theoretical foundation for the layout of GA network reasonably in various provinces and municipalities, combining with the results obtained above, this paper puts forward some reasonable suggestions for the development of GA in China. reasonable suggestions for the development of GA in various provinces and cities in China.



keywords: GA; development level; PCA; Hierarchical Clustering Analysis method

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通航区域飞行服务中心的功能与应用研究

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摘要: 通用航空产业的发展离不开空域以及空中交通管理与服务, 通用航空改革背景下各地区都在探索通航飞行服务的管理, 本文针对通航区域飞行服务中心的功能与实践应用进行了分析, 并就不足之处提出完善建议。

关键词: 通用航空; 低空空域; 飞行服务体系; 区域飞行服务中心

Research on Function and Application of Navigation Service Center in Navigation Area

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Abstract:

The development of the general aviation industry is inseparable from airspace and air traffic management and services. Under the background of general aviation reform, all regions are exploring the management of navigation services. This paper analyzes the functions and practical applications of the flight service center in the navigation area. And put forward suggestions for improvement on the shortcomings.

keywords: general aviation; low-altitude airspace; flight service system; regional flight service center

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Study on the Abrasion Resistance of Functional Surface Course of Airstrip Soil Pavement

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Abstract: Acting as a rapid take-off and landing platform for aircrafts, airstrip has played an important role in military operations, emergency relief and humanitarian assistance. However, the abrasion resistance of airstrip soil pavement has long been overlooked, leading to a significant reduction of the performance and longevity of the airstrip soil pavement. This paper explores the effectiveness of functional surface course formed by three coating materials by measuring abrasion mass loss of the coated soil specimens after accelerated weathering tests which include ultraviolet radiation, flame erosion, dry-wet cycles and freeze-thaw cycles. The results indicate that modified polyurea is the most effective in improving the abrasion resistance of soil pavement, followed by epoxy resin and silane. The mechanism that the abrasion resistance of solidified soil specimens can be enhanced by surface coating and the reason for the difference in performance of different surface coating materials were studied by scanning electron microscopy (SEM) test.

Key words: airstrip; functional surface course; abrasion resistance; microstructure analysis

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中国航空货运体系的空间格局演化及趋势判断

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摘要: 航空货运是经济活力和贸易的重要指标。加快现代化的航空货运体系建设, 反映到空间上, 重点则是货运枢纽机场及相关专业化配套设施的规划布局和建设, 但受制于经济发展的阶段限制和长期以来重客轻货的思维局限, 航空货运体系的空间布局建设相较于客运严重滞后。本文通过对比分析美国航空货运的发展历程及对应各阶段的货运枢纽机场布局特征, 结合中国的发展历程和现状特征, 提出未来中国货运枢纽机场在空间布局方面的演化趋势, 为中国航空货运体系构建过程中的空间规划建设提供参考。

关键词: 航空货运体系; 货运枢纽机场; 枢纽规划; 机场选址; 航空物流

The Spatial Evolution of China's Air Cargo System and Future Trend Analysis

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Abstract:

Air cargo is an important indicator of economic and vitality. From a spatial perspective, the focus of building a modern air cargo system is on the planning, layout and construction of freight hub airports and related specialized supporting facilities. However, due to constraints of economic development and the long-term preference on passengers over goods, the spatial development of an air cargo network is seriously lagging behind passenger transporting. By comparing and analyzing the developmental history of air cargo and the corresponding layout characteristics of freight hub airports in the United States, combined with the history and current demands of China's air cargo transport, this paper points out how China's air cargo system developed and analyze its future trend in the hopes of providing reference for the planning of cargo-specific airports.

keywords: air cargo system; freight hub airport; hub planning; airport site selection; aviation logistics

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考虑一发失效的高原机场平衡跑道长度设计方法

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(空军工程大学)

摘要: 针对高原机场飞机起飞可能出现的一发失效问题, 建立了平衡跑道长度及决断速度的计算模型, 分析了飞行过程及对跑道长度的要求, 给出了等长跑道长度与决断速度的计算与确定方法。计算模型不仅可用于高原机场, 也可用于平原机场着陆滑跑距离计算。对高原机场着陆滑跑距离的影响因素进行了分析, 为高原机场跑道长度设计奠定了基础。

关键词: 一发失效; 高原机场; 跑道长度

The Method of Equilibrium Runway Length for Plateau Airport Considering One Engine Failure

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(Air Force Engineering University)

Abstract:

In view of the problem of the first failure that may occur in the takeoff of the plane in plateau airport, the calculation model of the balance runway length and the determination speed was established, the flight process and the requirement of the runway length were analyzed, and the calculation and determination method of the equal length runway length and the determination speed were given. The model can be used not only for plateau airport, but also for the calculation of landing slip distance of plain airport. This paper analyzes the influencing factors of the landing slip distance of the plateau airport, and lays a foundation for the runway length design of the plateau airport.

keywords: one engine failure; plateau airport; runway length

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基于 ANP——可拓综合评价法的机场跑道方位优化

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摘要: 机场跑道方位优化是确定场址方案的重要步骤, 为了改进实际工程中跑道方位优化主要依靠设计者主观经验的现状, 本文分析了影响跑道方位选择的使用条件、建设条件、作战条件和保障条件等因素, 得到了机场跑道方位评价指标体系。通过 ANP 网络层次分析法确定指标权重, 建立基于可拓学的综合评价分析模型, 对影响跑道方位选择的因素进行定量分析。依据各方案的关联度确定其优劣等级, 并得出对于相应等级的趋向程度, 进一步细化评价标准, 确定最优方案。最后以某军用机场跑道方位优化为例进行了实例验证, 实践表明该评价方法可以有效地指导机场跑道方位优化。

关键词: 航空运输; 跑道方位优化; ANP 网络层次分析; 可拓综合评价; 关联度

Optimizing Orientation and Location of Airfield Runways Based on ANP-Extension Synthesis Evaluation Method

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Abstract:

Optimizing orientation and location of the airfield runway is an important process to select the site. But it mainly relies on subjective experience of the designer in engineering. In order to improve the current situation, the using conditions, construction conditions, combat conditions and support conditions that affect the runway orientation and location selection are analyzed to establish the evaluation index system for runway orientation and location of airfield. The index weights are obtained through the Analytic Network Process(ANP) ,and the extension synthesis evaluation model is established to quantificationally analyze the factors that affect runway orientation and location selection. The evaluation level is acquired according to the association degree and deriving the trend towards the corresponding level makes the conclusion more detailed to get the optimal solution. At the end of the paper, a military airfield runway orientation and location optimization was taken as an example to verify the method. It shows that the evaluation method can effectively guide optimizing orientation and location of airfield runway.

keywords: air transportation; optimization of runway orientation and location; ANP; extension synthesis evaluation; association degree

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着陆状态下飞机地面滑跑偏离的概率特征及风险评估

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(空军工程大学)

摘要: 针对飞机在着陆状态下地面滑跑过程中发生偏离的情况, 论文通过分析 FAA 数据库中提供的偏离事故数据确定跑道边沿作为偏离临界线, 并通过分析造成飞机着陆地面滑跑偏离的影响因素, 建立了基于信息熵和 Logistic 回归的偏离判定概率模型及基于飞机偏离事故历史数据的偏离超出跑道边沿范围概率模型, 由此得到偏离概率模型以分析偏离概率特征。通过运行偏离概率模型, 以 FAA 海恩尼斯机场为例, 结合风险矩阵分析了现有跑滑间距条件下飞机着陆时地面滑行的偏离风险, 基于风险理论提出了跑滑间距的确定方法和跑滑间距不满足标准时运行的限制条件, 为跑道运行条件确定和飞行区跑滑间距设计提供了理论依据。

关键词: 偏离概率模型; 偏离概率特征; 偏离风险评估; 跑滑间距; Logistic 回归; 风险矩阵

Probability Characteristic and Risk Assessment of Aircraft Ground Taxiing Deviation Under Landing State

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Abstract:

Aiming at the deviation of aircraft during ground taxiing under landing condition, this thesis determines the runway edge as the deviation critical line by analyzing the deviation accident data provided in the database, and analyses the influencing factors that cause the deviation of aircraft landing ground taxiing to establish the probability model of departure determination based on information entropy and logistic regression and the probability model of departure beyond the runway edge based on the historical data of aircraft departure accidents, and the probability model of departure is obtained to evaluate the departure probability. By running the deviation risk model and taking FAA Haynes airport as an example, this dissertation combines risk matrix to analyze the deviation risk of aircraft landing ground taxiing and bases on the risk theory, the determination method of separation between runway and taxiway and the operation constraints when the separation can not meet the standards to provide a theoretical basis for determining runway operation conditions and designing the separation between runway and taxiway.

keywords: deviation probability model; the distribution characteristics of deviation values; deviation risk assessment; separation between runway and taxiway; logistic regression; risk matrix

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流体加热道面融雪系统经济效益模型的建立及分析

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摘要: 流体加热道面融雪系统作为新型的绿色环保节约型技术在机场除冰雪领域有巨大的应用潜力, 而该项技术经济效益的研究对系统的建设及运行有重要的意义。为此, 本文基于 Rees 雪层模型假设构建了流体加热融雪系统的仿真计算模型, 并基于系统的运行方式和传热特性建立了系统经济效益模型, 利用北京新机场试验路面及哈尔滨工业大学试验平台的试验数据对模型进行了验证, 结果证明该模型的仿真精度良好。在此基础上, 探究了系统运行经济效益的时间分布特性, 认为系统的经济效益分布可分为急速降低区和稳定区两个阶段; 并针对该系统的动静态融雪模式进行了不同运行模式下, 系统经济效益的分布特性分析, 认为不同融雪模式对经济效益曲线影响微小, 可近似以空载曲线表征经济效益。最后, 对该系统的运行经济效益开展了多参数影响分析, 分析比较了在不同的材料参数、建设几何参数以及环境参数下, 系统经济效益的影响规律, 明确了经济效益敏感性参数, 为系统的建设和运行提供了理论依据。

关键词: 流体加热道面融雪系统; 经济效益; 时间分布特性; 动静态融雪; 影响因素

Thermal-Economic Modeling and Analysis of Snow Melting System for Airfield Runway Using Low Temperature Heating Fluid

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Abstract:

The hydronic heated pavement system with low temperature fluid was proposed as an environment-friendly and clean method to prevent the damage of ice and snow. However, the research on economic benefit of this system was not focused. Based on the hypothesis of pavement surface conditions proposed by Rees, this paper developed a 2D model to simulate the temperature field of pavement. And the economic model was developed to evaluate the economic benefit of system. The model was verified by the measured data. Based on the economic model, the time distribution of economic cost was analyzed. And the comparison of dynamic operation, static operation and idling operation in economic cost was conducted. In the last, the parameter analysis in economic cost was conducted included thermal parameter, geometry parameter and ambient parameter. The economic sensitivity parameters were expressed and the suggestion in system designing, construction and operation was proposed.

keywords: hydronic pavement system with low temperature; economic benefit; characteristic of time distribution; dynamic and static operation; factor of economic

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基于渗流理论的高填方边坡串并联地下排水系统设计方法研究

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摘要: 随着基础设施建设规模愈来愈大, 因限于地形地貌条件约束, 造成山区和丘陵地区建设中诱发的边(滑)坡地质灾害愈发严重。尤其是高危形式的高大填方边坡, 边坡稳定性影响因素多样, 特别是地下水的赋存、运移成为边坡失稳工程中最重要影响因素之一。本文在前人工作基础上, 基于相关渗流理论, 设计了一种基于“水-土”分离理念的填方边坡串并联地下立体排水系统; 且突破传统渗流有限差分复杂边界条件计算结果可靠性不足的缺陷, 以点安全系数计算理论为基础, 通过点安全系数有限差分计算, 形成了一套填方边坡工程地下排水系统的渗流-应力应变-点安全系数稳定性评价耦合计算设计方法。结合攀枝花机场 13#高填方边坡工程应用实例分析, 辅以现场监测数据, 充分验证了二者结果的一致性, 对高填方边坡地下排水系统设计方法提供新思路。

关键词: 高填方边坡; 串并联立体排水系统; 渗流模式; 点安全系数; 稳定性分析

Research on Design Method of Underground Filling System of High Fill Slope Based on Point Safety Factor of Seepage Mode

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Abstract:

With the increasing scale of infrastructure construction and the restriction of terrain and geomorphology conditions, the geological disasters of the edge (slip) slope induced in the construction of mountainous and hilly areas are becoming more serious. Especially for high-risk forms of high-filled slopes, the factors affecting slopes stability are diverse. In particular, the occurrence and migration of groundwater has become one of the most important factors in the slope instability engineering. Based on the previous work and relevant seepage theory, this paper designed a series and parallel underground three-dimensional drainage system for filled slope which based on the concept of "water-soil" separation. This also breaks the defect that the reliability of the traditional seepage finite difference complex boundary condition is insufficient. Based on the calculation theory of point safety coefficient, a coupling design method of percolation - stress - strain - point safety coefficient stability evaluation for underground drainage system of slope filling engineering is developed by finite difference calculation of point safety factor. Combined with the analysis of the application example of the NO.13 high fill slope engineering in Panzhihua airport and the field monitoring data, the consistency of the two results is fully verified. It provides a new idea for the design of underground drainage system for high fill slope.

keywords: Edge (Slip) slope; Series and parallel three-dimensional drainage system; Seepage

mode; Point safety factor; Stability analysis

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基于岩土界面流线折射特性的高填方系统地下水分布规律研究

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摘要: 高大填方边(滑)坡体具有致灾原因复杂、稳定性影响因素多样的特点, 尤其是地下水的赋存、运移已成为边坡失稳工程中重要的影响因素之一。本文基于渗流相关理论及岩土界面流线折射定律, 结合攀枝花机场 13#高填方应用工程实例分析, 提出了填方体填料、压实度差异形成不同渗流场的上层滞水、堆积层-基岩接触带水及深层基岩裂隙水高填方系统水文地质格局的多层段含、隔水分布模式。综合渗流分析的折射理论及高填方边坡渗流场、位移场和应力场计算, 不仅阐述了外边界条件的水动力变化, 更剖析了坡体内部因介质分布不均造成岩土分层的内边界因素, 很好的阐释高大填方边坡地下水在渗流模式下坡体内部各处的应力、应变机制。通过地下水渗流场与力学位移场-稳定性评价的耦合计算分析手段, 揭示了岩土界面流线折射特性的地下水分布规律, 从而为高填方系统地下水分布规律研究提供新思路。

关键词: 高填方系统; 渗流模式; 边界条件; 流线折射; 地下水分布

Study on Groundwater Distribution Law of High Filling System Based on Refraction Characteristics of Streamline Interface

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Abstract:

The slope (slide) with high fill has the characteristics of complex causes of disasters and diverse stability factors, especially the occurrence and migration of groundwater has become one of the important factors affecting the slope instability engineering. This paper is based on the theory of seepage and the law of rheological refraction of geotechnical interface, and combined with the application of NO.13 high fill application in Panzhihua Airport. It is proposed that the difference of the filling filler and compaction degree will form the upper layer of stagnant water and stacked layer- bedrock contact stagnant water of different seepage fields. It also puts forward a multi-layered and water-storage distribution model for the hydrogeological pattern of deep bedrock fissure water high fill system. With the refraction theory of comprehensive seepage analysis and the calculation of seepage field, displacement field and stress field of high fill slope, it not only analyzes the hydrodynamic changes of the outer boundary conditions, but also pays more attention to the internal stratification of the rock due to the uneven distribution of the medium inside the slope. It is a good explanation for the stress and strain mechanism in the groundwater of the high-filled slope under the seepage mode. Through the coupling calculation and analysis method for groundwater seepage field and mechanical displacement field-stability evaluation, the groundwater distribution law of streamline refraction characteristics at rock-soil

interface is revealed. Therefore, it provides a new idea for the study of groundwater distribution law in high fill systems.

keywords: High fill system; Seepage mode; Boundary conditions; Streamline refraction; Groundwater distribution

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Research on the Fatigue Life Prediction Model of Airport Composite Pavement Considering the Mechanics Behaviour of Reflective Crack

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Abstract: Asphalt layer is normally used to pave on the damaged cement concrete pavement to form a composite pavement structure in China civil airports. However, the existing researches on fatigue life design and evaluation methods are still far from sufficient for the design of overlay on original concrete slabs. Besides, the traditional fatigue models could not take into account the residual life during crack propagation state. Therefore, this paper aimed at obtaining the new propriety fatigue life model based on reflective crack mechanism. Primarily, the pavement mesh model was generated by the finite element technique in terms of the engineered structural parameters. Then, the bilinear cohesive zone model (CZM) and the extended finite element method (XFEM) were utilized to simulate the process of the reflective crack initiation and propagation inside the asphalt overlaid courses on rigid pavement in airfield. Furthermore, the new fatigue life prediction model was established based on the simulations under various cases in which orthogonal test design method was employed to consider such parameters as thickness and modulus of each layer. The accuracy of these simulations were verified by comparing with the theoretical solution of stress intensity factor (SIF) in typical cases. And the relationship among the SIF, interface contact and parameters of composite pavement was further studied. The results showed that cracks at the joint were more vulnerable to asymmetric load (i.e. offset load) than to the symmetrical load for the composite pavement structure with stone mastic asphalt (SMA) + asphalt concrete (AC) overlay. The laws of tensile and shear stress intensity factors in crack propagation were also analysis. Based on abovementioned efforts, this new fatigue prediction model was more precise and could provide guidance for the design of overlaid coursed for the airport rigid pavement..

Key words: fatigue life; prediction model; composite pavement; airport; stress intensity factor; extended finite element method

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机场复合道面荷载型反射裂缝的弯沉差指标

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摘要: 明确机场复合道面水泥混凝土 (PCC) 板接缝的弯沉差指标对防治荷载型反射裂缝具有重要意义。本文基于有限元法, 以内聚力单元模拟开裂, 用断裂面积率 (RFA) 表征沥青加铺层的损伤, 分析了板底脱空、接缝传荷、层间粘结及加铺层厚度对反射裂缝的影响, 并研究弯沉/弯沉差与 RFA 的相关性。结果表明, 板底脱空和接缝传荷对加铺层的反射裂缝的影响最为显著。存在单侧脱空的复合道面相对于双侧脱空的道面更容易产生反射裂缝; 弯沉差较弯沉更能反映 PCC 板接缝对加铺层的不利影响; 提高接缝传荷能力有利于延缓加铺层的反射裂缝。依据弯沉差与 RFA 的关系, 提出对应严重等级为轻-中-重的反射裂缝的弯沉差指标分别为 51 μm 、57 μm 和 71 μm 。

关键词: 复合道面; 反射裂缝; 脱空; 接缝传荷; 弯沉差

Deflection Difference Criterion of Traffic-Load-Induced Reflective Cracking in Airfield Composite Pavement

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Abstract:

Determining the deflection difference criterion at a joint of Portland cement concrete (PCC) slab in airfield composite pavement is meaningful for mitigating the traffic-load-induced reflective cracking. In this study, a finite element model (FEM) was developed, which used cohesive elements to simulate the cracking behavior of hot-mix asphalt (HMA) overlay. A representative fracture area (RFA) was used to represent the damage of HMA overlay. The effects of four influential factors on reflective cracking were investigated, including void beneath PCC slab, load transfer efficiency (LTE), interface bonding and thickness of HMA overlay. The relationship between deflection and deflection difference and reflective cracking was also studied. The results showed that both void and LTE significantly affected reflective cracking of HMA overlay. The void occurred at only one side of the joint would result in more severe reflective cracking. Additionally, comparing to deflection indicator, the deflection difference had a better corresponding relationship to RFA. It was also found that improving LTE could reduce reflective cracking. Finally, based on the curve of deflection difference and RFA, the deflection difference criterion corresponding to three damage severity level (light, medium, and high level) were 51 μm , 57 μm , and 71 μm , respectively.

keywords: airfield composite pavement; reflective cracking; void; load transfer efficiency; deflection difference

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基于振动感知的混凝土铺面板底脱空识别方法

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摘要: 水泥混凝土铺面在使用过程中常由于冲刷和沉降产生脱空, 进而诱发断板、错台等病害, 严重影响路面使用性能。通过有限元数值模拟与室内试验, 发现脱空会影响铺面板局部振动频谱分布, 且影响程度与脱空面积、位置相关。在此基础上提出了一种基于振动感知的混凝土铺面板底脱空识别方法: 采用分布式光纤传感技术搭建铺面板振动感知系统, 采集铺面板振动特性; 利用时频分析技术解析铺面板局部振动特性, 捕获振动频谱分布; 研究不同脱空状态下的振动频谱分布, 分析敏感频段的加权频率, 并以此为脱空监测指标。于上海龙华机场开展现场试验, 比较该方法和弯沉比法的脱空识别结果, 验证其用于脱空识别的可行性。

关键词: 水泥混凝土铺面; 脱空; 分布式光纤; 振动; 频谱

A Vibration-Based Method for Cavity-Underneath Identification of Concrete Pavement

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(Tongji University)

Abstract:

The cavity beneath the concrete pavement slab, usually resulting from eroding or foundation settlement, increases flexural-tensile stress in the concrete pavement slab, which may cause some distresses like joint faults and fracture. With finite element method (FEM), it is found that the frequency spectrum in the region with cavity is different from others. On the basis of this, a vibration-based cavity identification method is proposed. A distributed optical vibration sensing-system (DOVS) is utilized to measure the vibration characteristics. Besides that, a laboratory test is conducted to study the influence of cavities in different extents, and frequency spectrum is obtained with time-frequency analysis. The correlation between the frequency spectrum and the extent of cavity is studied, and a 'weighted frequency' is presented to represent the extent of the cavity. During the field tests, this vibration-based cavity identification method is compared with other conventional deflection-based methods. It is shown that this method is reliable in cavity identification.

keywords: concrete pavement; cavity; DOVS; vibration; frequency spectrum

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基于振动的斜向预应力铺面板锚固区预应力损失检测

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(同济大学)

摘要: 斜向预应力铺面板具有板长、缝少等优势, 但使用过程中预应力损失不断增大, 在荷载和温度作用下极易诱发大尺寸的斜向预应力铺面板产生病害, 影响安全性和耐久性。通过有限元数值模拟, 研究不同预应力状态下斜向预应力铺面板锚固区振动特性, 发现预应力状态会影响锚固区振动频谱分布; 分析各频段对预应力状态敏感性, 以 70~150 Hz 频段加权频率的变化量为检测指标来检测锚固区预应力状态; 修筑斜向预应力铺面板足尺模型并通过分级张拉模拟不同预应力状态, 开展室内试验分析该检测指标与预应力状态的相关性并验证其准确性。

关键词: 斜向预应力; 预应力损失; 振动; 频谱; 张拉

Prestress Loss Detection Based on Vibration of Anchorage Zone for Cross Tensioned Concrete Pavement

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Abstract:

Cross tensioned concrete pavement (CTCP) has the advantages of long slab and few joints. But the loss of prestress increases constantly in the process of use, which easily induces diseases under the action of load and temperature, affecting the safety and durability. Through the finite element simulation, the vibration characteristics of the CTCP under different prestress value was studied. It is found that the prestress value affects the vibration spectrum distribution of the CTCP anchorage zone. The sensitivity of each frequency band to the prestress value were analyzed. The variation of the weighted frequency in the frequency band of 70~150 Hz is proposed as the detection index to detect the prestress value of the anchorage zone. The full-scale of CTCP was constructed and different prestress values were simulated by grading tension. The indoor test was also conducted to verify the correlation between the detection index and the prestress value and to verify its accuracy.

keywords: cross tensioned concrete pavement (CTCP); prestress loss; vibration; frequency spectrum; tension

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商用飞机的可离合起降系统

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摘要: 起落架是当代飞机起飞与降落过程中不可缺少的装置。在飞行中,起落架又成了“负担”。与起落架相关的设计如果处理不慎,则会出现严重后果,不久前坠机的两架波音 737-8 就是例证。在现代动力与测控技术基础上,人们应当将飞机的起飞与着陆及在机场上运动行走的功能部件从飞机整体上分离出来,形成可以脱离处于飞行状态飞机而独立运行的起降系统——飞机可离合起降系统。本文概括介绍作者在这方面十多年探讨积累。

关键词: 飞机可离合起降系统;起降台;起降台坑道;载机车

The Separable Landing System for the Commercial Aircraft

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Abstract:

The landing gear is an indispensable device in the take-off and landing of contemporary aircraft. In flight, the landing gear became a "burden". Serious consequences can result if the design associated with the landing gear is handled carelessly. The two aircrafts of Boeing 737-8 that crashed not long ago are examples. In fact, on the basis of modern power and measurement and control technology, people should separate the landing system from the aircraft, to form the separable landing system. This article outlines the author's accumulation of research in this area for more than a decade.

keywords: The separable landing system, landing station; landing station; the tunnel of landing station; Locomotive for loading aircraft

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军用机场水泥混凝土道面性能检测评价体系优化研究

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(空军工程大学)

摘要: 分析总结了我国军用机场水泥混凝土道面性能检测评价体系所存在的问题, 阐明了对现行的道面性能检测评价体系进行优化的必要性。立足我国军用机场水泥混凝土道面性能检测评价体系现状, 在借鉴国内外民航和公路领域的先进检测方法设备和评价管理思想的基础上, 紧贴军用机场当前现实需求, 结合军用机场水泥混凝土道面的自身特点, 从机场道面的损坏状况、平整度、抗滑性能、结构承载强度等方面对军用机场水泥混凝土道面性能检测评价体系进行了一系列优化改进。建立了一整套基于军用机场水泥混凝土道面自身特点的, 检测评价方法合理的, 与我军当前发现形势和需求相适应的军用机场水泥混凝土道面性能检测评价体系。

关键词: 水泥混凝土道面; 性能检测评价; 体系优化; 道面损坏状况; 道面平整度; 道面抗滑性能; 道面结构承载能力

Optimizing the Performance Testing and Evaluation System of Cement Concrete Pavement in Military Airport

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Abstract:

This paper summarizes the problems existing in the performance testing and evaluation system of cement concrete pavement of military airports in China, and expounds the necessity of optimizing the current pavement performance testing and evaluation system. Based on the current situation of cement concrete pavement performance testing and evaluation system of military airports in China, and on the basis of drawing lessons from advanced testing equipment and evaluation management ideas in civil aviation and highway fields at home and abroad, close to the current actual needs of military airport, combined with the characteristics of military airport cement concrete pavement, a series of optimization improvements have been made on the detection and evaluation system of the performance of military airport cement concrete pavement from the aspects of damage condition, smoothness, anti-skid performance and structural bearing strength. Based on the characteristics of military airport cement concrete pavement, a set of detection and evaluation system for military airport cement concrete pavement is established, which has reasonable detection and evaluation methods, and is suitable for the current situation and needs of military airport cement concrete pavement.

keywords: cement concrete pavement; performance testing and evaluation; system optimization; pavement damage condition; pavement smoothness; pavement skid resistance; bearing capacity of pavement structure

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机坪管制智能化运行的应用研究

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摘要: 构建智能型机坪管制运行体系,可以优化和完善航空器机坪运行管理,并较大提升机场综合服务保障能力。应用移动互联网、大数据融合、人工智能等技术,建立机场与空管、航空公司之间的信息共享和协同决策系统,通过对航班运行相关数据、信息的收集、分析进行智能决策,可以实现航空器运行动态实时感知、进离港航班地面运行的智能化电子移交、离港航班协同放行预排序、机坪资源智能化分配等。机坪管制智能化运行可以促进机场与空管、航空公司之间的高效联动与无缝协作,是推动机场高质量发展、推进“智慧机场”建设的重要举措。

关键词: 机坪管制; 协同决策

The Research of Intellectualized Apron Control

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Abstract:

This paper proposes to establish intellectualized system of apron control, in order to optimize and improve the management of apron control and ground service. With the support of mobile network, big data and artificial intelligence technology, through information-sharing and collaborative decision-making between airport, air traffic control and airline company, it would realize the function of mastering information about real-time movement of the aircraft, handing over process of flight electronically and intelligently, providing collaborative decision-making to departure flights, allocating resource of apron intelligently. Intellectualized operation of apron control is important measure for construction of Smart Airport.

keywords: Apron; collaborative decision-making

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军民合用机场鸟撞风险评估和防范措施研究

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摘要: 为科学开展军民合用机场鸟撞预防工作, 减少鸟撞事故或事故征候的发生, 本文在分析比较国内外鸟撞风险评估模型的基础上, 针对军民合用机场单跑道鸟情观测和鸟撞防治的特点, 依据风险矩阵评估理论, 将风险因子划分为鸟撞严重性因子和鸟撞可能性因子, 并详细介绍了两类风险因子的选取方法和风险因子的数据处理方法。首次提出了自组织特征映射神经网络聚类算法的鸟类鸟撞风险等级划分模型, 将鸟类分别进行鸟撞严重性等级划分和鸟撞可能性等级划分, 然后利用建立的鸟撞风险模型, 对鸟类进行鸟撞风险等级评定。本文以潍坊军民合用机场为评估对象, 对该机场的鸟类鸟撞风险等级进行评估, 同我国鸟击航空器信息分析报告以及机场历年鸟撞事故征候数据进行比对, 以检验评估结果的正确性, 并针对性的提出鸟撞防范措施建议。

关键词: 鸟撞风险; 风险评估矩阵; 自组织特征映射神经网络

Study on Risk Assessment and Prevention Measures of Bird Strike in Civil and Military Airports

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Abstract:

For scientific prevention of bird strike at civil and military airports, for the characteristics of bird observation and bird strike prevention at single-runway civil and military airports, based on the theory of risk assessment matrix, the risk factors for the severity of bird impact factor and the probability factor, and introduces in detail the method of choosing two kinds of risk factors and risk factor data processing method. This paper first puts forward the self-organizing feature map neural network clustering algorithm bird strike risk hierarchy model of the birds. This paper takes WeiFang airports as evaluation object, with the bird strike aircraft information analysis, and compares the airport bird collision of calendar year data, to verify the correctness of the evaluation results, and pertinence of bird strike prevention measures are put forward Suggestions.

keywords: Bird Strike Risk, Risk Assessment Matrix, Self-organizing Feature Mapping Neural Network

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指廊机坪构型下飞机推出组合运行模式设计

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摘要: 指廊机坪构型下机位的分布比其他机坪构型密集, 导致传统的飞机推出方式在指廊机坪构型下带来诸多运行缺陷和推出延误。为了解决这个问题, 以上海虹桥机场 2 号指廊机坪为典型分析对象, 首次设计了一种飞机推出的组合运行模式以减少飞机推出之间的相互冲突, 其要点是首先将指廊机坪构型下天然互相影响的机位控制在同一个组, 以此为基础对机位进行合理分组; 接着为每个组设置一个共用推出停止点, 使组内飞机被推至这个点之后对组外的飞机没有影响; 同时在分组和设置推出停止点时考虑安全的纵向垂直间隔, 以避免飞机直接吹袭地面设备和人员。最后, 论文对飞机推出组合运行模式的优化效果进行了验证, 结果显示: 与传统推出模式相比, 新模式下机位重新合理的分组使指廊底部和指廊拐角机位的平均影响指数下降明显, 单位小时实际推出架次指标值提高了 50%。

关键词: 航空运输; 飞机推出; 指廊机坪; 运行模式; 绩效评估

Design of Aircraft Push-Back Combination Operation Mode Under Finger Pier Apron Configuration

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Abstract:

The densely distributed stands under the finger pier apron configuration result in operational conflicts in the traditional way of aircraft push-back. This paper puts forward the aircraft push-back combination operation mode for the first time to reduce conflicts, taking North Apron of No.2 finger at Shanghai Hongqiao Airport as an example. The main point of the new mode is to first group the stands according to the characteristics of the finger pier configuration. Grouping can control the stands restricted to each other in the same group. The second step is to set common tug stop points for each group, which can ensure that there will be no impacts on the aircrafts outside the group after an aircraft has been pushed back to the corresponding tug stop point. Safe longitudinal separations are also set to make sure that the jet exhaust will not blast directly on the ground equipment and personnel. Finally, the management rules matching the new operation mode are proposed. The results of numerical analysis and simulation evaluation showed that compared with the traditional mode, the average impact index of stands in the combination operation mode drops significantly. The practical push-back movements per hour are increased by 50 percent.

keywords: air transportation; aircraft push-back; finger pier configuration; operation mode; performance evaluation

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高原机场飞机起降减载使用研究

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摘要: 高原气候环境特殊, 空气稀薄, 飞机在高原机场起降时, 起降性能受气温气压影响显著, 起降质量受到限制。本文提出了高原机场飞机起降减载使用的判定准则和分析方法, 研究了跑道长度、道面承载能力、轮胎速度、刹车能量和端净空障碍物高度等因素对飞机起降重量的限制, 判断飞机起降是否需要减载, 明确了具体的减载使用方案。

关键词: 减载使用; 分析方法; 判定准则; 跑道长度; 道面承载力; 轮胎速度; 刹车能量; 端净空障碍物

Research on Load Reduction of Aircraft During Taking Off and Landing at Plateau Airport

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Abstract:

Because of the special plateau climate and the thin air, the aircraft performance of taking off and landing is affected by the air temperature and pressure significantly, and the load of the aircraft is limited. This paper puts forward the determination criteria and analysis method for the load reduction of the aircraft during taking off and landing at the plateau airport, studies the factors, including runway length, pavement bearing capacity, tire speed, braking energy and height of obstacle at web definition on restriction of the aircraft load, estimates the aircraft needs lighten load or not, points out the solution of lightening load.

keywords: load reduction; determination criteria; analysis method; runway length; pavement bearing capacity; tire speed; braking energy; height of obstacle

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基于时空长短期记忆网络的机场航班延误预测

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摘要: 准确预测机场航班延误情况, 对于全面协调空管、机场、航空公司的运行至关重要。目前, 长短期记忆 (LSTM) 神经网络在各领域得到广泛应用, 特别是在预测方面, 精度明显高于传统的机器学习预测方法。本文将对深度学习方法进行推广和应用到机场航班延误预测, 提出一种时空 LSTM 神经网络航班延误预测方法。通过考虑关联机场在时间和空间的相关性, 将所有关联机场的到达延误和出发延误作为特征变量, 能充分从高维特征变量中捕获延误传播内在机理, 从而可以提高延误预测的精度。以美国 2015 年至 2018 年主要机场四年的延误数据作为训练数据和测试数据, 大量的实验表明, 在不同时长预测精度上, 本文方法在预测精度上均优于目前主流延误预测方法。

关键词: 延误预测; 深度学习; LSTM 网络; 时空变量

Spatial-Temporal Long Short-Term Memory Networks for Airport Flight Delay Prediction

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Abstract:

Accurately predicting airport flight delays is important for overall comprehensive coordination of airports, airlines and air traffic management. However, due to the complexity of the impact on flight delays, the existing mainstream methods have lower prediction accuracy. Inspired by the method of traffic flow prediction based on deep learning, a method based on deep LSTM for flight delay prediction is proposed. Different from the existing mainstream methods, this paper firstly applies the Spatial-Temporal Long Short-term Memory Networks (LSTM) to flight delay prediction, and considers the correlation of time and space of associated airports, and features the arrival delay and departure delay of all associated airports. The algorithm can totally obtain information from high-dimensional data. Based on the four-year delay data of the major airports in the United States from 2015 to 2018 as training data and test data, Results from plenty of experiments have implicated that the airport delay prediction method is superior to the current mainstream delay prediction method in predicting accuracy in different time length prediction.

keywords: delay prediction; deep learning; LSTM Network; space-time variable

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