

ABSTRACT

A fast vertical trajectory prediction method for Air Traffic
Management, and relevant ATM system

The invention concerns a method for the prediction of aircrafts vertical trajectory, in particular for Air Traffic Management, comprising the following flight calculation modules: Take-off; Climb; Cruise; Descent; and Landing, corresponding to the relevant flight phases, characterised in that:

- the calculation of the predicted aircraft trajectory is effected by using the following TEM equations:

$$\begin{aligned}
 VRCD &= \frac{(T - D)}{mg} TAS \cdot ESF\{M\} \\
 m \frac{dTAS}{dt} &= (T - D) - mg \frac{VRCD}{TAS} = (T - D)(1 - ESF\{M\}) \\
 \dot{m} &= -f \\
 \frac{dh}{dt} &= TAS \sin \gamma
 \end{aligned}$$

Solved for $VRCD$, TAS , m ; $VRCD$ is the vertical rate of climb or descent; TAS is the true air speed, ESF is the energy share factor, T is the thrust and D the drag, m the mass of the aircraft modeled as point-mass, $\{M\}$ is the Mach number depending on TAS and temperature and altitude, g is the gravity acceleration, and f is the fuel flow, and γ is the flight path angle;

- the calculation of the predicted aircraft trajectory for Cruise phase, wherein only the mass is varying, is performed by using the following analytical solution to said TEM equations:

$$t - t_0 = \frac{dist}{TAS} = \sqrt{\frac{1}{k_9 \cdot k_{10}}} \left[\tan^{-1} \left(\sqrt{\frac{k_{10}}{k_9}} \cdot m_{fin} \right) - \tan^{-1} \left(\sqrt{\frac{k_{10}}{k_9}} \cdot m_m \right) \right]$$

Solved for the mass m_{fin} at the end of the cruise phase as a function of the initial mass m_{in} , and wherein t is the elapsed flight time, k_9 and k_{10} are constant terms pre-defined according to the individual aircraft.

The invention further concerns a system System for Air Traffic Management, which uses the method according to the invention.

Fig. 1