UDC 004.932.721 (043.2)

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AUTOMATIC SURVEY-COMPARATIVE NAVIGATIONAL

Today appear one of most perspective survey-comparative methods of navigation. The basic element of such systems is a man which executes an eventual position-fix aircraft. Automatic navigationals on the basis of survey-comparative methods of navigation appear perspective for application in pilotage-navigation complexes of modern air ships

One of the oldest methods of navigation - survey-comparative - has the special value for modern aircrafts. The modern survey-comparative systems provide the integral recreation of complete totality of navigation data, co-operate with side digital calculable machines, correct other sensors of navigation information and appear the major informative link of the system "an aircraft is a crew" [1].

Without regard to the variety of technical realization, essence of survey-comparative methods of navigation consists in determination of location of air ship by comparison of the locality represented on a map or memory of calculable machine, with her actual kind looked after by means of side survey devices (televisional sights, radiolocation systems and other) or by sight. If the images of locality gather on a map and looked after her kind, then the location of object is considered identified, and coordinates of him are defined.

Advantages of survey-comparative methods of navigation are:

- high authenticity and exactness of measuring;
- absence of story errors;
- possibility to conduct measuring in any districts of Earth and circumterrestrial space;
- high level of informative surplus of measuring;
- possibility of the use of the manned(visual orientation) and automated facilities of measuring.

However, there are defects and limitations in the input of survey-comparative methods. Measuring is possible only at visibility of terrene or reference-points. Influence of obstacles - cloudiness, fogs, insufficient luminosity - can substantially bring down efficiency of survey-comparative navigation. In addition, at flights above locality without reference-points (seas, deserts et cetera) this type of navigation needs the presence of the additional brightly-expressed artificial reference-points with a well-known location.

Navigation maintenance of survey-comparative methods of measuring is determined by the type of reference-points and their amount. Comparison of the physical parameters of standard object(area, geometrical forms, spectrum of radiation and other), stopped up in memory of the system, comes in the referencepoint systems true, with the measureable parameters of the real object. A few reference-points are simultaneously used in the reference-point systems. In memory of such systems information is kept not only about the physical parameters of separate reference-points but also coordinates of their mutual position. Advantage of the reference-point systems is a large volume of navigation information, less dependence on the loss of part of information about reference-points and influence of obstacles. However for realization of such systems it is necessary to have the powerful electronic computing engineering.

Realization of survey-comparative methods of navigation is taken to the performance of objective of recognition of reference-points (ground or astronomic) to comparing of them to the standard reference-points the site of that is known, and in relation to these reference-points to set the coordinates of aircraft.

The modern stage of development of scientific and technical progress determines automatic recognition of objects one of priority directions of researches for creation and improvement of automatic survey-comparative navigationals. Much attention in the modern aviation systems the Russian scientists spare the problems of technical sight [2], what examine possibilities of application of the automatic systems of recognition of surface objects for the facilitation of work of crew in the mode of event on landing in difficult terms. In particular the Moscow state scientifically-research institute of the aviation systems and Ryazan state radiotechnical university examine possibilities of application of various types of sensors of a priori information for the systems of technical sight. In particular the Moscow state scientifically-research institute of the aviation systems and Ryazan state radiotechnical university examine possibilities of application of various types of sensors of a priori information for the systems of technical sight.

Depending on physical nature of the perceived signals the sensors of the survey-comparative systems of navigation are divided by: optical (infra-red (thermal imaging), televisional (brightness), laser), radiation and radiotechnical.

Optical sensors (infra-red and televisional) mainly passive type. Televisional (brightness) sensors distinguish signs on the basis of difference of brightness between an object and environment. The lacks of the televisional systems of navigation is technical complication, large sensitiveness to the obstacles and limitation in visibility of reference-points. The televisional system can normally work only at optical visibility of reference-points and at their sufficient illumination.

Infra-red (thermal imaging) sensors distinguish signs on the basis of overfall of thermal (infra-red) contrast between an object and surrounding background. The infrared of energy answers lengths of waves of 700...300000 nm and it is located in part of spectrum, invisible for a human eye. Infra-red devices have a high inertance and limit nature for distances of action. Fog or rain limit their effective application, and the erroneous source of radiations can cause considerable deviation of aircraft from the trajectory of motion.

Radiation sensors have an elaborate design and technical realization, that is why as sensors of the survey-comparative systems not examined.

In radiolocation sensors extraction of features is executed on the basis of treatment of the electromagnetic signals removed from objects. Radiolocation sensors are active or semiactive type. For a radio-location radio waves are used in the range of lengths of waves of order a 1...3 cm. Exactly for such radio waves the atmosphere of Earth is fully transparent. Anymore the shortwaves are notedly taken in by the molecules of oxygen and aquatic vapors. The use of long-wave emitters requires a presence onboard of aerials of largenesses.

With the use of laser sensors possible creation of the laser location systems that distinguish signs on the basis of construction of two-dimensional (2D) and three-dimensional (3D) images of objects [3]. Laser sensors can be active or semiactive type.

All enumerated types of sensors differ in information got after their help content that in future can be used for automatic recognition of objects, complication of receipt of information, that depends on the volume of calculations, amount and complication of algorithms, technical account of devices the operationability of the use of the got information. Quality description of sensors is represented on Fig. 1 [4].

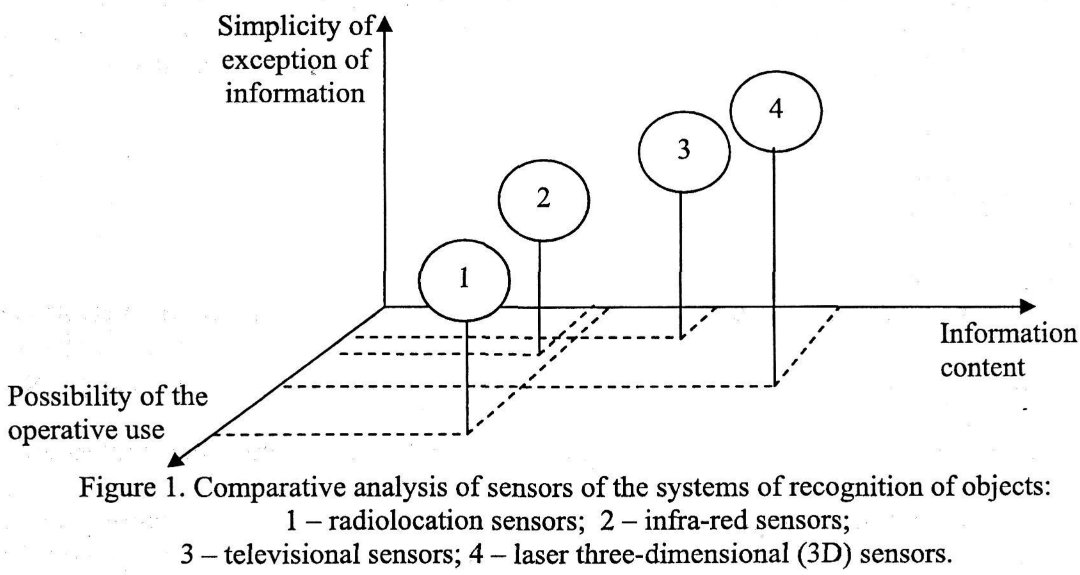

Figure 1. Comparative analysis of sensors of the systems of recognition of objects:
1 – radiolocation sensors; 2 – infra-red sensors;
3 – televisional sensors; 4 – laser three-dimensional (3D) sensors.

The comparative analysis of sensors testifies that maximal information content can be got from televisional and three-dimensional laser sensors, but they have the difficult system of exception of information. Information is most simply withdrawn by infra-red sensors, but taking into account influence of the enumerated factors, this information it can be not enough for correct recognition. Radiolocation sensors have the maximal opportunity of realization, so as allow to find out objects and distinguish their signs on distances in a few ten of kilometres, but the got information it can be not enough for automatic recognition. The analysis of achievements in area of three-dimensional picture generation and creation on their base of automatic identification devices shows that most perspective are the laser systems of three-dimensional picture generation [5].

For registration of three-dimensional (3D) images the active devices of reflection, LADAR behaves to that, - laser device of reflection of three-dimensional space and three-dimensional form of object of supervision apply, as a rule [6]. By basic properties of LADAR, that promote efficiency of the optical systems of reflection, are:

- quality of a 3D image does not depend on the size of contrast that can equal a zero, and from the changes of base-line situation;
- a 3D image contains metrical information about a three-dimensional form and sizes of object of supervision that is basic signs at his recognition;
- possibility of work in the conditions of zero-zero, at subzero transparency of atmosphere and at influence of light obstacles;
- long-range enough of action.

For a three-dimensional picture of objects and their further recognition generation it is necessary to define signs that can be withdrawn on the basis of three-dimensional images and that characterize recognizable objects most full. The analysis of signs of surface objects is conducted on the criterion of utility shows that the most informing signs that does not depend on the type of sensor are geometrical signs (size, area, configuration, volume et cetera). The use is for extraction of geometrical features of laser sensors, that form the three-dimensional images of objects, are most expedient from the point of view of simplicity of receipt of maximal information content for the minimum interval of time.

Principle of three-dimensional picture generation consists in the following (Fig. 2). Measuring of distance (R) in the laser systems (taking into account velocity of light of $c=3\cdot10^8$ m/s) is fixed sometimes (t) passing of radiation from a transmitter to the receiving system of

$$t = 2R / c.$$

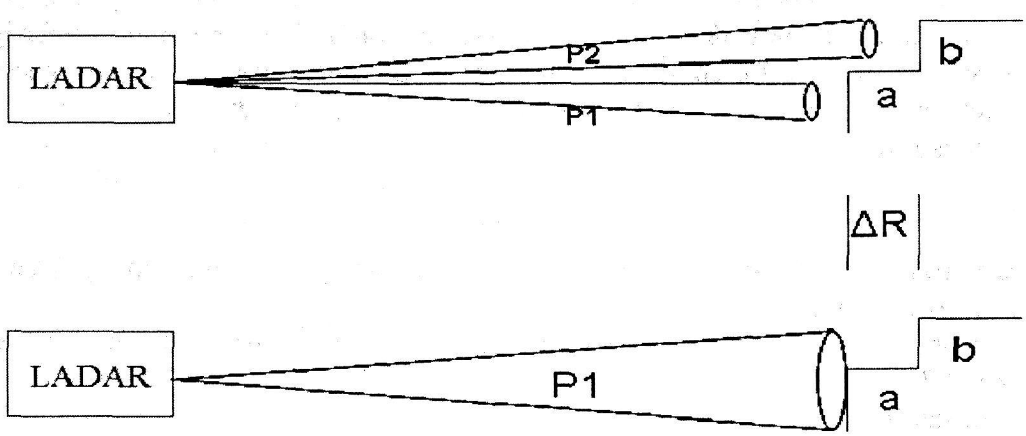

Figure 2. Principle of three-dimensional picture generation by LADAR.

If an object has a spatial form distance to his elements of form (a; b) will be different (R_1 and R_2) and will be fixed by the different elements of matrix transceiver of radiation (P1 and P2 accordingly). Therefore at the irradiation of object by the impulses of nanosecond duration the degree of his spatialness can be characterized the difference of distances to every element of form of

$$\Delta R = (R_1 - R_2).$$

The time-of-flight of radiation for every element of form will consist of time (t) that characterizes minimum distance to the object (R_1) is distance to the object, and sentinel interval (τ) that characterizes distance (ΔR) between the elements of form of object ($a;\ b$) – id est him spatial constituent:

$$t + \tau = 2(R + \Delta R)/c,$$

where $\tau = 2\Delta R/c$.

Thus fixing every element of transceiver of radiation the sentinel interval of ладар gives an opportunity to get three-dimensional digital representation of earth surface with the reference-points placed on her. In future a survey-comparative navigational will compare the got image to standard and in case of coincidence will allow with probability close 90% to define the coordinates of air ship.

There are some varieties of reference-point navigationals. It the cross-correlation-extreme navigational of robot of that is based on the use of cross-correlation connections between realization of casual functions for determination of navigation parameters of surface objects(coordinates, sizes, orientation) by means of searching for of extremum of cross-correlation function. But integral survey-comparative complex systems of robot of that based on establishment onboard simultaneously a few survey-comparative systems that perceive the pictures of locality and surrounding space sensors with different physical principles of treatment of information. The integral systems of reflection produce to the crew navigation information from the enormous amount of sensors, synthesize on-line, command, control and other data necessary for implementation of tasks to the navigation.

Conclusions

Realization of automatic survey-comparative navigationals is taken to the performance of objective of recognition of surface reference-points, to comparing of them to the standard reference-points the site of that is known, and in relation to these reference-points to set the coordinates of aircraft.

Recognition of surface objects in such systems most expediently can be realized by 3D sensors on the basis of LADAR, that forms digital three-dimensional representation of earth surface. Got a 3D image can be used for the automatic exposure of surface reference-points and determination of them geometrical signs necessary for the job of automatic recognition processing.

Automatic navigationals on the basis of survey-comparative methods of navigation are autonomous and perspective for application on modern air ships. Basic advantages of such systems are high exactness of measuring, absence of story errors, possibility of the use of the automated facilities of measuring.

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