Simulation of aircraft navigation L410 UVP - E20

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Abstract

The article describes the basics of navigation procedures for air transport. The specialization is characterized for defining the application for L 410 aircraft. The modeling is based on the classical algorithm design of the given problem.

***Keywords* -** simulation, modeling, navigation, L410

I. INTRODUCTION

Navigation is a generic name for procedures whereby you can locate your location (or the position of another moving object) anywhere on the globe, the sea, or generally in some space (even more generally in a situation) and find the path that is most appropriate to the chosen criteria (for example, the fastest, the shortest, etc.).

Aerial navigation is the doctrine of aircraft management on scheduled routes and the determination of geographic positions in flight.

Pilots determine the geographic location of their aircraft in flight in different ways and use different navigation methods to guide planes on scheduled routes. Pilots of aircraft use only some of the following methods with respect to aircraft equipment:

- Comparative orientation,
- Navigation by calculation,
- Radionavigation,
- Combining navigation methods.

Flight visibility (commonly referred to as “VFR flight”) is a way of managing a flight allowing flight in compliant meteorological conditions. The pilot manages and navigates the airplane in the flight from the cabin view.

Instrument Flight (commonly referred to as “IFR Flight”) is a flight management mode even when weather conditions are poor when VFR is not available. The pilot controls such an aircraft on the basis of the instrument data, not the cabin view.

II. BASIC INPUT PARAMETER

When flying the plane certain courses (HDG) and true airspeed (TAS) affects wind (W/V) direction of flight (you know him on the left or right side) and speed of flight to Earth (slowing or accelerating). At a certain direction of the wind to the aircraft course (in the direction of the wind or upstream) of the flight, the aircraft is borne from the set rate and when the wind direction is perpendicular to the left or right side of the aircraft, there is no deceleration or acceleration of the aircraft.
Air angle between the vector (HDG/TAS) and a position that is outlined Ground vector (actual track TK/GS) is the angle of drift (drift).

Angle of drift (drift) is:

- The right (Starboard) - plane flies to the right of the specified routing,
- Left (Portboard) - plane flies to the left from the prescribed route.

Size drift angle depends on the size and direction with respect to the course (HDG) of the aircraft. At the end of Air vector we connect the direction and speed of wind (Wind vector). Combining Air starting point and an end point of the vector Wind vector receive real track (Track-TK). From the size of the vector obtained Ground line speed (GS) and the angle of drift.
If there is two of the above three vectors (Air, Ground, Wind vector) can be determined, third, either graphically - Fig. 1 or calculation (the classic solution of the triangle) and on the navigation ruler.

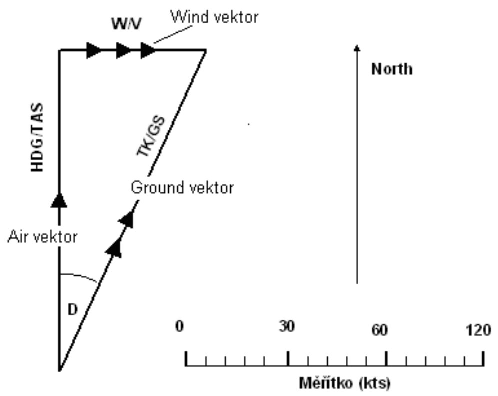


Fig. 1 Graphical vector triangle solution

It follows that the vector triangle has 6 elements:

- Course Plane (Heading - HDG),
- True airspeed (True Air Speed - TAS),
- Wind (Wind Direction - W),
- Speed (Wind Speed - V),
- The track, which plane flies against the earth´s surface TR (Track - TK),
- Line speed at which the plane flies toward the earth´s surface TR (Ground Speed - GS).
  If we know four of them, we can calculate the missing 2.
- Detecting the position of aircraft - There are three basic ways of positioning the aircraft to ground:

  - o Visually detect the location - mainly in VFR flights,
  - o Using radio navigation aids including radar and satellite navigation systems,
  - o Use astronavigation that but in aviation used very rarely.

- Radio focus - *Focusing via the terrestrial VHF Direction Finder (VDF)* - When an aircraft transmits a radio signal (radio communication), field sight is able to determine the direction from which the signal comes and the focus after adjusting the position of the pilot complains goniometer.

  As the radio waves propagate along ortodroma, can not be drawn in the right direction Mercator's map, but must be corrected by the conversion angle. Lambert projection for this correction need not be performed.

- Speed Measurement - One of the most important parameters for navigation is speed.

  The atmosphere in terms of the pressure and density of the heterogeneous, both values decrease with height. The air is compressible, which affects the speedometer reading. The speed of measurement is based on the principle of measuring dynamic pressure Pitot tube. The measured dynamic pressure is changed with the speed of the aircraft, first, second, with the change in air density. Changing the density of the air is the air temperature and the amount in which the measured speed. With increasing height, the air density decreases. So as to maintain the aerodynamic characteristics of an aircraft in the air it has a lower density from the ambient air to move faster mass (preserve the buoyancy, controllability, etc.). Speedometer indicates the speed of the aircraft itself, such as the plane flew to the ground. We distinguish several kinds of speeds:

  - o indicated airspeed - Indicated Air Speed (IAS),
  - o Fixed rate - Rectified Air Speed (RAS), or Calibrated Air Speed (CAS),
  - o True airspeed - True Air Speed (TAS),
  - o Mach number - Mach Number (M).

- Measurement height above ground - As the Earth´s surface, in addition to the seas and oceans rugged and air pressure field varies in time and space, there is always a relative altimeter and depend on the pressure scale pressure measurement device. The actual amount of the Earth's surface to an accuracy meter is able to directly indicate only radio altimeter. Barometric altimeter indicates only the amount corresponding to the pressure level in terms of the International Standard Atmosphere - MSA (ISA), and only when certain settings. The height is measured by measuring the static pressure, which corresponds to the aircraft.

  Currently, the vast majority of countries around the world used the altimeter setting QNH. The definition says that it is the air pressure converted to sea level, so called stationary pressure to which is added pressure that will draw the air mass fictional column about the amount of which is identical with the altitude measuring points. In practice, this means that the pressure set on the scale of the device shown altimeter instantaneous height above mean sea level (Mean Sea Level - MSL). Determination of the height above the ground then lies in the deduction of the elevation from the meter reading. To navigate this means first of all finding the highlights of obstacles around the routes, ie. hills, towers, antennas, chimneys and more.

When climbing to higher levels altimeter is reset to standard pressure, STD (resp. QNE). It´s pressure by MSA for the amount of 0 m, which is 1013,25 hPa. The altitude at which the adjustment altitudes is called the transition altitude. It is set for each airport, and is listed in the AIP.

III. SIMULATION MODELS

The equations that define the navigation model:

- calculate the flight path,
- calculate the orientation Radio compasses,
- simulation of track crossing waypoint,
- calculating aircraft deviation from ILS glide path.

Figures 2 and 3 illustrate the flowcharts for simulating aircraft navigation options. The modeling of the aircraft's navigation features has to be solved depending on the type of the aircraft - its aerodynamic parameters, the engine units used (turboplant, jet), on the avionics equipment.

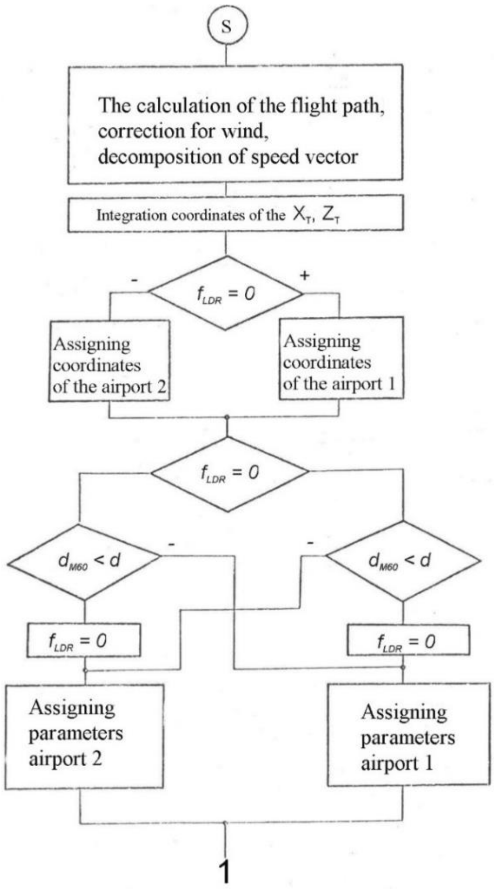
The proposed flowchart is based on flight parameters of L410 UVP.

Fig. 4 shows an example of a L410 UVP aircraft dashboard solution that is used in a simulator that allows pilot training for a given aircraft type. This solution is realized from the point of view of ergonomics and maintaining the closest approach to the reality of the given type of aircraft.

Fig. 5 and 6 show examples of environmental visualization solutions for a given type of training (VFR, IFR) when used in simulated environments. The solution is to maintain the most realistic conditions for flight operations while training pilots.

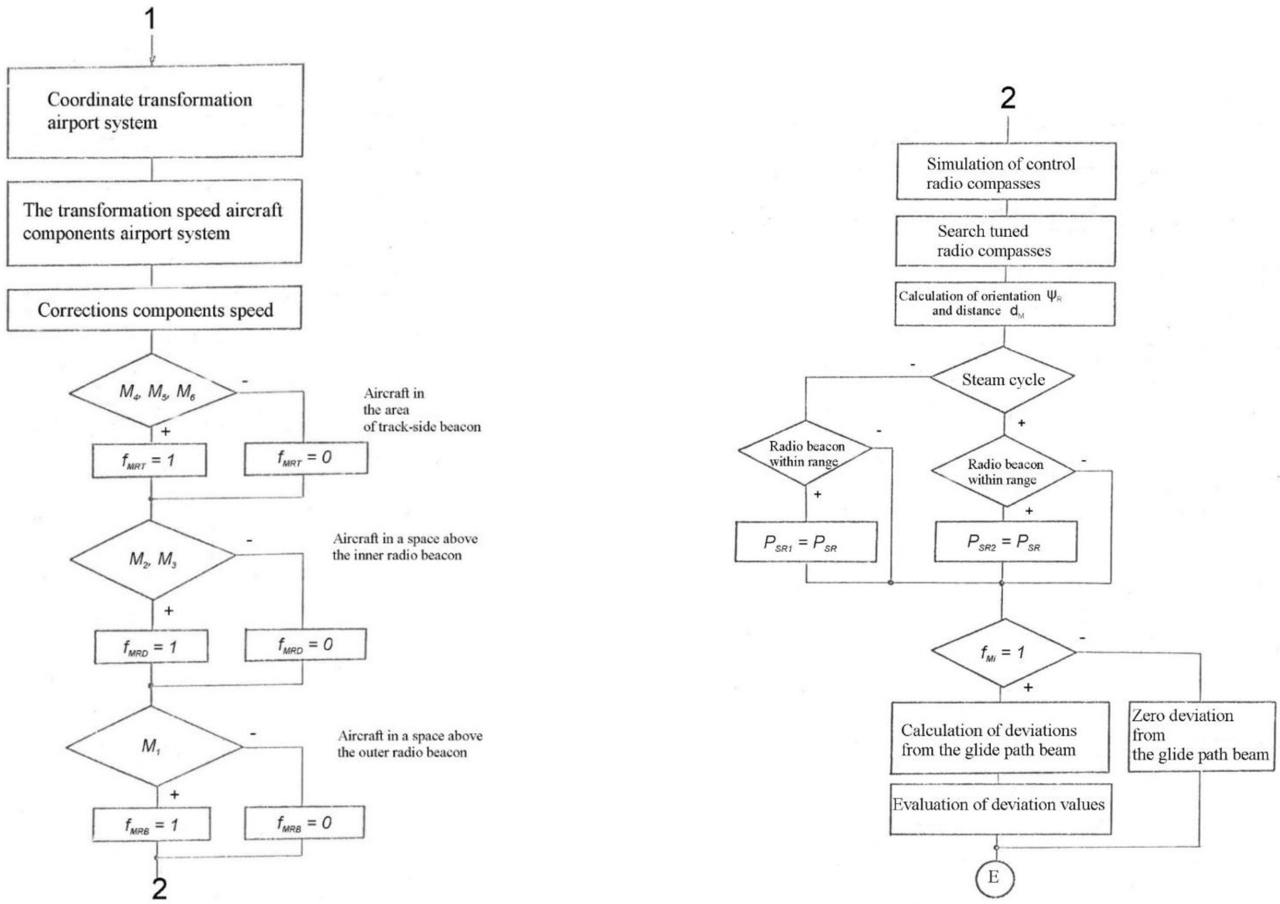
ACKNOWLEDGEMENTS

The article was prepared within the project TA04031376 „Research/development training methodology aerospace specialists L410UVP-E20“. This project is supported by Technology Agency Czech Republic.



X_T, Z_T - Terminal coordinates, d_{M60}- Distance of the aerodrome boundary,

Fig. 2 Block diagram of simulation of aircraft navigation systems - part 1



M – beacon, marker, f_{MRT}*,* f_{MRD}*,* f_{MRB} *– signal beacons (markers),* D_M *– distance from the runway threshold,* Ψ_R *– focusing angle,* P_{SR} *– focus of the radio compass*

Fig. 3 Block diagram of simulation of aircraft navigation systems - part 2

1-Artificial Horizon, 2-HSI, 3-Speedometer, 4-RMI, 5-Height Driver for Autopilot, 6-Altimeter, 7-Vertical Speed Indicator, 9-DME indicator, 10-Hour

Fig. 4 Overall view of device layout - left side of the dashboard [6]

Fig. 5 Visualization settings for VFR flying [6]

Fig. 6 Visualization settings for IFR flying [6]

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