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COMPUTER - AIDED SYSTEM OF NAVIGATION SYSTEMS ACCESSIBILITY FORECASTING

The working out of computer – aided system of navigation systems accessibility forecasting for the purpose of increase of aircrafts' flights safety, which use aids of satellite navigation.

Posing the Problem

Satellite navigation within the next few years is going to transform into the only aids of aeronavigation for the civil and military aviation service in countries-participants of European conference of civil aviation and the USA, hence, nearly in the whole world. Material resources of the transition to the satellite aeronavigation are the global GPS and GLONASS satellite systems, up-to-date created systems of wide area addition WAAS (USA), EGNOS (European Union), MSAS (Japan), GAGAN (India), the system of local addition LAAS (USA), ground regional system of functional addition GRAS, European constellation of navigation satellites GALILEO, local (aerodrome) control-corrective stations made for the ensuring of precise arrangements of the landing up to the third category of meteorological minimum. The most powerful stimulus of this process is the possibility of aircrafts' flights on arbitrary routes, substantial reduction of the ground navigational equipment cost, as well as the opening of satellite navigation aids market, and it is valued at more than 600 milliard dollars within the next few years [1].

Under conditions of intensive satellite navigation aids application into the navigational practice the problem of increase of aircrafts' flights safety gets extraordinarily topical. It refers to the aircrafts which are rigged with satellite radio navigation equipment. One of the effective aids of increase of aircrafts' flights safety and the decrease of aviation occurrences risk is method of computation of satellite navigation systems accessibility by means of forecasting of their precise performances at any leg of the route using information received from navigational satellites exactly before the flight performance, and the information received while modelling scripts of sudden navigation satellites rejection, when the satellites are out of ground services control zone.

Analysis of Last Researches

At present there are no systems of computation of navigation systems accessibility in Ukraine. However, it is necessary to notice that ARINC Company (USA) officially distributes software product WSEM (version 3.6) created for the purpose of accessibility forecasting only GPS satellites. WSEM3.6 programme forecasts navigation satellites accessibility only for one fixed consumer position and does not ensure satellites accessibility forecasting for the objects, coordinates of which are constantly changing in time, for instance such as an aircraft. Thus, at present time there are no systems, which enable to forecast satellites accessibility forecasting in the course of the entire aircraft flight route.

Formulation of Article Aims

In the given article the computer – aided system of navigation systems accessibility forecasting is examined. The main objective of the given complex is increase of aircrafts' flights safety, which are rigged with satellite radio navigation equipment owing to effective forecasting of satellite radio navigation systems accessibility (SRNS) at any moment of time and in any point of the route.

The Main Material Statement

The most optimal way of realization of navigation satellites accessibility forecasting method is computer – aided forecasting system (CFS), which contains multichannel satellite navigational receiver, computational environment in the form of a computer and object-oriented software that works up navigational data received from satellites. The genuine component part of CFS is the software fulfilling data handling using special mechanisms. It handles data obtained by navigation receiver from satellites, and by means of computed geometric factors elaborates satellite navigation systems accessibility criteria in any point of the forecasted route of the aircraft flight [2, 3].

The main principles of CFS construction are modularity and transfer of functions of produce and formation of forecasted information in the computer. The modularity principle has separate, almost free-running constructions for the main functional devices which are connected either with the help of coaxial cable or a great number of wire communication lines which connect the ports of successive interface RS-232 or RS-422. The modularity principle assumes the use of compatible with the computer multichannel satellite navigation receiver in the form of an article, located in a separate unit. The modularity principle applies to the software that gives the possibility to update the software in case of its modernization need.

Multichannel satellite navigational receiver is one of the main functional elements of CFS. For the CFS as a supporting receiver on the first stage it is possible to be guided by more up-to-date GNSS- sensors of the state enterprise "Orizon- -Navigation» or GNSS receiver of the GG24 type produced by Magellan company (USA), which in case of need smoothly by means of module CFS structure can be substituted for more perfected ones.

CFS software is worked out taking into account data received from navigational receiver and transformed into corresponding format. For this purpose corresponding data converters are worked out effectiveness of which is confirmed by the previous modelling.

CFS consists of functional knots and elements given in pic. 1.

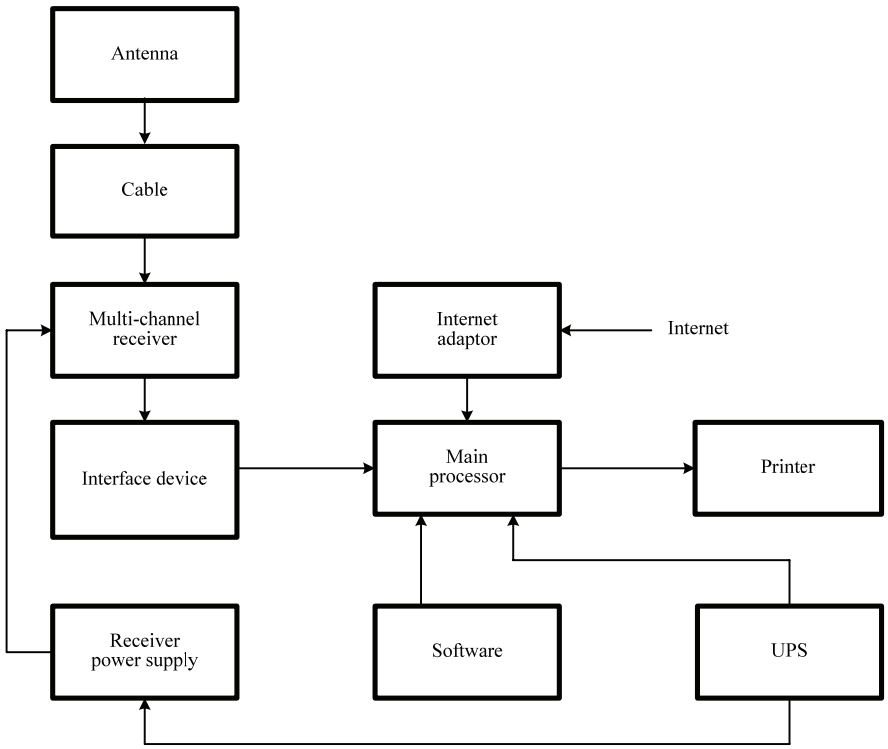

Fig.1. Structural scheme of CFS

To the antenna of antenna-feeder device (AFD) transmit the signals of navigational satellites GPS and GLONASS on frequencies L1. Through the unified cable navigational signals intense by the AFD amplifier, are directed to multichannel navigational receiver. After the processing by navigational receiver signals through the knot of joining with the computer in the form of marked information enter to the data handling device (DHD) and are preserved according to the proceedings in singled out folders of the computer. From Internet by means of joining device into the singled out DHD folders almanac data are registered. The almanacs are published by independent organizations. In DHD with the help of the software navigation data handling is produced. The data is received by multichannel receiver and there produces information on the satellite navigational systems accessibility. The produced information is represented on the paper carrier by a printer, and is recorded on a CD – disk (diskette) and is transmitted to the customer. CFS power supply (computer and navigational receiver) is realized through the uninterruptible power supply and power module of the navigational receiver.

The appearance of CFS model which is assembled from hardware-based means available in National Aviation University is given in pic. 2. The model consists of antenna with multi-radial suppression, basic station ProPak-G2, 12- channel navigational receivers-StarBox (NovaTel company equipment) and computer.

The model is assembled for the purpose of working through of CFS software.

Along with genuine software the model has the following technical performances:

Data receiving form GPS navigational satellites by 12 channels [2].

Data receiving from GLONASS navigational satellites (in the form of logical files by 12 channels) [3].

GPS almanac data receiving from Internet.

Data receiving of the aircraft route, formed with the help of specialized Jeppesen programme.

Data handling in correspondence with interface control GLONASS and GPS documents.

Evaluation of navigational satellites accessibility parameters and the aircraft route accessibility only through navigational of GPS satellite, only through navigational GLONASS satellites and through the common application of GPS and GLONASS satellites.

The time needed to accomplish an accessibility task does not exceed 2 minutes.

The time needed to load the navigational satellites data is within the limits of 1- 2 minutes under the condition of a «hot» start.

The time of solution and documentation of the task of the aircraft route accessibility and documentation of received data takes less than 10 minutes.

The time of sudden messages scripts modelling: one message per minute.

Fig.2. CFS outward

The genuine component of CFS is the software fulfilling data handlingusing special mechanisms. It handles data obtained by navigation receiver from satellites, and by means of computed geometric factors elaborates satellite navigation systems accessibility criteria in any point of the forecasted route of the aircraft flight.

The main CFS modules. The managing CFS programme fulfils the tasks of inquiry and formation of coming and outcoming data, procedures of data streams direct between navigational receiver, databases, specialized Jeppesen programme, Internet, software-based functions that take part in computation conducting and decisions, and the reflection of the decisions on the monitor or/and documentation.

The mathematical CFS server computes geometrical factors, visibility angles, orbit parameters, navigational satellites accessibility and the aircraft route accessibility.

CFS interface console reflects information on satellite navigation systems accessibility and the route of the aircraft flight accessibility in automatic and manual mode. Interface also

contains functions of reflection of the satellite visibility angles (azimuth, the place angle), «sorting» of navigation satellites accessibility according to the time and coordinates of the aircraft, filter for the sudden messages scripts modelling.

Jeppesen programme is made for formation of coordinate - temporal information on the aircraft route (where and when the aircraft is).

MySQL database is made for the preservation and organization of convenient access to the following data:

- data on aircraft routes, namely points coordinates and their titles, which are received with the help of Jeppesen programme;
- incoming data from navigational receivers that contain navigational satellites almanacs information;
- outcoming data on the computation of navigational satellites and the aircraft route accessibility.

The receiver gives an opportunity in real time to receive almanacs of navigational satellites of GPS and GLONASS system, to evaluate the current situation of satellite GPS and GLONASS systems.

Internet is an alternative (non-effective) source of receiving almanacs information.

The worked out complex of navigational satellites accessibility forecasting makes it possible owing to effective (2 hours before the flight) radio navigation systems accessibility forecasting to determine at any moment of time and in any point of the aircraft route accessibility.

Conclusions

The use of satellite technology of radio navigation for the purpose of increase and ensuring of aircrafts flights safety can be effective if inculcated equipment facilities will meet the demands as for the sharpness, integrity, persistence and operating preparedness. It is recommended by standards and ICAO practice; by normative documents that regulate the rules and procedures of elaboration and navigation systems exploitation; scientifically grounded methodology of valuation of ground and board navigational facilities parameters.

The CFS application in aviation companies and aviation enterprises will give the possibility to considerably increase flights safety by means of forecasted navigational satellites accessibility on the stage of preparation for the flight, to foresee situations concerning sudden and uncontrolled navigational satellites refusals.

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