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THE METHODS OF EVALUATION OF THE AIRCRAFT LOCATION USING MULTILATERATION SURVEILLANCE SYSTEM DATA

Multilateration, also known as hyperbolic positioning, is the process of locating an object by accurately computing the time difference of arrival (TDOA) of a signal emitted from the object to three or more receivers. It also refers to the case of locating a receiver by measuring the TDOA of a signal transmitted from three or more synchronized transmitters.

Multilateration offers air navigation service providers (ANSPs) the possibility of providing a surveillance service at a potentially much lower cost, greater reliability and higher levels of accuracy than conventional secondary surveillance radar. Multilateration requires no additional avionics equipment, as it uses replies from Mode A, C and S transponders, as well as automatic dependent surveillance-broadcast (ADS-B) transponders.

The applications of Multilateration system in the air traffic control are: airport surface surveillance applications for ground and aerodrome control; area and approach surveillance in airspace with radar coverage; area and approach surveillance in airspace without radar coverage; air traffic management (ATM) system technical improvements including sampling of reduced vertical separation minimum (RVSM) performance and sampling ADS-B performance.

Mathematically speaking, the TDOA between two receivers corresponds with a hyperboloid (in 3D) on which the aircraft is located. When four receivers detect the aircraft's signal, it is possible to estimate the 3D-position of the aircraft by calculating the intersection of the resulting hyperbolas. When only three receivers are available, a 3D-position cannot be estimated directly, but if the target altitude is known from another source (e.g. from Mode C) then the target position can be calculated. This is usually referred to as a 2D solution.

Estimation of the aircraft location consists in solving the systems of nonlinear parabolic equations, which establish a connection between the time difference of arrival of a signal from the aircraft and the coordinates of the location of the aircraft. Using advanced computer processing techniques, these individual time differences allow an aircraft's position to be precisely calculated.

In the performed research several methods of solution the nonlinear equations were investigated. Some numerical methods such as least-squares method, Newton-Raphson methods were considered to solve the problem that lies in the linearization of a system of equations. The analytical method was also investigated.

Comparison characteristic of the accuracy estimation of aircraft location was made using the computer modeling. The impact of geometry factor on the accuracy of the system was investigated. The influence of errors in the measurement of the time of arrival of pulses was modeled. The obtained results are represented in graphical form.

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