SHIRATECH
KNOWTION

Air Traffic Control

Algorithms for localization and tracking of civil aircraft
(Surveillance Data Processing System)

Project Goal

Air traffic control relies on a continuously updated Air Situation Picture that provides essential information such as aircraft type, flight number, position, and speed for effective decision-making. To achieve this, a Surveillance Data Processing System (SDPS) combines data from multiple radar stations to generate tracks for each aircraft. This project aimed to develop a highly accurate and reliable algorithm for the SDPS, capable of processing diverse data and information to produce a precise Air Situation Picture. The resulting algorithm was seamlessly integrated as a software module into an existing SDPS, meeting stringent reliability and quality standards.

The project's primary data processing challenge was in accommodating a wide range of radar technologies, including primary radar, Mark X and Mark XII secondary radar standards, Automatic Dependent Surveillance - Broadcast (ADS-B), and Wide Area Multilateration (WAM). Each radar technology presented distinct measurement models, interference properties, error patterns, and measurement rates. Real-time processing and merging of data from these diverse radar sources were essential for generating a comprehensive and accurate Air Situation Picture. The algorithm's software implementation had to balance efficiency, precision, and reliability to calculate tracks effectively. Additionally, ensuring high precision and reliability under all circumstances, including significant interference, posed another significant challenge.

Overcoming these challenges required the algorithms to autonomously identify and compensate for incorrect measurements, such as reflections, radar interference, and erroneous radar settings. By doing so, these algorithms could reliably provide a high-quality depiction of the air situation, including all moving objects.

Primary and Secondary Radar
(below and above)

Primary and Secondary Radar:
A primary radar uses the radar principle exclusively and directly, i.e. it analyzes the immediate (passive) echoes of the previously transmitted impulses and derives the distance to the object.

Secondary radar, on the other hand, works with active, cooperative objects and derives additional information from a data signal. In practice, a combination of primary and secon-dary radar is often used.

Procedure & Solution

We developed and optimized algorithms for data association and track updates, surpassing existing research and technology.

Initially, we focused on developing an algorithm to handle data association challenges. This algorithm efficiently assigns radar measurements, even in the presence of interference, to their corresponding aircraft. Additionally, we worked on an algorithm for track updates in a 3D environment. This algorithm optimally calculates the position and speed of aircraft while also updating and processing other variables transmitted by the aircraft, such as mode C and mode S.

To ensure algorithm effectiveness, we utilized a rapid prototyping environment for development, evaluation, and optimization. Implementation followed the V-Model and adhered to quality standards (EUROCAE ED153) and specific coding rules in C++. Through testing was integral, including comprehensive unit tests, partially automated tests with real data, and a simulation tool for testing with simulated data.

Results & Benefits

Internal representation in a global coordinate system for worldwide tracking

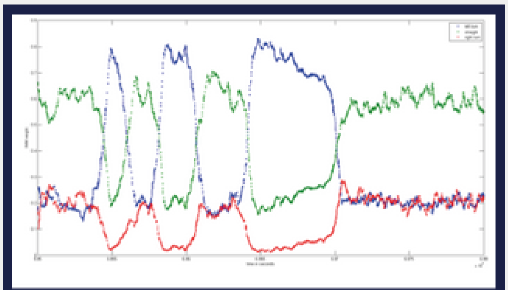
Detection of flight maneuvers, such as climbing & descending or turning maneuvers

Automatic detection and compensation of outliers, disturbances and reflections

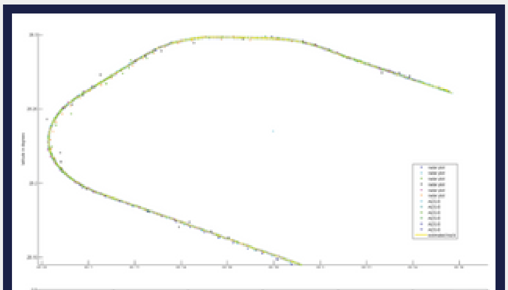
Redundant system to instantly take over data processing in case of failures

Monitoring of all radar stations for automatic shutdown of faulty systems

Very precise and reliable position determination of the aircraft



Sensor Data



Detected Flight Trajectory

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