OSYRIS

Trajectory Predictor

Providing a reliable 4-dimensional (space and time) predicted trajectory is a pre-requisite for the introduction of any advanced ATC tool such as safety-net functions (medium term conflict alert, flight path monitoring, ...) and decision support tools (arrival manager, tactical load smoother, look-ahead display, ...). Most modern Flight Data Processing Systems (FDP) are based on a precise trajectory prediction as well.

The emerging trend is towards an integrated cluster of decision support tools all working with the same system trajectories. These system trajectories provide a consistent representation of the future traffic situation to all the tools.

In the same way such an integrated cluster could base alternative what-if scenarios consistently on corresponding sets of test trajectories.

The OSYRIS Trajectory Predictor provides accurate predicted trajectories based on flight plan information, ATC constraints, meteorological data, and a detailed aircraft performance model. Radar data or co-ordination messages like OLDI may be used to update the trajectory prediction and increase its precision as more information on the actual flight becomes available.

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Technical features of OSYRIS Trajectory Predictor

Input

A trajectory calculation is based on the following input data:

- Flight Plan data for the individual flights, containing route information as a list of waypoints and A/C type.
- Track data for each individual flight, at least current position and altitude. Speed, heading, and rate of climb/descent might be calculated internally if not available.
- Meteorological data, wind fields are most important for accuracy.
- Configuration including airspace data, standard routes from regional airports nearby the destination airport.
- Speed and altitude constraints at waypoints, e.g. standard handover conditions at coordination points or altitude restrictions.

Output

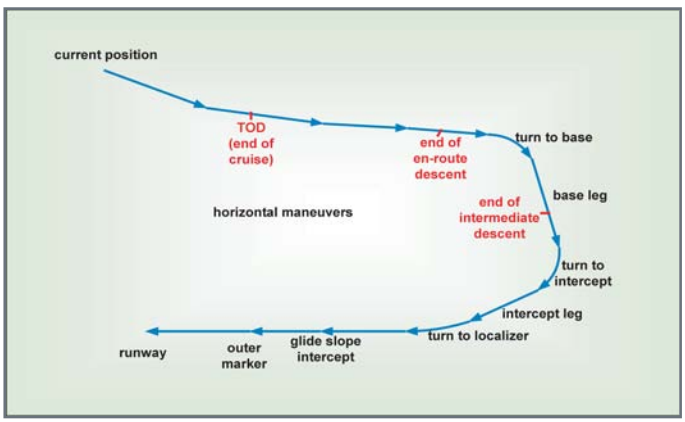
The output of OSYRIS Trajectory Predictor can be summarized in three groups:

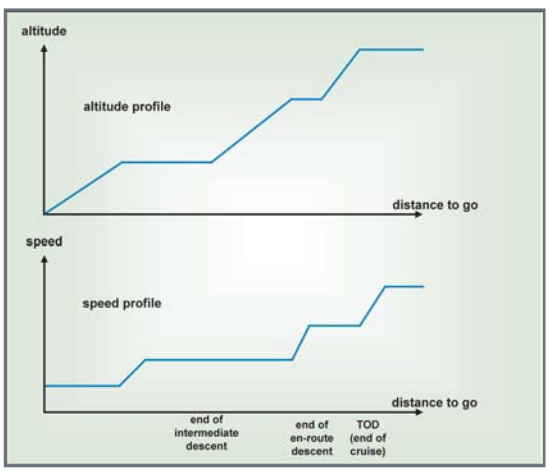
- Trajectories including a list of points that are passed (either named way points, pure geographical points, or specific calculation points like Top of Climb (TOC) or Top of Descent (TOD). For each trajectory point the whole flight state (altitude, speed, heading, time) is defined.
- Notifications whether the passage of waypoints is detected by evaluating the radar data, comparing it to the planned route, and using point specific configurable geometric criteria. These notifications can be requested for each flight individually.
- Administration messages to request radar data for specific flights or distribute warnings. These warnings are generated if trajectories could not be calculated or deviations from the planned profile are detected.

Functions

OSYRIS Trajectory Predictor provides various functions, such as:

- Trajectory calculation with preferred, minimum clean, or maximum acceleration profile.
- Speed and Top of Descent advice generation.
- Flight profile calculation based on flight plan data
- Genertaion of sector crossing lists
- Request monitoring of waypoint passage
- Change on-line configuration (e.g. logging, ATC handover conditions)
- Support of What-If-Scenarios, a technical prerequisite for conflict resolution tools or graphical route editing
- Co-operation with an external Trajectory Predictor.





The basis for the trajectory prediction: horizontal maneuvers, altitude and speed profile (compare: "The way OSYRIS Trajectory Predictor works") shown for a trajectory that starts at the current position of a flight in cruise phase.

The way OSYRIS Trajectory Predictor works

Three simple steps evaluate the input data

Step 1: Processing of Input Data

- The current track position and the route information in the flight plan are used to predict the route of the flight which is described as a sequence of points to be followed.
- The track and flight plan data are used to determine boundary conditions (altitude, speed) at the first and the last point (and perhaps other special points) of the trajectory being calculated
- The current flight phase (starting / en-route / approaching) is determined based on route information and track data.
- For each flight a trajectory calculation with arbitrary route and constraint settings can be requested to support What-if scenarios.

Step 2: Construction of Flight Profiles

The altitude- and speed-profiles used for the trajectory prediction are constructed based on a pool of standard flight maneuvers like:

- a level flight with constant speed
- a climb or descent with constant Calibrated Air Speed (CAS) or constant Mach,
- an acceleration or deceleration at constant altitude.

The horizontal profile containing the route information is directly given by the route obtained during the preprocessing of input data.

Step 3: Trajectory Calculation

Evaluation of Flight Profiles

The flight maneuvers, that are described by the instructions in the profiles constructed in step 2, are modeled using the equations of motion given by the physical aircraft model and its performance parameters.

Detecting deviation from filed route for SAZ 463 (red: filed route; green: calculated trajectory with ETO specified points)

Technical details

Configuration

Configuration of the OSYRIS Trajectory Predictor is based on plain files (readable ASCII text files) that include the configuration parameters together with the corresponding documentation.
All configuration data are held in memory during runtime. Thus no performance overhead is produced due to data base access. The internal data structures of OSYRIS Trajectory Predictor are almost completely configurable. They are created dynamically based on configuration parameters and received on-line data.

Performance

On a standard workstation (e.g. HP C360 with HP-UX 10.20) OSYRIS Trajectory Predictor is able to calculate more than 130 trajectories per second with a prediction horizon (time/distance to go) of 15 minutes.

Integration

OSYRIS Trajectory Predictor is a stand-alone trajectory engine for seamless integration with third party ATC components. There are two main possibilities to integrated OSYRIS Trajectory Predictor:

- as a stand-alone component (single process or service) that communicates via
  - TCP/IP messages
  - XML messages
  - CORBA services
- as a library that may be linked directly into the foreseen application

Delivery

- OSYRIS Trajectory Predictor is a set of libraries and example applications for almost any common UNIX platform.
- The documentation includes operation, installation and programmer's manuals
- On-site support as well as training and maintenance are provided according to your needs.

Brent Crossfield (left), NAV CANADA's manager for Air Traffic Flow Management Systems, receives OSYRIS Trajectory Predictor from Barco's Dr. Harald Dierks (right).

Operational benefits

Precision

OSYRIS Trajectory Predictor uses an elaborated physical aircraft performance model to achieve very high precision in its trajectory prediction. Detailed analysis of recorded scenarios has shown an average deviation in the time estimates at waypoints of less than one minute.
OSYRIS Trajectory Predictor provides an interface to Eurocontrol's BADA model. This BADA model specifies operational performance parameters and operating procedure data for more than 80 unique aircraft types. In addition, over 100 other aircraft types are supported via functional equivalent performance parameters. The BADA model is maintained at the Eurocontrol Experimental Center (EEC) at Brétigny-sur-Orge, France. BADA contains technical data and information made available by The Boeing Company.

Advice Generation

In addition to the trajectory calculation and the corresponding arrival time prediction, OSYRIS Trajectory Predictor has the capability to generate speed advice for flights with fixed arrival times e.g. by the scheduling process of an arrival manager.
The trajectory engine obtains the speed advice by full featured trajectory calculations in which the standard speed profile is varied within the speed envelope of the given aircraft type.
Beside this specific advice calculation all internal results of the trajectory prediction, e.g. Top of Climb (TOC) or Top of Descent (TOD) can be used as helpful hints to the user.
For predictions that include the start phase (typically for short route flights around a major airport served by an arrival manager) the complete flight profile will be generated by OSYRIS Trajectory Predictor . The resulting total flight time may be used to define an optimum departure time for the given flight.

References

EUROCONTROL

Barco's arrival manager OSYRIS, including the Trajectory Predictor component has been integrated in EUROCONTROL's simulator system ESCAPE within the scope of the ERIS programme at EUROCONTROL's Experimental Center Brétigny. The system is used for pre-operational tests and validation at major airports.

Skyguide

Barco's OSYRIS Arrival Manager makes use of the Trajectory Predictor component. In this framework it is used within Skyguide's Computer Assisted approach and Landing Management System (CALM) that has been built by Orthogon for use at Zurich airport. CALM and thus OSYRIS Trajectory Predictor are operating successfully in Zurich since March 2001.

NAV CANADA

NAV CANADA, the private not-for-profit company that owns and operates the Canadian Civil Air Navigation Service, will use OSYRIS Trajectory Predictor as a major component of its new Sequencing And Scheduling System (SASS) which is being developed to improve the flight arrival sequencing and airport arrival capacity at Toronto Airport.

Lockheed Martin ATM

As the kernel of the arrival manager OSYRIS, Barco's OSYRIS Trajectory Predictor tool is an integral component of the SkyLine® system marketed worldwide by Lockheed Martin ATM.

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