Literature Review

Flight Trajectory Visualization

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Literature Review Reference

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Year	Journal	Author	Title	Topic	Problem	Method	Objective	Dataset	Measurement	Result	Future
2016	2016 Integrated Communications Navigation and Surveillance (ICNS) Conference. April 19-21, 2016	Candidate, Anvardh Nanduri M S and D, Lance Sherry Ph	ANOMALY DETECTION IN AIRCRAFT DATA USING RECURRENT NEURAL NETWORKS (RNN) Previous Research in Flight Data Anomaly Detection	anomali detection	anomali clasification	recurrent neural network (rnn) with long term short term memory (ltsm) and gate recurrent unit (gru)	rnn acuration	time series, flight data recorder, flight operational data recoder	true false percentage	The RNN algorithms detected 9 out the 11 anomalies in the test dataset with Precision = 1, Recall = 0.818 and F1 score = 0.89.	(1) we would continue to refine the RNNs architecture and training methodology to detect runway change configuration and abnormal pitch anomalies. (2) Experiments with varying feature combinations may be valuable in assessing the performance of recurrent neural networks in detecting even the subtlest anomalies in the dataset. (3)Also expand the data set beyond 21 parameters, and evaluate the performance of proposed models using various feature combinations.
2016	Proceedings - International Conference on Natural Computation	Hu, Chunchun and Kang, Xionghua and Luo, Nianxue and Zhao, Qiansheng	Parallel clustering of big data of spatio-temporal trajectory	enhancing computational efficiency by distributed parallel computing model	computational efficiency (time)	the fast calculation method of the trajectory similarity based on coarse-grained Dynamic Time Warping, the parallel trajectory clustering strategy of big data under the Hadoop MapReduce model, TOOLS : MAHOUT	(1) how many time reduce when distributed parallel computing model, performance of the fast calculation method of the trajectory similarity based on coarse-grained Dynamic Time Warping, (2) how parallel trajectory clustering strategy of big data under the Hadoop MapReduce model reducing time	trajectory data set which include trajectories of 50 cars within 37 day (http://www.chorochronos.org/). The structure of each trajectory point is {\{}objective-ID, trajectory-ID, date (dd/mm/yyyy), time (hh:mm: SS), latitude, longitude, x, y{\}}.	Trajectory similarity measure, Dunn Index Value per cluster, Running Time per Data Size,	The computing performance of parallel clustering are obviously improved as the trajectory data size increases. And the new parallel clustering method outperforms the traditional algorithm like k-means algorithm.	no future
2016	IEEE Transactions on Visualization and Computer Graphics	VanderPlas, Susan and Hofmann, Heike	Spatial Reasoning and Data Displays	demographic characteristics and visual skills to perception of graphical lineups	classification test in a visual domain	The Lineup Protocol, Measures of visuospatial ability, Test Scoring	specific graphical tasks associated with certain visual skills, which visual skills are required in order to understand certain plot types	an evaluation of 38 undergraduate students at Iowa State University. 61{\%} of the participants were in STEM fields, the others were distributed relatively evenly between agriculture, busi- ness, and the social sciences. Students were evenly distributed by gen- der, and were between 18 and 24 years of age with only one exception in the 25-28 bracket.	figure classification task, card rotation test, paper folding test, lineups, visual search	in the fall 2014 semester, 26{\%} of students were associated with the college of engineering, 24{\%} were associated with the college of liberal arts and sciences, 15{\%} were associated with the college of human sciences, 7{\%} with the college of design, 13{\%} with the business school, and 15{\%} with the school of agriculture	(1) For the future work, we will consider more attributes of trajectory, such as position and acceleration. (2) Moreover, user studies will be done to evaluate the visualization tool subjectively.

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2015	2015 19th International Conference on Information Visualisation	Liang, Sheng and Xu, Qing and Guo, Yuejun and Fan, Yang	Multiscale Visualization of Trajectory Data	Multiscale Visualization of Trajectory Data	understanding trajectory data analisis from different perspective	Multiscale Visualization	how effective Multiscale Visualization for trajectory data analysis	DATA https://c3.nasa.gov/dashlink/resources/132/ no measurement	RESULT TrajView, ColorBar, MultiProperty and TrackMap.	(1) As for the future work, we will advance the user interaction by joining more interactive elements. (2) Additionally, user studies will be conducted to evaluate the visualization tool subjectively.	
2015	2014 IEEE Conference on Visual Analytics Science and Technology, VAST 2014 - Proceedings	Murray, Paul and Forbes, Angus	StretchPlot: Interactive visualization of multi-dimensional trajectory data	visualization of space-time trajectory data	determining trajectory positions	method is based on Star Coordinates	how Star Coordinates visualize multi-dimentional space-time data	StretchPlot was used to explore a large dataset related to traveling musicians. The essential space-time data included the date and ge- ographic location of performances given by over 3000 musicians over the span of four years. No Measurement	exploratory analyses	Future work will apply this technique to other data sets, and enable additional interactive tools for geospatial analysis.	
2015	Digital Avionics Systems Conference (DASC), 2015 IEEE/AIAA 34th	Prats, Xavier and Vilardaga, Santi and Isanta, R and Bas, I and Birling, F	WEMSgen: A real-time weather modelling library for on-board trajectory optimisation and planning	WEMSGEN Application for aircraft landing trajectory planning and optimisation	Trajectory modeling	WEMSgen	how to make trajectory base operation (TBO)	lateral flight route, meteorological input data (temperature, pressure, wind filed), aircraft altitude, runway threshold	no measurement	trajectory base operation (TBO), simulation, piece-wise polynomial fitting functions that can be used in a latter stage in trajectory planning and/or optimisation algorithms	no future
2015	SIGSPATIAL Special	Toohey, Kevin and Duckham, Matt	Trajectory similarity measures	trajectory similarity measure	many problem	spatio-temporal similarity(movement speed based similarity{\{}DTW Based Approach [8]{\}}, time series based similarity{\{}Time Warp edit distance [9], Edit Distance with Real Penalty [to] Dynamic, Dynamic Time Warping [11],	One of the main functions for a wide range of application domains is to measure the similarity between two moving objects' trajectories many dataset	many measurement	TABLE III. COMPARISON BETWEEN SIMILARITY MEASURES	the need for a generic trajectory similarity measure and a corresponding operator in one of the moving objects databases that allows user to choose what is the similarity meaning from his perspective.	

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						Edit Distance on Real sequences [12], Longest Common subsequence Based Approaches [13,14]{\}}), spatial similarity(spatial data similarity{\{}Euclidean Distance [15]{\}}, geometric shape based similarity{\{}Spatial Assembling Distance [15], Hausdorff and Frechet distance [17], Angular Metric for Shape Similarity [18]{\}}, movement based similarity{\{}Trajectory Match Algorithm [19], Edit Distance on movement Pattern Strings [20]{\}})					
2015	IEEE Transactions on Control Systems Technology	Wang, Yu and Wang, Shuo and Tan, Min and Zhou, Chao and Wei, Qingping	Real-time dynamic Dubins-Helix method for 3-D trajectory smoothing	Trajectory Smoothing	Trajectory generation, path planning	real-time dynamic Dubins-Helix (RDDH) method, Dubins-Helix trajectory generation, pitch angle smoothing	analyzing the relationship between the parameters and the effectiveness of the RDDH trajectory, how smoothing algorithm generate appropriate parameters for a shorter and smoother trajectory	The vehicle initial and final poses are denoted by Ps (xs , ys, zs , ϕs , γs) and Pg(xg, yg, zg, ϕg, γg), respectively, where ϕi , γi (i = s, g) represent the initial heading and pitch angles	reduced closed-loop model.	The numerical results demonstrate that the proposed method can generate an effective (not far from optimal) and feasible path, which satisfies the geometric constraints and different initial conditions, and is able to be implemented in real-time.	no future
2015	2015 Integrated Communications Navigation and Surveillance	Wang, Zhenming and Candidate, Ph D and D, Lance Sherry Ph and D, John Shortle Ph	AIRSPACE RISK MANAGEMENT USING SURVEILLANCE TRACK DATA : STABILIZED APPROACH	feasibility of using surveillance track data to measure, track, and trend airspace risk	achieve the stabilized approach criteria	Simulation-Based Methods, Data Analisis Method(Data Mining Approach, Heuristic Approach)	Find parameter of : (1) Changes in speed from one location to another location (e.g. 1000 ft. AGL to runway threshold), (2) Rate of descent in excess of a threshold (e.g. 1000 fpm.) and (3) last for a time period, (4) Alignment with runway centerline, (5)	Navigation procedure data come from the FAA's National Flight Data Center (NFDC), The surveillance track data used in this research is provided by the FAA National Offload Program (NOP).	Statistical Deskriptif	Results show that 27.8{\%} of the approaches exhibited more than 10 knots change in groundspeed after sequencing 1000 ft. AGL, 14.1{\%} after sequencing 750 ft. AGL, and 4.4{\%} after sequencing 500 ft. AGL. Results show that a	(1) For these reasons the “smoothing” and “filtering” algorithms are critical in developing accurate statistics. (2) It would be better practice to provide stochastic criteria for stabilized approach that provides the flightcrew with the stochastic

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	(ICNS) Conference. April 21-23, 2015		ES 1 Introduction				Alignment with glidepath, (6) Go-around trajectory flown (if any), (7) Location of acquisition of the glidepath, (8) Location of acquisition of the runway centerline, (9)Speed at FAF, (10)Aircraft weight class			flight that acquires glidepath after FAF has a higher probability of having an excessive speed change from 1000 ft. AGL to the runway threshold.	measures to determine if risk-free criteria are met. (3) Additions to the algorithms include the improved filtering techniques, calculation of true airspeed by the addition of wind data, and the addition of aircraft performance calculations to determine minimum safe operating speeds

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2014	Proceedings of the International Conference on Information Visualisation	Guo, Yuejun and Xu, Qing and Li, Xiu and Luo, Xiaoxiao and Sbert, Mateu	A new scheme for trajectory visualization	Trajectory Visualization	Clustering strategy	Trajectory clustering	During clustering, speed and direction are both taken into account as the important properties of a trajectory. Additionally, the temporal change of the trajectories is explicitly considered in the procedure of clustering.	The first dataset, containing 1149 trajec- tories from which we choose 252 trajectories for experiment, is composing of people trajectories at a public transport hub in Graz, Austria and is denoted as Puntigam [18] (see Fig. 1.1). The second dataset, publishing on the Web [19] and containing 82 trajectories, is drawn from evacuation routes in a certain building named DOH and is denoted as Evacuation (see Fig 1.2). The third dataset, containing 150 trajectories, is from the well-used Edinburgh (see Fig. 1.3).	cluster	A novel scheme for trajectory clustering and visualization has been introduced and its effectiveness has been demon- strated by applying different datasets	we intend to devise a user interface for facilitating user selection of parameters, and consequentially achieving far better interaction capability. We can improve the approach by adaptively selecting optimal number of clusters in the clustering stage. In addition, highlight visual- ization of local change will be taken into consideration
2014	2014 9th International Conference on Intelligent Systems : Theories and Applications, SITA 2014	Kaidi, R. and Lazaar, M. and Ettaouil, M.	Neural network apply to predict aircraft trajectory for conflict resolution	Collision Avoidance	Intersection Detection, Trajectory Prediction	Optimization of Multilayer Perceptron Architecture (OMPA)	(1) develop an approach based on Artificial Neural Networks (ANNs), called Optimization of Multilayer Perceptron Architecture (OMPA)(develop ANN architecture). (2) forecast trajectory in vertical plane to solve conflicts between two aircrafts in airspace	spherical coordinate position z respectively(xi,Yi, i) , (Xj,Yj,Zj), altitute	yes true percentage of collitions	a network of 10 neurons in the hidden layer, the conflict detection rate is 98.36{\%}, with 30 neurons rate is 98.8{\%} and with 45 neurons the rate is 97.98{\%}.	(1) we plan to extend system more than two aircraft, decided to use unsupervised learning with GAs. (2) In future work, we apply the GA to prorogue the conflict resolution for several aircraft in vertical plane and the neural network hybrid with Ant Colony Optimization (ACO) to solve the conflict between n aircraft in horizontal plane.
2014	MIPRO 2014, 26-30 May 2014, Opatija, Croatia	Osmanovi, D and Me{\v{s}}kovi, E	Visualization of Streaming Trajectories	managing spatio-temporal data streams	visualization of continuous queries results	OCEANUS Visualizer from OCEANUS DSMS prototype	how to perform continous positional queries, distance queries, scalar queries	carStream {\textless} id: integer, carType: varchar(8), driver: smallint, pos:intime(point),speed: real, tcqtime: timestamp timestampcolumn {\textgreater}	no Measurement	OCEANUS Visualizer, an application for querying and visualizing streaming trajectories of moving objects. With this approach, application is found appropriate for beginners and advanced users as well.	expanding its functionality and applications. As an example, it can be implemented as an intelligent navigation control, in which the aircrafts can cooperate to one another so as to perform different missions. Another development is the decentralization of the GCS's system. In this approach, the system would not longer function in a

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											station on the ground, but embedded into the aircraft. Alongside these suggestions, another logical continuation of this work is to implement an autopilot hardware to expand the use of GCS in controlling real aircrafts.
2013	Sadhana-Academy Proceedings in Engineering Sciences	Coogan, Samuel and Arcak, Murat and Fallis, A.G and Illner, Reinhard and Mcgregor, Geoffrey and Scheepens, Roeland and Hurter, Christophe and Wetering, Huub Van De and Wijk, Jarke J Van and Tiwari, Geetam and Fazio, Joseph and Gaurav, Sushant and Yin, Derek and Qiu, Tony Z	Visualization, Selection, and Analysis of Traffic Flows	interaction tools to visualize traffic flow	Visualization of the trajectories of moving objects leads to dense and cluttered images, which hinders exploration and understanding.	No Method	In this paper we present our approach to visualize traffic flows and provide interaction tools to support their exploration. We	We describe a trajectory of a moving object o by a state α o(t). Astate is a tuple containing at least attributes such as position po(t), velocity vo(t), and heading ho(t), but may also contain additional attributes such as the altitude of an aircraft ao(t), or the type of a vessel τ o.	We validate our approach through use cases where we explore and analyze the temporal behavior of aircraft and vessel trajectories, e.g., landing and takeoff sequences, or the evolution of flight route density. The aircraft use cases have been developed and validated in collaboration with domain experts.	we explored the design space to visualize and interac- tively explore traffic flows in moving object data sets. Traffic flows have intrinsic properties that can be displayed and analyzed even in dense visualizations: location, direction, and intensity.	As future development, we plan to extend this software together with air traffic control practitioners to provide “a what if” system that enables the user to remove, change, or simulate trajectories. This
2013	IEEE Aerospace Conference Proceedings	Foster, Cyrus	Trajectory Browser: An online tool for interplanetary trajectory analysis and visualization	Trajectory Analysis and Visualization	finding preliminary trajectories to planetary bodies and for providing relevant launch date, time-of-flight and ΔV requirements	Trajectory Browser, An Online Tool	A search engine allows the user to find trajectories meeting desired constraints on the launch window, mission duration and ΔV capability, while a trajectory viewer tool allows the visualization of the heliocentric trajectory and the detailed mission itinerary	a database of trajectories with specific constraints on destination, launch date, duration and ΔV.	No Measurement	This paper describes a web-based tool for searching for transfer trajectories from Earth to planetary bodies within the Solar System for a variety of mission configurations. It is designed to be a low-fidelity but quick-turnaround method for probing the existence of trajectories during conceptual design phase of	Trajectories to small-bodies other than NEOs can be readily implemented, such as the larger members of the main asteroid belt, Jupiter Trojans and other objects of interest. Additional trajectory configurations are also being considered that utilize more complex gravity assist and deep space maneuvers. Finally,

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										a mission.	the implementation of low-thrust trajectories is also being considered to reflect the availability of electric propulsion technologies for current and planned missions.
2013	Proceedings of the International Conference on Information Visualisation	Fukute, Aya and Itoh, Takayuki and Onishi, Masaki	A linked visualization of trajectory and flow quantity to support analysis of people flow	People flow analysis	trajectory classification into pattern	spectral clustering	so that we can clear and analyze the major moving patterns of pedestrians.	people flow datasets which we obtained by using a stereo camera located near escalators of a complex facility in Akihabara, Tokyo.	No Measurement	This paper proposed a technique for linked visualization of trajectory and flow quantity to support the analysis of people flow	Classify trajectories at freely walking spaces, Visualize representative trajectories, Visualize directions of the trajectories.
2013	2013 IEEE International Conference on Robotics and Biomimetics (ROBIO)	Kong, Min-xiu and Ji, Chen and Chen, Zheng-sheng and Li, Rui-feng	Smooth and near time-optimal trajectory planning of robotic manipulator with smooth constraint based on cubic B-spline	trajectory planning	Minimum time optimization trajectory planning problem which can generate smooth trajectory of joints of robot is still complex and difficult to solve	hybrid cubic B-spline and convex optimization method	(1) the first and second derivatives of path trajectory coordinates s , called pseudo-velocity and pseudo-acceleration respectively, are introduced into robot dynamic model, and consequently transformed the optimal trajectory problem into convex optimization problem. (2) to obtain a jerk-bounded smooth trajectory of manipulator joints, the cubic B-spline was employed to construct the curve of the square of pseudo-velocity as smooth constraint of the transformed convex optimization model.	three-DOF manipulator	time, acceleration, jerks, Torque	the proposed optimization method can generate smooth and minimum time trajectory which is very useful for accuracy improving of path tracking tasks and producing efficiency of industrial robot, such as arc welding robot and spray painting robot.	No Future
2013	IEEE ISI 2013 - 2013 IEEE International Conference on Intelligence and Security Informatics: Big Data,	Lei, Po Ruey	Exploring trajectory behavior model for anomaly detection in maritime moving objects	Anomaly Detection in maritime traffic	Classification	Hostorical anomaly detection	to detect anomalous moving objects. multidimensional outlying features are first identified and defined	maritime trajectory	No Measurement	No Result	No Future

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	Emergent Threats, and Decision-Making in Security Informatics										
2013	2013 IEEE 2nd International Conference on Actual Problems of Unmanned Air Vehicles Developments, APUAVD 2013 - Proceedings	Mykhatsky, O. Yu and Kuzmenko, N. S. and Savchenko, O. V.	Experimental UAV flight data structuring, transmission and visualization by narrowband telemetry transmission	flight analysis	Flight Data Structuring, Transmission and Visualization	No Method	flight data processing and visualization tools	TABLE I. GROUPING AND COMPOSITION OF THE TRANSMISSION PARAMETERS	No Measurement	combining graphical data comparison with trajectory visualization allows to make conclusions of autopilot tinning quality and to perform necessary corrections for increasing the trajectory keeping accuracy.	No Future

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2013	Integrated Communications, Navigation and Surveillance Conference, ICNS	Weitz, Paul	Determination and visualization of uncertainties in 4D-trajectory prediction	Trajectory forecast	4D-TRAJECTORY PREDICTION	uncertainty calculation (spatial error, horizontal error, along track error, cross track error, vertical error, temporal error)	This paper presents a concept to detect uncertainties based on air traffic simulations, and to visualize the results in a quantitative (diagrams) as well as a qualitative way (geospatial imaging)	we get approximately 2,000 different trajectories for the flight with departure airport Hamburg and arrival airport Munich.	process of evaluating the accuracy of a trajectory concerning the predicted flight path	(1) VIsualization framework, (2) smulated uncertainted, (3) The results show large vertical uncertainties with deviations of the weight, and horizontal uncertainties under different wind conditions. The true airspeed affects mostly the duration of flight. Deductive, we can resume that a more precise forecast of the influencing parameters aimed a smaller uncertainty and thus higher efficiency and safet	Tools will use for mapping of sector complexity, detection of conflicts in case of intersections of ellipsoids
2012	AIAA/IEEE Digital Avionics Systems Conference - Proceedings	Buchholz, Alexander K. and Eftekari, Robert R.	Terminal area visualization tool for approach analysis	Visualization tools	the simulation lacks a significant visualization capability	Terminal Area Visualization (TAV) tool provides the capability to visualize flight trajectories in fast or real time using airframe and satellite imagery	to specify synthetic approach scenarios output from the Monte Carlo simulation (or other data sources) and simultaneously illustrates multiple perspectives of characteristics that are not clearly evident from basic statistical analyses or typically require sequential graphical analyses. Features include dynamic plan (bird's eye) and profile views, plots of numeric data, and optional visualization of estimated wake vortex positions.	a case study of proposed operations for San Francisco International Airport (SFO)	No Measurement	This paper describes the TAV tool, mathematical algorithms, user interface design, a case study of proposed operations for San Francisco International Airport (SFO), and other potential applications.	Potential future applications include departure, surface, and independent approach operations. Additionally, the TAV tool can accommodate input and visualization of real world aircraft state data.
2012	AIAA/IEEE Digital Avionics Systems Conference - Proceedings	Crowell, Andrew and Fabian, Andrew and Nelson, Nicole	An interactive 4D visualization system for air traffic concept analysis	Visualization tools	When a new concept is introduced, it is often difficult to find a tool that can easily be adapted to help analyze it.	a flexible, extensible,interactive 4D visualization tool for analysis of virtually any aviation concept. Flexible Flight Traffic Exploration Visualization 4D (FliteViz4D)	platform specifically directed at visualizing air traffic concepts in three-dimensional space, with two addi- tional temporal dimensions for current time and fu- ture time. It allows concepts such as 4D Trajectory Based Operations, National Convective Weather Forecast, and 3D Path Arrival Management to be visualized in all their dimensions	flight data	No Measurement	The result is a powerful visualization and analysis system, scalable from a single airport to the entire world, which can be used to analyze any concept that could possibly be visualized abstractly or physically. This	In the future work, we are studying alternative weighting schemes as well as making the weighting schemes automati- cally adapt to the data set. At the same time, we will try to utilize the geometric and topological information of the road networks to tackle more vehicle mobile data related issues. Another interesting direction is that how much impact will the historical information make to the vehicle related applications and research.

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2012	AIAA/IEEE Digital Avionics Systems Conference - Proceedings	Park, Sang Gyun and Clarke, John Paul B	Fixed RTA fuel optimal profile descent based on analysis of trajectory performance bound	trajectory performance analisis framework	Minimum time trajectory and minimum fuel trajectory are obtained by trajectory optimizer of TPA and performance bound is determined between two optimal trajectory results.	To meet the scheduled time of arrival to the meter fix, fixed time RTA minimum fuel descent profile generation method is proposed. The proposed method is suboptimal minimum fuel trajectory generation method constructed with known FMS Vertical Navigation (VNAV) descent algorithms.	The proposed method is suboptimal minimum fuel trajectory generation method constructed with known FMS Vertical Navigation (VNAV) descent algorithms. The VNAV segments used in this method is determined by analyzing minimum fuel trajectories with fixed RTA.	The numerical simulations with B737-800 and B767- 400 are given to illustrate the proposed TPA framework and fixed RTA suboptimal trajectory generation method for FMS.	Performance of trajectory is affected by aircraft parameter variation. Among many parameters, descent weight variation is very large, and it significantly affects trajectory performance	a framework, called Trajectory Performance Analyzer (TPA), for analyzing performance bound of descent trajectory using optimal control problem formulation is proposed	No Future
2012	International Conference on Information and Automation	Song, Yue and Cheng, Peng and Mu, Chundi	An improved trajectory prediction algorithm based on trajectory data mining for air traffic management	Air trafic management	Trajectory prediction	An improved trajectory prediction algorithm is proposed based on the typical trajectory, which is used as the intent information to update the transition probability matrix, and is also used to propagate the nominal trajectory instead of the flight plan path.	data mining algorithms are used to process the historical radar data and to abstract a typical trajectory library	Here historical flight radar data from North China Air Traffic Management Bureau is used, and one week's data (from 2009.1.19 to 2009.1.25) is abstracted to analyze	The prediction performance of the proposed algorithm is tested using real radar data from North China Air Traffic Management Bureau	The simulation results show that the improved algorithm has a better prediction performance and the prediction accuracy is improved by 10{\%} at most.	No Future
2012	IEEE Transactions on Visualization and Computer Graphics	Tominski, Christian and Schumann, Heidrun and Andrienko, Gennady and Andrienko, Natalia	Stacking-based visualization of trajectory attribute data	Visualizing trajectory attribute data	showing the trajectories in their spatio-temporal context as well as the attribute values associated with the individual points of trajectories	Based on an analysis of relevant visualization tasks, we designed the visualization solution around the principle of stacking trajectory bands	We present a novel approach to visualizing trajectory attribute data. Our solution covers space, time, and attribute values.	three examples related to radiation surveillance, traffic analysis, and maritime navigation.	No Measurement	User feedback obtained in a small experiment indicates that our hybrid 2D/3D solution can be operated quite well.	As soon as the tracked movements become less and less constrained or even chaotic (e.g., for particle movements at the cellular level), clustering methods and so our visualization ap- proach will produce worse results. More research is needed to find ways to cope with such data. Additional interaction mechanism can be

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											considered to better han- dle larger data sets
2011		Chan, David S K and Brooksby, Glen W and Hochwarth, Joachim and Klooster, Joel K and Systems, G E Aviation and Rapids, Grand	Air-Ground Trajectory Synchronization – Metrics and Simulation Results	4-Dimensional Trajectories prediction	Trajectory prediction	This paper briefly discusses the high-level trajectory synchronization algorithm and its implementation in a fast-time simulation environment that incorporates actual Flight Management and Air Traffic Control software.	It then focuses on the analysis of metrics and simulation results from several case studies.	Controller-Pilot Data Link Communications messages as well as the Automatic Dependent Surveillance-Contract service (including the Extended Projected Profile application) achieves consistent trajectory predictions between the air and ground systems.	An initial test suite run in our fast-time simulation environment shows that trajectory synchronization can be achieved by means of ADS-C EPP exchange	high-level trajectory synchronization algorithm and its implementation in a fast-time simulation environment that incorporates actual Flight Management and Air Traffic Control software.	Further work is required to quantify the benefits and identify the bottlenecks in more comprehensive scenarios.
2011	Proceedings of the 15th Symposium on International Database Engineering {\&} Applications - IDEAS '11	Desmier, Elise and Flouvat, Fr{\'{e}}d{\'{e}}ric and Gay, Dominique and Selmaoui-Folcher, Nazha	A clustering-based visualization of colocation patterns	spatial pattern mining	visualization and interpretation of extracted patterns	we formalize this visual representation as a colored and labeled clique where each vertex is associated to spatial coordinates. We also pro- pose a new levelwise algorithm combining a heuristic clus- tering method optimized for this problem.	to find sets of spatial object-types with instances locatedin the same neighborhood	This proposition has been integrated in a Geographic Information Systemand ex- perimented on a real-world geological data set.	In this context, the main drawback is the visualization and interpretation of extracted patterns by domain experts	Todeal with this problem, we propose aclique-based representation of colocations and a new clustering-based vi- sualization of colocations.	This work has several per- spectives. The algorithm performances could be improved in order to deal with more features and more complex spa- tial relationships. Dedicated data structures or new mining strategies are possible solutions. Finally, we plan to test our prototype on other datasets dealing with soil erosion and other thematics
2011	Proceedings of the International Conference on Information Visualisation	Haridas, Anoop and Pelapur, Rengaraja n and Fraser, Joshua and Bunyak, Filiz and Palaniappan, Kannappan	Visualization of automated and manual trajectories in wide-area motion imagery	trajectory visualization	automated object tracking and performance assessment	provides visual methods for the intercomparison of very long manual tracks with multi-segmented automatic tracker outputs and a flexible KOLAM TrackingSimulator (KOLAM-TS) middleware that generates vi- sualization data	We describe an interactive visualization system that supports very large gigapixel per frame video facilitates rapid, intuitive monitoring and anal- ysis of tracking algorithm execution provides visual methods for the intercomparison of very long manual tracks with multi- segmented automatic tracker outputs and a flexible KOLAM TrackingSimulator (KOLAM-TS) middleware that generates vi-	The PSS database is a WAMI repository collected and maintained by Persistent Surveillance Systems Inc.	No Measurement	The KOLAM environment provides an integrated toolset for: (i) interactive visualization of WAMI datasets (ii) manual ground truth generation of moving and stationary objects (iii) an efficient assisted tracking mode to increase user pro- ductivity and (iv) KOLAM-TS to facilitate automated eval- uation of tracking algorithms.	No Future

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							sualization data by automating the object tracker performance testing and benchmarking process.				

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2011	RAST 2011 - Proceedings of 5th International Conference on Recent Advances in Space Technologies	Xie, Yu and Liu, Luhua and Tang, Guojian and Zheng, Wei	A reentry trajectory planning approach satisfying waypoint and no-fly zone constraints	trajectory planning	a longitudinal trajectory planning subproblem and a lateral trajectory planning subproblem	longitudinal trajectory planning, Lateral Trajectory Planning	The latter is to specify the sign of bank angle for satisfying the waypoint and no-fly zone constraints and minimizing the final crossrange error. The	flight data, GIS data	degree	The approach has proven quite effective in solving this trajectory planning problems with multiple constraints.	No Future
2010	AIAA/IEEE Digital Avionics Systems Conference - Proceedings	Gallo, Eduardo	Prediction of descent trajectories based on aircraft intent	trajectory prediction tools	trajectory prediction base on aircraft intent	AIDL is a univocal, rigorous, and standardized method to express aircraft intent	As part of its Advanced Trajectory Technologies (ATT) activities, Boeing Research {\&} Technology Europe (BR{\&}TE) has developed a TCI that employs the Aircraft Intent Description Language (AIDL) as the main input to the TCI. AIDL	weather data, base aircraft data (bada), data point	Throttle, Speed, Vertical Speed, Path Angle,	Trajectory Computation Infrastructure (TCI) developed by Boeing Research {\&} Technology Europe (BR{\&}TE) based on the Aircraft Intent Description Language (AIDL).	No Future
2009	ICDM Workshops 2009 - IEEE International Conference on Data Mining	Chang, Cheng and Zhou, Baoyao	Multi-granularity visualization of trajectory clusters using sub-trajectory clustering	trajectory visualization	pattern mining	Sub-trajectory Clustering	In this paper, we propose an approach for visualizing the trajectory clustering results based on sub-trajectory clusters discovered from large-scale trajectory data	We currently use real trajectory datasets: the Starkey animal movement dataset [12].The dataset represents the major habitat variables derived for radio-telemetry studies of elk, mule deer, and cattle at the Starkey Experimental forest and range in northeastern Oregon from the years 1993 through 1996	To measure spatial similarity between segmented sub-trajectories, we choose discrete Fr{\'{e}}chet distance, a very proper metric method for polygonal curves.	we have designed a multi-granularity visualization framework to effectively represent the hot spots of the trajectory dataset by leveraging density based clustering algorithm and Fr{\'{e}}chet distance measure	no Future
2006	IEEE Transactions on Visualization and Computer Graphics	Li, Lewis W F and Li, Frederick W B and Lau, Rynson W H	A trajectory-preserving synchronization Method for collaborative visualization	Collaborative Visualization	Trajectory-Preserving Synchronization	Consistency Control Model,Gradual Synchronization, Client-Server Synchronization, Client-Client Synchronization, Synchronization at an Arbitrary Moment	In this paper, we propose a synchronization method to support collaborative visualization. It considers how interaction with dynamic objects is perceived by application participants under the existence of network latency, and remedies the motion trajectory of the dynamic objects. It also handles the false positive and false negative collision detection problems.	trajectory dataset for visualization	Latency	we have proposed a synchronization method to support collaborative visualization	For example, it assumes using connection-oriented network protocols and message loss is not considered.

Year	Journal	Author	Title	Topic	Problem	Method	Objective	Dataset	Measurement	Result	Future
2006	IEEE Transactions on Medical Imaging	Liu, Jing and Redmond, Michael J. and Brodsky, Ethan K. and Alexander, Andrew L. and Lu, Aiming and Thornton, Francis J. and Schulte, Michael J. and Grist, Thomas M. and Pipe, James G. and Block, Walter F.	Generation and visualization of four-dimensional MR angiography data using an undersampled 3-D projection trajectory	Undersampled 3-D Projection Trajectory Tools	improve sampling efficiency	VIPR Acquisition Implementation, Density Compensation Computation, Temporal Weighting Function, Four-Dimensional Cluster Visualization	interactive visualization, improve sampling efficiency	No Dataset	Quantitative SNR was measured in the descending aorta, the right renal artery, and in the superior mesenteric artery in the peak arterial frame. SNR was measured as the ratio of the mean signal within a vessel to the mean background region	Results from volunteer and patient studies demonstrate the advantages of dynamic imaging with high spatial resolution	No Future
2006	Proceedings - International Conference on Pattern Recognition	Xi, Li and Weiming, Hu and Wei, Hu	A coarse-to-fine strategy for vehicle motion trajectory clustering	Vehicle Motion Trajectory Clustering	High-level semantic understanding of vehicle motion behaviors	clustering framework in which a coarse-to-fine strategy	trajectory smoothing, feature extraction, trajectory coarse clustering and trajectory fine clustering.	vehicle trajectory data	calculate the clus- tering accuracy of each cluster	From Figure 4, we can see the performance of our framework is good	Vehicle motion behavior analysis is our future work
2005	Proceedings. IEEE SoutheastCon, 2005.	Brown, D.R. and Dunn, D.B.	Trajectory visualization by using Global Positioning Systems (GPS)	Trajectory visulization	Learning method to sudent	No Method	to give students hands on experience in the integration of hardware and software equipment used for GPS applications.	gps simulator	no Measurement	airplane trajectory, rocket trajectory	No Future
2003	The 22nd Digital Avionics Systems Conference, DASC '03	Dang, Nguyen-Thong and Le, Hong-Ha and Tmanii, Monica	Visualization and Interaction on Flight Trajectory in a 3D Stereoscopic Environment	Visualization tools	representation for flight trajctory	No Method	This paper describes the design of visualizations and interactions within a multidisciplinary kamework for the empirical analysis of the applicability of three-dimensional (3D) stereoscopic visualization in Air Traffic Control (ATC)	flight trajectory data	No Measurement	In this paper, we have analyzed difference aspects in representations of flight trajectory, waypoints and proposed some new metaphors and selection techniques for handling waypoints and flight trajectories in a 3D stereoscopic environment. Hermite polynomial curve or Bezier polynomial curve can be used to model flight	Haptic input device will be next 3D input device to study. Intelligent interaction, interaction that reduces at much as possible user's effort to accomplish an interaction task, will be also studied basing on haptic interaction

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										trajectory in comparing with normal straight-line trajectory.	
2002	IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS, VOL. 7, NO. 1, JANUARY-MARCH 2002	Keim, Daniel A	Information Visualization and Visual Data Mining	Information Visualization and Visual Data Mining	Exploring and analyzing the vast volumes of data	classification	In this paper, we propose a classification of information visu- alization and visual data mining techniques which is based on the data type to be visualized, the visualization technique and the interaction and distortion technique	no Dataset	no Measurement	Visual data exploration has a high potential and many applications such as fraud de- tection and data mining will use information visualization technology for an improved data analysis.	Future work will involve the tight integration of visu- alization techniques with traditional techniques from such disciplines as statistics, maschine learning, operations re- search, and simulation.

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1997	Proceedings of International Conference on Robotics and Automation	Kubota, N. and Arakawa, T. and Fukuda, T. and Shimojima, K.	Trajectory generation for redundant manipulator using virus evolutionary genetic algorithm	trajectory generation	hierarchical trajectory planning of a redundant manipulator	virus-evolutionary genetic algorithm (VEGA)	The hierarchical trajectory planning is composed of a trajectory generator and position generator	trajectory data	fitness, error	The simulation results show that the hierarchical trajectory planning can generate effective intermediate positions and a collision-free trajectory of a redundant manipulator simultaneously	As future subjects, we will apply various kinds of manipulators and discuss its effectiveness, furthermore, research mathematical analysis of the virus infection of the VEGA in detail