**LITERATURE SURVEY**

**1) Ads-b anomalies and intrusions detection by sensor clocks tracking**

**AUTHORS:**  M. Leonardi

Automatic dependent surveillance-broadcast (ADS-B) is an air traffic control system in which aircraft transmit their own information (identity, position, velocity etc.) to ground sensors for surveillance scope. The tracking of the different sensors' clocks by the use of time difference of arrival of ADS-B messages is proposed to check the veracity of the position information contained in the ADS-B messages. The method allows detecting possible on-board anomalies or the malicious injection of fake messages (intrusion) without the use of the multilateration (or any other) location algorithm. It follows that it does not need the inversion of the location problem (usually strong nonlinear and ill-posed), and, contrary to the multilateration, it works also with less than four sensors.

**2) Adaptive air-to-ground secure communication system based on ads-b and wide-area multilateration**

**AUTHORS:** Y. A. Nijsure, G. Kaddoum, G. Gagnon, F. Gagnon, C. Yuen, and R. Mahapatra

A novel air-to-ground (ATG) communication system, which is based on adaptive modulation and beamforming enabled by automatic dependent surveillance-broadcast (ADS-B) and multilateration techniques, is presented in this paper. From an aircraft geolocation perspective, the proposed multilateration technique uses the time-difference-of-arrival (TDOA), angle-of-arrival (AOA), and frequency-difference-of-arrival (FDOA) features within the ADS-B signal to implement the hybrid geolocation mechanism. Moreover, this hybrid mechanism aims for the optimal selection of multilateration sensors to provide a precise aircraft geolocation estimate by minimizing the geometric dilution-of-precision (GDOP) metric and imparts significant resilience to the current ADS-B-based geolocation framework to withstand any form of attack involving aircraft impersonation and ADS-B message infringement. From an ATG communication perspective, the ground base stations can use this hybrid aircraft geolocation estimate to dynamically adapt their modulation parameters and transmission beampattern in an effort to provide a high-data-rate secure ATG communication link. Additionally, we develop a hardware prototype that is highly accurate in estimating AOA data and facilitating TDOA and FDOA extraction associated with the received ADS-B signal. This hardware setup for the ADS-B-based ATG system is analytically established and validated with commercially available universal software-defined radio peripheral units. This hardware setup displays 1.5° AOA estimation accuracy, whereas the simulated geolocation accuracy is approximately 30 m over 100 nautical miles for a typical aircraft trajectory. The adaptive modulation and beamforming approach assisted by the proposed GDOP-minimization-based multilateration strategy achieves significant enhancement in throughput and reduction in packet error rate.

**3) Radar error calculation and correction system based on ads-b and business intelligent tools**

**AUTHORS:** J. A. F. Zuluaga, J. F. V. Bonilla, J. D. O. Pabon, and C. M. S. Rios

With the growth of air transport, the air traffic control needs to enforce the Communication navigation surveillance air traffic management (CNS-ATM) because this is the back bone of the air operation in any country. This system has the responsibility of guaranteeing air safety and management of the national air space (NAS) that nowadays needs to increase the flight density to respond to the demand. To accomplish this, new technologies like air dependent surveillance broadcast (ADS-B) have been used to increase the accuracy and time response of data air surveillance sensor integration of sensor location and the reliability of ATM system. CNS-ATM system for surveillance and control of aircrafts have been mainly used in primary and secondary radars to calculate the aircraft position through signal delay or time difference between transponder pulses. The accuracy of each sensor depends on internal and external factors such as frequency, power, target distance, noise, maintenance, and others. When an aerodyne is detected by multiple sensors, it could create a multiple track in a geographic and temporal space where the aircraft will be possibly flying. This space depends of radar update time, aerodyne speed, and the accuracy of each sensor, and it is difficult to know where the aircraft really is. This work proposes a technique based on ADS-B for making an error calculation of each sensor in a fusion system, using business intelligence techniques for understanding the error condition of each sensor in a geographical area. Based on results, we propose a technique that could make an error correction to avoid phase shifts between sensors. The information of this data study was used for statistical calculation values such as variance and standard deviation. For fusion accuracy improvement, three steps have been proposed in this research. First, the use of the radar error by region and statistical values by calculating the Kalman filters for each sensor to reduce the internal error of the radar. Second, the bias measured against ADS-B signal, used like a parameter to calculate radar bias correction that could be applied as a feedback input in a homogenization signal process or tracking process to reduce sensor bias in a recurrent process. Third, the use of Kalman prediction characteristic to replace missing points in a trajectory calculation. This technique was implemented by Colombian system to reduce error and bias sensor and a user's quality perception in a radar tracking and fusion track system in a surveillance network. In this process, it was found that it is possible to use it by a repetitive error measured ADS-B track like a reference track to calculate the error and in this way, it could be possible to reduce the uncertainty about the aircraft position. On the other hand, the use of data analysis process based on business intelligent tools allows us to easier understand the radar error behavior. Both methodology and results will be described here.

**4) Supervised neural network with multilevel input layers for predicting of air traffic delays**

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Air delay is a problem in most airports around the world, resulting in increased costs for airlines and discomfort for passengers. Air Traffic Flow Management (ATFM) programs were implemented with the main objective to reduce the delay levels in the whole air transportation sector. The question is to find a suitable way to predict possible delay scenarios to better apply ATFM measures. The present work seeks to enrich the academic literature on the subject and aims to present the application of Artificial Neural Networks (ANN) to a prediction model of delays in the air route between São Paulo (Congonhas) - Rio de Janeiro (Santos Dumont). The configuration of ANN exerts a great influence on its predictive power. To better adjust the parameters of the proposed ANN and for the hyperparameterization of the network to occur, the Random Search technique is used. By using the recall, precision and Fscore metrics in the performance measurement, the prediction results show the satisfactory in the case study.

**5) A statistical approach to predict flight delay using gradient boosted decision tree**

**AUTHORS:** S. Manna, S. Biswas, R. Kundu, S. Rakshit, P. Gupta, and S. Barman

Supervised machine learning algorithms have been used extensively in different domains of machine learning like pattern recognition, data mining and machine translation. Similarly, there has been several attempts to apply the various supervised or unsupervised machine learning algorithms to the analysis of air traffic data. However, no attempts have been made to apply Gradient Boosted Decision Tree, one of the famous machine learning tools to analyse those air traffic data. This paper investigates the effectiveness of this successful paradigm in the air traffic delay prediction tasks. By combining this regression model based on the machine learning paradigm, an accurate and sturdy prediction model has been built which enables an elaborated analysis of the patterns in air traffic delays. Gradient Boosted Decision Tree has shown a great accuracy in modeling sequential data. With the help of this model, day-to-day sequences of the departure and arrival flight delays of an individual airport can be predicted efficiently. In this paper, the model has been implemented on the Passenger Flight on-time Performance data taken from U.S. Department of Transportation to predict the arrival and departure delays in flights. It shows better accuracy as compared to other methods.