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Book of Abstracts

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Monday, July 8th. 2013

ISIATM Technical Session 1.1: Modelling and Simulation I

Functional Principal Component Analysis of aircraft trajectories

Florence Nicol

Abstract: In Functional Data Analysis (FDA), the underlying structure of a raw observation is functional and data are assumed to be sample paths from a single stochastic process. Functional Principal Component Analysis (FPCA) generalizes the standard multivariate Principal Component Analysis (PCA) to the infinite-dimensional case by analyzing the covariance structure of functional data. By approximating the infinite-dimensional random functions by a finite number of random score vectors, FPCA appears as a dimension reduction technique just as in the multivariate case and cuts down the complexity of the data. This method is applied to aircraft trajectories and the problem of registration is discussed when phase and amplitude variations are mixed.
Keywords. Functional Data Analysis, Principal Component Analysis, Random Variable, Karhunen-Lo` eve Decomposition, Registration, Dimension Reduction

On the Probabilistic Modeling of Runway Inter-departure Times

Ioannis Simaiakis and Hamsa Balakrishnan

Abstract: This paper examines the validity of the Erlang distribution for runway service times. It uses high-fidelity surface surveillance data, for the first time, to model the probability distributions of runway service times and departure throughput, and to validate the Erlang service time assumption. The paper proposes several potential approaches to determine departure runway service time distributions from empirical data, and compares the results. In particular, it finds that a displaced exponential fit may be a better match to the empirical service time distribution than an Erlang distribution. However, the computational benefits offered by the Erlang service time distribution, its accurate reflection of the means and variances of the empirical service time and throughput distributions, and its ability to represent the tail of the service time distribution, make it attractive for use in queuing models of airport operations.
Keywords: Runway service times, Probabilistic modelling, Queuing models

ISIATM Technical Session 2.1: Trajectory Based Operations I

Non-time indexed modelling for en-route flight planning with speed – fuel consumption trade-off

Ali Akgunduz, Brigitte Jaumard, Golbarg Moeini

Abstract. This paper discusses the Air Traffic Flow Management Problem (ATFM) by introducing alternative routing options for aircrafts in a constrained airspace. A mathematical model that aims at minimizing the total flight cost while all safety constraints such as mid-air collision avoidance and separation distance between aircrafts are respected is introduced. Furthermore, speed change and speed dependent fuel consumption issues are addressed. In this regard, a mixed integer programming (MIP) model based on a non-time indexed modelling strategy that benefits from a 3-dimensional (3D) network is introduced. Despite of NP-hard nature of the developed MIP, we were able to solve large instances on a personal computer using CPLEX. Real-time decision making capability on the other hand is achieved through a decentralized solution strategy.
Keywords. Air Traffic Flow Management, Varying speed, Speed based fuel consumption, Mid-air collision avoidance

Strategic De-confliction of Aircraft Trajectories

Supatcha Chaimatanan, Daniel Delahaye, Marcel Mongeau

Abstract. In this work, we present a methodology to minimize the number of potential conflicts between aircraft trajectories based on route-slot allocation techniques. The traffic assignment problem is modeled as a combinatorial optimization problem for which two metaheuristic optimization algorithms are developed and implemented. The first algorithm relies on a standard simulated annealing, while the second algorithm uses a hybrid-metaheuristic method. The proposed algorithms were implemented and tested on real air-traffic data for which an optimal solution for every trajectory is obtained within affordable computation time.
Keywords. 4D trajectory planning, Strategic deconfliction, Hybrid-metaheuristic optimization

Multiobjective Optimization for the Pre-tactical Phase of Air Traffic Control

Gaetan Marceau-Caron, Pierre Savéant and Marc Schoenauer

Abstract. In this paper, we study a method for monitoring and optimizing the target time of arrival on the waypoints for every flight plan considered in a given airspace. Then, air traffic controllers use these targets to collaborate without the use of point-to-point communication and therefore, avoid a substantial increase of complexity. As a matter of fact, the targets are intended to optimize certain criteria over the entire airspace. Also, it allows the transfer of workload from a sector to the others. The effort required to meet the targets for a controller will help to reduce the workload of others in the need. This concept gathers idea from Time-Based Flow Management (TBFM) in the United States and Arrival Managers but also, from the Central Flow Management Unit in Europe. As a matter of fact, the goal is to smooth the transition from the flow management to the air traffic control. Consequently, the time horizon is bounded to 3 hours, which encompass many sources of uncertainty, especially around the estimated time of departure. Our study is focused on a theoretical probabilistic model required to estimate the time of overflight of the waypoints. Many operational constraints are deliberately ignored at this time of the research in order to focus on the study of the properties of the model. These include the different measures of performance used by the Air Navigation Service Providers. We concentrate our effort to minimize the delays at the arrival from the airlines point of view. Also, we do not take into account characteristics of the existing system such as the accuracy of the trajectory prediction. As a matter of fact, we claim that the model is general enough to integrate different kinds of uncertainty from a time-based trajectory point of view. Consequently, we believe that different statistical studies concerning the evaluation of uncertainty can be included naturally in our model.
Keywords. Probabilistic Model, Multiobjective Optimization, Pre-tactical phase, Air Traffic Control

ISIATM Technical Session 2.2: Terminal Maneouver Area I

Arrival trajectory control by split and merge concept at metering point

Masato FUJITA

Abstract. This paper proposes the 'split and merge' arrival management concept. Aircraft make a turn and follow an auxiliary route after intercepting it in this concept, when a detour is required for the separation establishment at the metering point. The degree of the initial turn is determined in the airspace design. The timing of the turn and the used auxiliary route is computed by the automatic adviser. The automatic adviser will choose the auxiliary route so that the generated detour is conflict-free. For the generation of conflict-free detour, a fast conflict detection algorithm is required. We propose a very simple sequencing algorithm as well as conflict detection algorithm in this paper.
Keywords. Airspace design, Conflict-free trajectory, Sequencing

A Dynamic Programming Approach to the Control of Runway Configurations and Arrival and Departure Service Rates

Alexandre JACQUILLAT

Abstract. The high levels of airport delays require the implementation of airport congestion mitigation tools to improve the efficiency and reliability of the air transportation system. This paper presents a decision-making tool to optimize the utilization of airport capacity at the tactical level in the face of operational uncertainty. A novel approach is developed to minimize congestion costs by jointly controlling runway configurations and arrival and departure service rates through the course of a day of operations as a function of observed congestion on the ground and in the air and of meteorological and wind conditions. The approach combines stochastic queue dynamics with a decision-making framework based on dynamic programming. The application of this model to one of the busiest US airports, John F. Kennedy International Airport, suggests that the implementation of this control can result in significant congestion cost savings.
Keywords. Airport, Capacity, Delay, Runway Configuration, Dynamic Programming, Queuing Model

Optimization Model for Sequencing Arrival Flights on Parallel Runways

Li-li WANGa, Qiu-li GUa, Wan-le Wang

Abstract: The problem of terminal area congestion has become increasingly serious with the rapid development of civil aviation of China and growth of air traffic flow. This paper is to study the optimization of arrival flights sequencing and the assignment of runways for arrival flights when air traffic congestion happens in an airport so as to expedite the air traffic flow and reduce flight delays. A model of sequencing arrival aircraft on parallel runways is set up according to aircraft wake turbulence separation requirement. And then the genetic algorithm (GA) of dual codes is employed for the model to determine the sequencing strategy and assign the landing runway for each arrival flight with a pair of chromosomes. The simulation demonstrates that the proposed model can reduce flight delays more effectively compared with three other algorithms: the First Come First Service (FCFS) sequencing algorithm, the algorithm of firstly optimizing arrival flights sequencing and then optimizing the assignment of runways and the algorithm of firstly optimizing the assignment of runways for flights and then optimizing arrival flights sequencing.
Keywords: air traffic control, runway assignment, arrival aircraft sequencing, genetic algorithm

ISIATM Technical Session 1.2: Ergonomics I

Mining Aeronautical Data by using Visualized Driven Rules Extraction Approach

Gwenael Bothorel , Mathieu Serrurier & Christophe Hurter

Abstract. Data Mining aims at researching relevant information from a huge volume of data. It can be automatic thanks to algorithms, or manual, for instance by using visual exploration tools. An algorithm finds an exhaustive set of patterns matching specific measures. But, depending on measures thresholds, the volume of extracted information can be greater than the volume of initial data. The second approach is Visual Data Mining which helps the specialist to focus on specific areas of data that may describe interesting patterns. However it is generally limited by the difficulty to tackle a great number of multi-dimensional data. In this paper, we propose both methods, by combining the use of algorithms with manual visual data mining. From a scatter plot visualization, an algorithm generates association rules, depending on the visual variables assignments. Thus they have a direct effect on the construction of the found rules. Then we characterize the visualization with the extracted association rules in order to show the involvement of the data in the rules, and then which data can be used for predictions. We illustrate our method on two databases. The first describes one month French air traffic and the second stems from a FAA database about delays and cancellations causes.
Keywords: Association rules, Visual Data Mining, characterization of a visualization, aeronautical data

A Model for the Workload Measurement of Air Traffic Controller

Yuan Leping, Sun Ruishan, Wang Lei and Jin Huibin

Abstract: The DORATASK, an air traffic controller workload measurement model, evaluates mental workload by the ratio of busy time occupation. The model seems impractical due to the existence of difference of composition and its measurement of task-induced workload, as well as the variation of controller task allocation among positions in different regions. Therefore, it is nature to customize the model for the operation of air traffic control. This paper presents a workload measurement model that is based on the DORATASK method. The model specifies tasks of observable, non- observable, recuperation and its measurement. For the executive position, air-ground communication and operation of the ATC automation system are identified as the observable workload, and radar scanning is selected as an indicator of non-observable workload. For the coordination position, liaison with other sectors, operation of flight progress strips and the ATC automation system, monitoring of executive position communication are listed in the observable workload, meanwhile flight progress strips scanning is used in calculation of non-observable workload besides radar scanning. The model is used in a real environment by feeding data from an approach control center, and correlation analysis is carried out. Results showed that there are positive correlation between number of flights and the workload of the two positions which also indicated the sensitivity and validity of the model.
Keywords: human factor; air traffic controller; workload; DORATASK

ISIATM Technical Session 2.3: Human Factors I

Preliminary assessment of Passenger experience in a future Personal Air Transport System

Patrick Le Blaye and Bruno Berberian

Abstract This paper describes a preliminary human-in-the-loop experiment focusing on the Passenger issues of a future Personal Air Transport System (PATS). This experiment was conducted as an action of a Human Factors case regarding this revolutionary PATS concept, involving remotely Personal Air Vehicles. Volunteers participated as Passengers to the whole process of a simulated flight starting from booking. The main variable researched in the experiment was the information (limited vs. full) provided by the remote pilot to the Passenger regarding events occurring during the flight. The level of information was found to affect the Passenger's satisfaction and feeling of trust and safety. While acceptance of the concept was generally high, possible mitigation means were identified and discussed in order to favor trust, appropriate communication and sharing of situation awareness with the ground. Further experiments will be required to validate the results as the PATS concept is matured.
Keyword: Human factors, Personal air transport system, Passenger, Remotely piloted vehicle

Real-Time Pilot Support System for Airborne Self-Separation

Vittorio Di Vito, Salvatore Luongo, Giulia Torrano, Luca Garbarino,
Federico Corraro and Edoardo Filippone

Abstract. In the future ATM scenario, a relevant increase of air traffic density is expected, leading to the increase of the risk of occurrence of hazardous collision situations. In this framework, the pilot workload will also consequently be incremented, so inherently leading to further risks, especially with reference to the General Aviation domain, being usually these aircraft less equipped than the commercial ones. In the paper a system is presented, developed by the Italian Aerospace Research Center (CIRA), which is able to support the pilot in real-time in order to ease his/her tasks in presence of congested traffic scenarios. The proposed system is able to act in real-time during the flight in order to: detect possible conflict situations involving own vehicle and surrounding traffic, compute a safe maneuver to maintain separation with other traffic and, finally, propose the manoeuver to the pilot as a suggested escape strategy. This allows reducing the pilot's decision-making process related workload in performing the self-separation task, while at the same time enhancing the flight safety level. In the paper, the proposed system is first functionally described at architectural level, and then the algorithms for conflict detection and resolution are briefly presented. Relevant focus is then devoted to the presentation of the system validation results. To this aim, first in the paper some relevant numerical simulations with challenging scenarios are presented and discussed. Then, the results obtained by real-time with pilot in the loop simulations are reported and commented. Pilots' feedback about the system overall performances and features are also described. The validation campaign results show the ability of the proposed system to alleviate the pilot's workload.
Keyword: Self-separation, Conflict detection, Conflict resolution, Real-time implementation, Pilot support, Pilot in the loop simulations

Interdisciplinary Collaboration to Improve Air Traffic Management Safety

Clifford Elliott Noble IIa, Brenda Jacobsb, and Daniel Rundc

Abstract. A pilot, air-traffic controller and airspace manager describe communica- tion ambiguities inherent in aviation, and provide solutions that are based on interdisciplinary collaboration. The pilot describes verbal ambiguities between pilots and air-traffic controllers who speak in a common second language. The controller describes ambiguities in written directives. The airspace manager describes aviation mapping ambiguities. Solutions are presented for each referential ambiguity. The pilot provides a language-assessment template using ICAO language functions to obtain a more sensitive measure of language performance. An electronic-directives change-order program is described that expedites the revision and distribution of directives to support imminent airspace-change operations. The airspace manager illustrates workarounds to incompatible inter-agency mapping programs using Google Earth to present collaborative mission-oriented mapping solutions.
Keywords. Air Traffic Control; Air Traffic Management; Air Space Management; ICAO Language Functions; Maps; Procedures; Flight Guides; Pilot-Controller Communications

Tuesday, July 9th. 2013

ISIATM Technical Session 3.1: Trajectory Based Operations II

Optimal Control – A new Approach to Automation in Air traffic Control

Matthias Poppe, Leif Walter, Markus Hochstrasser and Jutta Heinz

Abstract Beside capacity and safety, cost efficiency became an evident driver for new operational concepts over the last years. In average, a single Air Traffic Controller controls approximately one aircraft or at most two aircraft per hour on duty. Further automation is the key to improve cost efficiency, not only in terms of information acquisition and information analysis, but also in terms of decision selection and action implementation. Currently proposed concepts like ASAS or Free Flight impose high requirements on new equipment, avionics, and cause high certification costs. Here, a centralized concept is presented which does not require any new onboard equipment. Main idea is to calculate conflict-free trajectories for all aircraft in a large en-route airspace area on a centre level scale. Trajectories are optimised due to certain criteria like flight time, or lateral and vertical deviations. Parameters for manoeuvres can be bounded in terms of speed, level or heading changes. The algorithm calculates these trajectories taking into account operational constraints, most prominently vertical and horizontal separation as well as exit and entry conditions for the considered airspace.
Keywords: Optimal Trajectories, Automation, Air Traffic Control, Optimal Control

Optimal Control Approaches for Aircraft Conflict Avoidance using Speed Regulation

Loïc Cellier, Sonia Cafieri and Frédéric Messine

Abstract: In this paper a numerical study is provided to solve the aircraft conflict avoidance problem through velocity regulation maneuvers. Starting from optimal control based model and approaches in which aircraft accelerations are the controls, and by applying the direct shooting technique, we propose to study two different large scale nonlinear optimization problems. In order to compare different possibilities of implementation, two environments (AMPL and MATLAB) and deterministic local optimization solvers are used. Numerical results are discussed. They show that the considered problem is really difficult to solve to global optimality, as different local minima are found using different methods.
Keywords. Air Traffic Management; Conflict Avoidance; Speed Regulation; Optimal Control; Pontryagin's Maximum Principle; Interior Point-Based Solvers; Numerical Study.

Flight Trajectory Optimization Tool with Dynamic Programming Developed for Future Air Transportation System

Akinori Harada, Yuto Miyamoto, Navinda Wickramasinghe and Yoshikazu Miyazawa

Abstract. Trajectory Based Operations (TBO) have been studied to solve problems in air traffic management, such as fuel price increase, global warming concerns, and inefficient operation in high density area. An easily-handled trajectory optimization tool is required in the study. The purpose of this paper is to propose a flight trajectory optimization tool which is useful for future air transportation system research. Dynamic Programming (DP) is applied as a numerical optimization method. An appropriate dynamic model, meteorological data and aircraft performance model are selected for the DP calculation. Although DP generally has many advantages, immense increase of computational time with the number of state variables, so called 'The Curse of Dimensionality,' is a problem for practical application. In this paper, an effective technique which is named Moving Search space Dynamic Programming (MS-DP) is proposed to alleviate this problem. Although it does not guarantee the global optimality, it gives the same results with the full space DP, which requires far more computational time, in many examples. Availability of the tool is demonstrated by typical examples of minimum fuel flight considering the effect of wind profile for a single jet passenger aircraft and the results are compared with a reference flight data measured by GPS data logger.
Keywords. Trajectory Based Operations, Optimal Control, Trajectory Optimization, Dynamic Programming

ISIATM Technical Session 4.1: Risk Assessment I

Stationary Point Process, Palm measure and collision risk

Ludovic D'Estampes and Pascal Lezaud

Abstract. The classical probability of collision between an aircraft whose the path crosses a flow of aircraft is derived under the assumption that it is described by a Poisson process. Using the so-called Palm measure, we extend the classical result to a stationary point process.
Keywords. Palm measure, point process, collision risk

On the Relation Between Air Traffic Capacity, Separation and Safety

Luís Campos and Joaquim Marques

Abstract. ICAO has established a Target Level of Safety stating a probability of collision of less than 5.0 E-9 per flight hour. The probability of collision depends on: (i) aircraft separation along their intended flight paths; (ii) unintended position errors due to any cause (wind/weather, navigation inaccuracy, pilot inputs, etc…). The calculation of collision probabilities for a pair or a set of flight paths can be used to check if the ICAO TLS is met by current separation rules and trajectory accuracy. If the TLS is not met it is necessary to increase separation and/or decrease position errors; if the TLS is exceeded it is possible for the same position error to decrease separation and increase capacity. The calculation of collision probabilities allows reducing separation and hence increasing capacity, while keeping safety by specifying an upper bound for position errors along the trajectory. The required level of position accuracy may require more accurate navigation; in addition Automatic Dependent Surveillance reporting and/or radar tracks may be used to check that the limits on position errors along the trajectory are respected. In conclusion, the present method indicates how a desired capacity or separation can preserve safety by specifying the required position accuracy along the trajectory.
Keywords. Capacity, separation, safety, collision probability

ISIATM Poster Session

Air Traffic Management Principle Based Development of an Airport Arrival Delay Prediction Model
David Ison, Katherine Moran, Linda Weiland and Ian McAndrew

A PHD Filter for Air Traffic Flow Intensity Estimation
Tao Zhang, Zhe Zhang and Renbiao Wu

The Uniform Model for Conflict Prediction and Airspace Safety Assessment for Free Flight: An Electromagnetic Approach
Zhe Zhang, Tao Zhang, Xiaoliang Wang, Wanwei Wang and Renbiao Wu

Air Traffic Flow Management Problem Under Weather Disruption
Soumia Ichoua

Ability requirements in ATM – from where do we come?
Hinnerk Eissfeldt, Per Ekelof, Peter Maschke and Katja Knappe

Customised information on adverse weather situations for aviation stakeholders
Thomas Gerz, Caroline Forster, Arnold Tafferner and Felix Keis

Fleet Prioritization a Concept Evaluation
Carlos Castro and Todd Waller

A Modified Simulated Annealing Optimisation Method Based on Discrete Model of SSR Surveillance Network Configuration and Deployment
Jungai Tian

Research of the risk manegement system based brain storming for air traffic control
Geng Zengxian, Zhao Yifei, Meng Linghang and Han Hongrong

The theory of planned behavior in civil aviation majors:a model for developing non-technical skills training of ATC, pilot and maintenance
Du Xing, Qin Rui and Huang Yanxiao

E-Learning Opportunities For Air Traffic Controllers
Esra Turhan and Ugur Turhan

Back-to-the-future: Temporal zooming over 4D trajectories for effective air traffic control
John Wise, K. Krishnan and Steve Kertesz

A unified system for the optimization of the observation and measuring of tephra clouds
George Bogdos and Dinos.Konstantinides

Analysis of Critical States and Risks for Human Errors in Aviation
Huibin Jin, LepingYuan AND Qing Zhao

ISIATM Technical Session 4.2: Terminal Maneouver Area II

On Wake Vortex Separation Distances Theory Compared With Regulations

L.M.B.C. Campos and J.M.G. Marques

Abstract. The capacity of ATM is limited by the runway availability at airports. The number of take-off and landings from the same runway is limited by wake vortex separation distances. Currently the safe separation distances (SSD) are established by empirical rules using as sole criterion the classification of the leading and following aircraft into three weight categories "light", "medium" and "heavy". The Boeing B757 has been the subject of an exception to the rules increasing the separation distance on the basis of flight incidents; the Airbus A380 has been subject of an extended separation distance for "super heavy" aircraft as a safety precaution. The purpose of the present paper is to obtain a formula for wake vortex separation distance that involves a number of assumptions and simplifications, but does include more parameters rather than just the weight of the leading and following aircraft. The predicted SSD for pairs of typical light (Citation 500), medium (B737-300) and heavy (B747-400) aircraft are comparable to the ICAO minimum separation rules, suggesting that the latter are moderately conservative on the safe side. The special case of B757-200 is considered justifying the increased separation. In the case of A380-100, the special "ultra-heavy" rules appear to be excessively conservative highlighting the need for a more scientific approach to the subject, especially in cases where a long experience from the past is not available.
Keywords. capacity, separation, safety, wake hazard

Optimisation of take-off runway sequences for Airports-CDM

Roland DEROO

Abstract. With the regular growth of air traffic, airports are becoming the most critical part of the aircraft path. Improving ground operations to absorb the delays generated is becoming a necessity. This paper presents a new departure sequencing algorithm based on operation research methods in the context of the CDM implementation over the European airports. This algorithm is described and results and benefits are demonstrated using data from Paris Charles de Gaulle airport.
Keywords. Collaborative Decision Making, Pre-Departure Sequence, TSAT, operation research, capacity, delays, optimization

ISIATM Technical Session 3.2: Airspace Design I

ADS-B Ground Station Optimal Site Selection based on GIS

Xiaoyun Shen, Siyuan Zhang, Bo Zhou, Weidong Jiao and Di Wan

Abstract: ADS-B surveillance is based on the satellite positioning and Controller-Pilot Data Link Communication. Compared with the traditional radar surveillance, ADS-B has the characteristics of low price, high accuracy and powerful surveillance ability. In the development plan of CAAC's new generation ATM system, ADS-B will be the key technique to be developed and applied. The ADS-B radio signal transmission pattern considering the curvature of the earth, terrain influence is discussed. The ADS-B ground station testing site in China is introduced. The signal coverage range influenced by the terrain is simulated by MatLab software, and to be more visualization, the outputs is displayed in the GIS system.
Keywords: ADS-B, site selection, Optimal, GIS

SSR Surveillance Network covering problem with obstacle effect consideration

Jing Guan, Zhigang Su, Jianxun Tang and Hongying Wu

Abstract. In this paper, SSR surveillance network covering problem with obstructing affected by surface features is studied. The purpose is to improve the performance of SSR surveillance network, thus ensure the efficiency and safety management in airspace. The objective is to minimize the number of radar and the decision variable is the site of radar. Only one type of radar is considered. Firstly, radar network covering problem without obstructing affect is studied. The objective is to minimize the number of radar by arrange them in suitable position satisfying the requirement of complete coverage. For this problem, regular hexagonal expansion algorithm and tabu search algorithm is proposed. Worst-case analysis is provided. We conclude the performance of the algorithm is better when the ratio between the whole region area and radar coverage area is bigger. Secondly, double covering problem in the whole region is taken into account. For this problem, regular triangular expansion algorithm and tabu search algorithm is provided firstly which is more efficient for double covering problem. For those convex target areas worst-case analysis is provided also. Finally, SSR surveillance network covering problem with obstructing affected by surface features is studied. The constraint of complete coverage in whole region is also considered in this problem. This problem is more complex and no efficient optimal algorithm can be used. For this problem, improved hexagon expansion algorithm and tabu search algorithm is applied.
Keywords. SSR surveillance network optimization, approximate algorithm, dominant rule, worst-case analysis, tabu search algorithm

An Optimized Deployment Method of Radar Network Based on Spatial Discrete Model

Shuqin Hu, Zhi Tao, Dongjie Shi and Jing Guan

Abstract. With the rapid development of civil aviation, the airspace coverage of radiation signals and address selection of radar in air traffic control are showing their importance. In order to achieve the purpose of effective surveillance, we must to consider the problem of reasonable deployment of radar. The purpose is to select the minimum number and best site of radar to ensure the complete convergence of the whole airspace or the requirement of overlap degree in some special monitor space. The key to establish the best radar network is to build relatively perfect mathematical models based on network conditions and select suitable optimization algorithms. This paper established a spatial discrete mathematical model to solute the deployment problem of terrain with obstacle. We used simulated annealing algorithm to optimize compute and the solution showed this method effectively and feasibility.
Keywords. Grid, radar network, elevation, spatial discrete model, simulated annealing, optimized deployment

ISIATM Technical Session 4.3: Ergonomics II

Development of a Horizontal Collision Avoidance Display to Support Pilots' Self-Separation in a Free Flight Environment

Yakubu Ibrahim, Peter Higgins and Peter Bruce

Abstract: In a Free Flight Environment, managing separation between aircraft is delegated to the pilot by Air Traffic Management. The future adoption of a Free Flight Environment is necessary, as Air Traffic Controllers will be unable to handle the workload from the forecasted doubling of air traffic within two decades. The responsibility of pilots will expand to include a new set of cognitive demands associated with separation tasks. In managing separation, pilots adjust speed and direction of their aircraft within specified constraint boundaries. An Ecological Interface Design approach has been used to design a novel collision avoidance display to support pilots as they visually evaluate their constraints and implement manoeuvres to avoid air conflict, as compared to conventional approaches. The novel airborne display makes full use of a relative motion and protective cone display to bring these constraints to view as flight progresses. The interactive nature of these displays enables pilots to improve situation awareness and reduce cognitive workload. This paper describes the development and evaluation of the novel collision avoidance display.
Keywords: Free Flight Environment; Ecological Interface Design; Cockpit Display of Traffic Information (CDTI); Situation Awareness; Human and Machine Interactions.

A Training Support Tool for Controller Trainees by Visualizing Trade-offs in Air Traffic Control Tasks

Daisuke KARIKAWA, Hisae AOYAMA, Makoto TAKAHASHI,
Kazuo FURUTA, and Masaharu KITAMURA

Abstract. In order to meet increasing air traffic demands, skilled air traffic controllers are definitely required. Thus, effective an d efficient controller training is a key issue in the Air Traffic Control (ATC) domain. Since controllers are required to achieve safe and efficient air traffic operations in variable situations, their working strategies need to be understood from two aspects: performance in an existing situation and its tolerance for the variability of the situation. Therefore, for supporting ATC training, the present research attempts to analyze trade-offs between these two aspects using our process visualization tool of ATC tasks. Through a tentative analysis of trade -offs in a certain traffic situation derived from a high fidelity human -in-the-loop simulation, the applicability of the COMPASi for the trade-off analysis in ATC tasks was demonstrated.
Keywords. Visualization, Trade-offs, Education and training, and Air Traffic Controller

ISIATM Technical Session 4.4: Human Factors II

Organizational Psychology Issues in Future ATM

Suzanne Wise and John Wise

Abstract: The recent increase of automation and technology in Air Traffic Management (ATM) allows for greater access to information, which has the potential to reduce errors. However, change is always difficult. Implementing and adapting to changes will not be error free. While changes may ultimately relieve some of the stressors of the job, the inherent nature of change creates additional stress. Additionally, when change impacts a large percentage of the personnel, implementation becomes more difficult and complex. To ensure success, change needs to be carefully managed. The success of a change depends on a combination of both technical and organizational skills. The process needs to include recognizing and planning for resistance to change by having both a clear strategic plan, and (perhaps most importantly) strong leadership. Those in positions of authority can block or drive the change process and are therefore critical in the change's ultimate success or failure. However, it is not management alone that is important. While the change must be top-down to provide vision and create structure, it must also be bottom-up to encourage participation and generate support. Leading the technical changes at ATM is the responsibility of everyone in the organization. The whole organization must be moving in the same direction to achieve successful change. This paper will outline the type of leadership. skills and techniques that have been demonstrated to positively enhance the successful change implementation in similar organizations
Keywords: Organizational psychology, Change, Buy-in, Change management, Group performance.

ATC activities, working memory performance, alertness and psychosocial job characteristics: Investigation across the shift in a test flight control centre.

Pauline Maruque, Bostyn Nathalie, Nadine Cascino, Edith Galy

Abstract. Nine out of the 11 ATCs from the French Air Force (mean age 42.7; 10-year control experience) working in a flight test control centre participated in this study. The aim was 1/ to determine to what extent cognitive and psychological processes are related to ATC activities, and 2/ whether the different measures relating to each process vary across shift. ATC activities were observed 1hr after shift-beginning during the first test flight operated in the morning by recording communications (pilot, colleagues, phone calls,…) and radar activities. On shift-beginning, but also on an intermediary shift-phase and 1h prior shift-end of the shift, the following measures were recorded: Response latency in an arithmetic mental task exploring the effects of task difficulty and time pressure, alertness and tension ratings on Thayer's adjective checklist, and perceived job characteristics. The latter were explored by using a 55-item questionnaire (Cascino and collaborators, submitted), addressing well documented dimensions of job perception job demands, job control, and social support, in addition to two as yet unexplored job dimensions (available technical resources, work/family conflicts). Results indicate that on each of the three shift-phases, performance decreased significantly when either or both time pressure and task difficulty increased. In addition, alertness, tension and task performance were positively related to flight control activities. ATCs' alertness decreased, however, across the shift, and so did task performance, but only in the high time pressure condition. These data show that the shift-beginning is a crucial phase in this job-situation, like has been shown previously for other air operation activities. Further, on shiftbeginning ATCs perceived high psychological job demands correlatively to high job control, a combination indicating low strain job situation. In addition, high availability of technical and human resources was associated on this shift-phase with high demands, control and support at work, indicating that this newly introduced dimension modulates well-documented job dimensions.
Keywords. Shift-phase, ATC activities, task performance, subjective measures, job perception

Wednesday, July 10th. 2013

ISIATM Technical Session 5.1: Risk Assessment II

Robust Dynamic Delaunay Triangulation Technology for Moving Points

Zhigang Su, Zheng Wang and Renbiao Wu

Abstract - Dynamic Delaunay triangulation (DT) applied to the field of flight conflict detection effectively reduces the computational complexity of the detection algorithm. Aiming at the decreased credibility due to the reduction of computational complexity, the algorithm of Delaunay mesh maintenance for moving points is presented in this paper. This algorithm ensures detection reliability through real-time topological maintenance and uses local optimization procedure (LOP) to reduce the computational complexity further. The theoretical analysis and simulation results show that the algorithm, which takes into account the computational complexity and detection reliability, is a robust dynamic Delaunay triangulation technology.
Keywords: Delaunay triangulation; dynamic maintenance; moving points; flight conflict detection

Framework for Airspace Planning and Design Based on Conflict Risk Assessment

Fedja Netjasov and Obrad Babic

Abstract: This paper presents a framework for airspace planning and design based on a conflict risk assessment developed for the purpose of preventing aircraft conflicts and collisions. During airspace planning and design process airspace designers follow criteria such as capacity increase and/or reduction of air traffic controller workload. Usually, the safety assessment is not explicitly performed. In order to consider safety in a systematic way (explicitly), here an additional step is proposed. This step contains risk and safety assessment, performed by safety analysts who follow risk reduction criteria, and provide useful feedback to airspace designers regarding safety issues of their solutions. The paper presents a conflict risk assessment models for airspace strategic, tactical, operational and current day planning levels, as crucial steps of the proposed framework. For each planning level required input data, flight path characteristics, and nature of the models are proposed. Also, models developed for each planning level were presented. Idea behind every model, i.e. basic development principles were explained together with specific objectives, assumptions and risk concepts. Models are illustrated by the simple numerical examples.
Keywords: Risk Assessment Aviation Safety, Air Traffic Control, Air Traffic Management

ISIATM Technical Session 5.2: Trajectory Based Operations III

Generating optimal aircraft trajectories with respect to weather conditions

Brunilde Girardet, Yohann Brenier, Stéphane Puechmorel and Laurent Lapasset

Abstract. Two major projects have been initiated to improve air traffic management by enabling 4D trajectory planning, whereby the aircraft plan their trajectory both in position and in time. In this paper, we are interested in a Free Flight variant of the concept, whereby airspace users are allowed maximum freedom when selecting routes: aircraft are no longer restricted to fly along airways; rather, they are allowed to fly along optimal routes, from origin to destination, following optimal altitudes, using favourable winds and avoiding hazards. Such optimal routes are good for the environment, for the airlines, and for passengers.

The goal of our research is to generate trajectories which minimize congestion and travel time of each aircraft in a way that is fair and efficient. We first optimize the route of a single aircraft relying on an algorithm called Ordered Upwind. And

then, with a multi-agent system, we modify trajectories in order to minimize the congestion and to stay as close as possible to the optimal trajectories.

Keywords : Weather, Trajectory planning, Ordered Upwind Method, Multi-agent System

Design of Fly-around of Dangerous/Forbidden Zones with Using Digital "Safety Map

Nikolay Grevtsov and Andrey Dymchenko

Abstract: The method of aircraft trajectory generation for flyaround of no-go (dangerous/forbidden) areas en-route is considered. Fly-around is assumed to perform in horizontal plane. Fly-around trajectories are fulfilled in general way for assigning routes, i.e. with the help of WPs (waypoints). No-go areas are specified on the horizontal rectangular coordinate system. The grid with an identical discreteness value □l along both axes is put on this coordinate system. The discreteness value is chosen to enable the desirable precision of no-go area approximation. Considered method provides fly-around of no-go areas of any form even concave one.

Keywords : trajectory, no-go area, fly-around, waypoint, safety map

ISIATM Technical Session 5.3: Human Factors III

Air Traffic Controllers' Fatigue and Work Performances

Shannakay Watson

Abstract Research suggests the quantity and quality of sleep (or lack thereof) has an impact on concentration levels and work performance of each individual. The purpose of this presentation is to inform whether or not air traffic controllers' sleep habits have an impact on their concentration levels and work performance. A survey was conducted of naval air traffic controllers from various commands around the world. The survey data assessed the quality and quantity of sleep and the controllers' average sleep routines. The following research questions were addressed: To what extent do air traffic controllers' sleep habits affect their daily work performance and concentration levels? Are naval air traffic controllers getting adequate sleep? What might naval air traffic controllers do to improve their sleep behavior, concentration levels and work performances? The results of the survey will be presented as well as recommendations from the presenter/author.

Keywords. Work effectiveness, work performance, circadian rhythm, sleep deprivation, human factors air traffic, air traffic management

User-Centered Development and Evaluation of Helicopter EGPWS Mandarin Alerts

Fenfei Guo, Thea Feyereisen, Kevin Conner, Emmanuel Letsu-Dake, Rui Wang and Qinhua Zhao

Abstract: This paper describes the development and evaluation of Helicopter Enhanced Ground Proximity Warning System (EGPWS) Mandarin alerts for Mandarin speaking pilots. In the Chinese cockpit environment, a cognitive workload was identified with native Mandarin speaking pilots in their ability to clearly comprehend the standard EGPWS English aural alerts. Feedback was gathered from various representative pilot groups to develop the appropriate terms and voice characteristics for Mandarin alerts which convey the same meaning and urgency as English alerts. EGPWS Mandarin alerts were then evaluated by Chinese helicopter pilots during a part-task pilot-in-the-loop evaluation in a fixed base helicopter simulator in China. The newly developed EGPWS Mandarin alerts have a high acceptability for terminology and voice characteristics and were easily and effectively learned by the Chinese pilots. The EGPWS Mandarin alert functions reduced workload and response time and improved situation awareness for the Chinese pilots compared to EGPWS English alerts. The customized localization of the aural interface of EGPWS demonstrated a potential enhancement to aviation safety in China and is expandable to additional cross-cultural avionics interfaces.

Keywords: Mandarin alerts, EGPWS, Chinese pilots, Cross-cultural avionics

ISIATM Technical Session5.4: Modelling and Simulation I

Inference of a random environment from random process realizations: Formalism and application to trajectory prediction

Cécile Ichard and Christophe Baehr

Abstract. We are interested in aircraft trajectories seen as stochastic processes. These processes evolve in an unknown atmospheric random environment. As several aircraft parameters are unknown, such as true airspeed (TAS) and wind, we have to estimate them. To this end, we suggest to use ensemble weather forecasts, which give different scenarios for the atmosphere, with a system of trajectory predictions. In this way, we evaluate the likelihood of each element and we construct a random weather environment organized by the element weight. To get this result, we use sequential Monte Carlo methods (SMC) in the special context of random environment. We propose to use particle Markov chain Monte Carlo method (pMCMC) to estimate the aircraft parameters.
Keywords. Non-linear filtering, random environment, estimation, sequential Monte Carlo method, particle Markov chain Monte Carlo method, aircraft trajectories

Multi-scale Tracking for Maneuver Target using Single Sensor

Tao Zhang, Zhe Zhang and Renbiao Wu

Abstract - On the basis of the theories of Discrete Wavelet Transform and Dynamic Multi-scale System, we propose a novel algorithm for multi-scale fusion and estimation for maneuver target tracking using single sensor. With discrete wavelet transform, we reformulated the state equation and observation equation of Kalman filter into a multi-scale form, in order to establish a novel multi-scale Kalman filtering model. By making full use of the signal feature on the diffident scales, our method is more effective for tracking maneuvering target while the given measurement is in a low S/N ratio. A set of Monte Carlo simulation is performed, and the results show that our algorithm is effective and efficient as well.
Keywords: Target tracking, Multi-scale transform, Wavelet transform, Kalman filter