THE CONTROL AND AUTOMATION MANAGEMENT MODEL FOR AIR TRANSPORT MONITORING USING MACHINE LEARNING

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Abstract

In general, aviation is an area where modern achievements of IT technologies find rapid practical implementation. Automation of airports, aircraft, aircraft maintenance, baggage and air cargo tracking has rapidly exploded into our lives and has overtaken many areas of automation. Without the availability of online booking and ticket sales, remote check-in for flights using web kiosks at airports or via the Internet, not to mention free access to flight departure and arrival information cannot imagine a reality. When there was a significant decline in air travel during the global crisis, IT technologies became a key tool for competition between airlines. In this paper, the control and automation management model was proposed for air transport monitoring using machine learning. Air transport accounts for a quarter of passenger traffic and allows bookings for charter flights through tour operators and any air carrier online. At the same time, for the convenience of users, the system is supplemented with a payment gateway.

Keywords:

Aviation, Rapid, Automation, Airports, Aircraft, Maintenance, Baggage

1. INTRODUCTION

As the main direction to improve the use of road transport, the use of automatic navigation systems is proposed, through which the optimal route for the movement of vehicles is determined [1]. At present, many such systems with various software are known. Most of these systems are based on Global Automated Geographical System GIS with topographical maps in digital form, which is used not only in automobiles but also in other modes of transportation to automate management. As an example of a GIS-based navigation system we can consider the system developed by Macon GmbH (Germany). The 30-type computer has a 64-bit processor and runs Windows CE operating system, has D and E-network radio communication devices and GSM standard mobile telephony text labels [2]. The resolution of the camera is 330 thousand pixels. A special module can be embedded in the computer to determine the location of vehicles using a global GPS system based on satellite communications [3]. The global positioning system for vehicles based on satellite communication (GPS) coupled with the global system for mobile communication based on the GSM standard has created numerous opportunities for the design and construction of automated transportation systems for various modes of transportation [4]. Cubic Transportation Systems is known as a developer of automated systems for public transportation. It has also developed and introduced vending machines for tickets, as well as ordering and selling tickets online [5]. In total, it has implemented more than 400 projects. Specializes was in developing software for transportation and logistics using global systems such as satellite communications (GPS), GSM mobile phone system [6]. Software production companies are sold in more than 30 countries of the world and provide a wide range of services in developing and implementing software for automated control systems for various purposes [7]. The company develops application software using Automated Geographical System (GIS), Computer Aided Design System (CAD) etc. A number of software packages have been developed and implemented to improve the management of enterprise resources and manage public utilities and urban transport, organizing marketing to provide quality customer service and so on [8].

Mobile devices are functionally expandable. For example, fuel level sensors or cargo temperature sensors can be installed in tanks to monitor these indicators from the control room. View the location of cars on raster maps [9]. Send and receive messages from drivers and other external callers. All messages and the time they were sent and delivered are documented. Computers are like e-mail [10]. The system creates a traffic schedule with check points of stops and their route schedule. If it is late, the car icon on the map is painted in red, if it is late - in yellow, and if it is on the map - in green. Free cars and repair cars are marked with their own colors. External subscribers can be partners, forwarders, customers [11]. According to the tasks and needs of external subscribers, information is sent to them, for example: customers - the location of cargo, consignors - a list of vehicles with their parameters and the date and place of publication, partners can send [12]. All information regarding loading of vehicles, their movements and correspondence with drivers. The composition and availability of information sent to external subscribers is determined by the sender [13].

2. RELATED WORKS

It is no exaggeration to say that transportation has changed the modern world tremendously since the era of great geographical discoveries. A conclusion can be drawn from this: strategic development, both in the world and in the domestic economy, has no non-transportation topics [1]. The future, given its unique geographical features, depends on the integrity of today transport policy. The ability to improve the efficiency of the company through innovative technologies, the ability to efficiently manage income has become necessary conditions for the survival of pilots in the current conditions [2]. Integrating information products between all participants in aviation, reducing transportation costs, increasing the attractiveness of air travel for passengers and improving aviation safety - these are the main tasks of modern aviation information technology solutions used in many information systems of the industry [3]. There are many directions for the development of IT technologies in aviation - video surveillance servers and access control systems, deploying servers to provide additional services to passengers, for example, a web server for the Aeroflot-Bonus program using Microsoft [4]. SQL

Server 7.0 DBMS uses visualization and 3D modeling technologies to allow pilots to practice takeoffs and landings on unfamiliar routes or with new technology. Airlines and airports are the most advanced in terms of development of IT infrastructure in the transport sector [5]. The system has an advanced modern interface and has a wide range of options for customization. Unnecessary traffic or individual roads may be blocked and excluded from consideration when planning a route [6]. The city search, zoom and map navigation tools are easy to use and there are many different ways to access them. Before or during the flight, the operator receives such a legend and a printout of the instructions on the route, taking into account satellite telecommunication capabilities [9]. If the user of the program has set a specific work and rest regime for the driver (for example, an hourly stop after every 6 hours of driving or half an hour after every 200 km), reminders of the stops will be highlighted [11]. A PC miler/mapping subroutine can be added to vehicle tracking and dispatch programs using satellite positioning systems [12].

3. PROPOSED MODEL

To ensure operational conditions, a transceiver with a built-in location indicator measuring 360x250x50 mm is installed in the vehicle, a compact unidirectional antenna; a printing device and a compact kit are included. The ability to monitor the status of cargo and the technical condition of the vehicle according to the selected parameters is provided by the touch sensors installed in the vehicle. Its operating functions provide changes depending on the price, configuration and delivery terms of the equipment installed in the vehicle. Currently, there are about 170 types of vehicle tracking and dispatching systems in operation in the world, and more than half of them use satellite navigation system sensors to determine the location of vehicles. An object velocity represents the exact time at any location on Earth. The capabilities of the system help to determine the location of an object with an accuracy of more than 100 meters, and with relative measurements up to 2-5 m. The proposed model was shown in Fig.1.

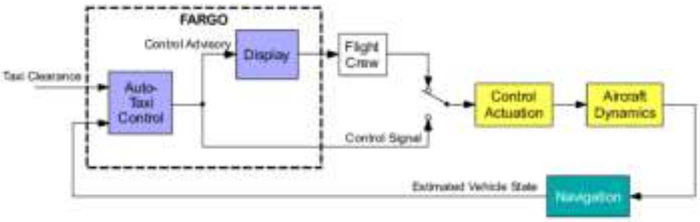

Fig.1. Proposed model

The principle of operation of software systems for fleet management of vehicles (FMS - Fleet Management System) is as follows. To transmit a radio frequency signal, the technical and information capabilities of the Inmarsat-C International Satellite System for Mobile Communications or the Satellite System for Mobile Communications Euteltrax, the GPS / Navstar Navigation System, the GLOBALSTAR low-orbit system tube-to-tube principle, or the ICO Global Medium-Orbit System. A GPS signal receiver located on a moving object allows you to determine its coordinates and speed. The information is sent to the control room. Navigation information is supplemented with data from various sensors in the car, which determine the technical condition of the vehicle, the level of loads, the level of safety of the driver and the vehicle. Highly accurate vehicle speed and location information is superimposed on electronic road maps at a central monitoring and dispatching station. This was shown in the Fig.2.

- Account for orders for allocation of vehicles;
- Regulation of operation of flights;
- Making advance reports on flights;
- Accounting for operation of rolling stock, mileage and fuel consumption, control and maintenance planning, accounting for repairs, tires, batteries, etc.;
- TTN processing, incl. and CMR;
- Monitoring the validity of various documents both for rolling stock and drivers;
- Generating analytical reports in any form at any time, including.

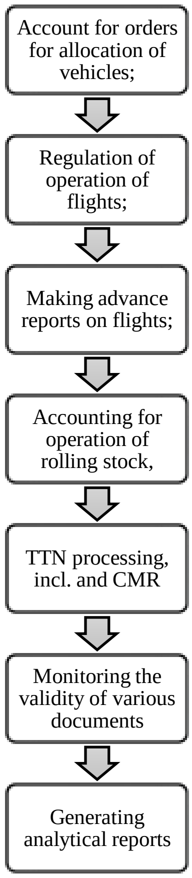

Fig.2. Road maps at a central monitoring and dispatching station

Thus, any vehicle can be identified accurately and unambiguously, regardless of location. Information about the location, speed and position of the vehicle is stored in the database and can be used for analytical purposes. The rate of receipt of information about each vehicle allows the dispatcher to control the situation almost in real time. At the same time, the dispatcher controls the receipt / delivery of an order, information about the arrival, loading, departure and unloading of the vehicle, as well as refueling, repair and maintenance. The Inmarsat-C satellite communication system provides two-way data transmission from almost anywhere on Earth, viz. Its four geospatial satellite systems (4F2 + 4F3) provide coverage of the entire planet in longitude and latitude up to 75 degrees. Communication is carried out through coast ground stations, which allow messages to be sent to various data networks. - Telephone, Telex, to a mobile subscriber with a registered Inmarsat-C terminal. This was shown in the Fig.3.

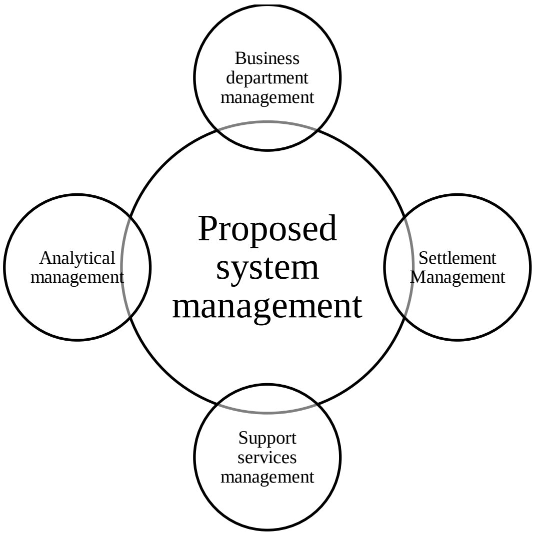

Fig.3. Proposed system management

- *Business Department Management*: It working with the company clients. The commercial department looks for applications for transportation and determines the feasibility and cost of transportation.
- *Settlement Management*: The clearing department is the control system for order dispatch from receipt of financial documents to closing.
- *Analytical management*: It should provide the company with information for making management decisions and inventory-related decisions, as well as monitor the need for maintenance and replacement of drivers.
- *Support Services Management*: It including IT department, external offices for document transfer etc. Support the company core business.

Already mentioned is Inmarsat, which provides global coverage of the Earth surface using 4 high-altitude (orbital altitude 35786 km) satellite systems. Transmission speed of voice information is 4.8 Kbps, fax information - up to 14.4 Kbps, data in electronic form - from 0.6 to 64 Kbps. The size of the mobile terminal is 2.2 kg. The low-orbit satellite system, which also provides global coverage, began operations based on a network of 66 satellites at an orbital altitude of 780 km.

The data transfer rate is slightly lower than the Inmarsat system (voice - 4.8 Kbps, fax - 2.4 Kbps, electronic messages = 2.4 Kbps.), however, the cost of a communication device is the size of a telephone tube and weighs 0.5 kg. Currently, 48 satellites at an orbital height of 1414 km, a low orbit system based on a base of 20 satellites with an orbital height of 10,000 are also being developed. The advantages of these systems are the small size of the receiving-transmitting terminal (weight does not exceed 300 grams) and relatively cheap (from 1000 to 1500 dollars per set) with high speed of information transfer (voice - 4.8 Kbps, fax - 2.4 Kbps, e-mail - 9.6 Kbps).

The Documents section contains information on all documents required for aviation: waybills, CMR-waybills, TIR-carnets, permits, company orders, contracts, transport orders. The records section reflects the complete information about the flights. The daily Transport Information journal records all the information about the condition of the rolling stock, its location, loading, unloading, telephone conversations and accounting for arising problems. This is the sender workspace. Flight Log contains all information about flights. Planes, depending on their status (creating, current, completed, archived), are highlighted in different colors. Other records (routes, expenses, currency exchange, fuel, tires, vehicle documents, permits, exchange rates, etc.) contain detailed information about related items. In the Statements section, the main form is the Preliminary Statement. To create it, it is enough to enter the sections of routes by country indicating the date and weight of goods, costs for receipts, advances, currency conversion certificates, and the system will automatically calculate.

4. RESULTS AND DISCUSSION

The proposed control and automation management model (CAMM) was compared with the existing a turnaround control system (TCS), machine learning models for aviation (MLMA), machine learning and cognitive ergonomics (MLCE) and Bayesian neural networks for flight trajectory (BNNFT)

Designed to work with raster (scanned) maps and capable of displaying up to 35 vehicles in real-time as an icon on the map. With the help of this system, the selected vehicle is tracked; its geographic coordinates, course and speed are displayed in text format. The direction of movement of the vehicle (vector) is displayed on the map, and the possibility of signaling to the computer when the vehicle deviates from the specified path is provided. The comparison of tracking management was shown in the Table.1.

Table.1. Tracking Management

Inputs	TCS	MLMA	MLCE	BNNFT	CAMM
100	40.11	62.53	66.27	52.68	94.05
200	39.78	61.03	65.68	50.81	93.04
300	39.45	59.53	65.09	48.94	92.03
400	39.12	58.03	64.50	47.07	91.02
500	38.79	56.53	63.91	45.20	90.01
600	38.46	55.03	63.32	43.33	89.00
700	38.13	53.53	62.73	41.46	87.99

Obtaining coordinates from the vehicle is possible in time-sharing mode or at the request of the sender. In raster maps, individual point objects, lines, waypoints can be drawn. The advantage of this monitoring system is the ability to connect to any radio station in the VHF to MW range.

Designed to work with both raster and vector maps and has the ability to display various layers of information (roads, flats, houses, etc.). When using this system, the sender has the ability to determine the position of a point on the map by postal address, and, if there is relevant information in the map database, display the address of the specified point. The comparison of Cartographic windows management was shown in the Table.1.

Table.2. Cartographic windows management

Inputs	TCS	MLMA	MLCE	BNNFT	CAMM
100	38.44	59.92	64.70	49.98	92.88
200	37.30	59.54	63.49	49.07	91.92
300	36.16	59.16	62.28	48.16	90.96
400	35.02	58.78	61.07	47.25	90.00
500	33.88	58.40	59.86	46.34	89.04
600	32.74	58.02	58.65	45.43	88.08
700	31.60	57.64	57.44	44.52	87.12

A group of vehicles is displayed in real time in the form of regular icons in one or more cartographic windows on the computer screen, which allows monitoring of the selected group of vehicles.

The program provides geographic coordinates, heading, speed and postal address of the object location (VH), as well as a textual display of the status of the sensors installed in the vehicle. With the help of this system, two-way exchange of text messages is carried out between the sender and the driver. This information system allows you to connect user-created application programs. The comparison of Information update rate was shown in the Table.3.

Table.3. Information update rate

Inputs	TCS	MLMA	MLCE	BNNFT	CAMM
100	36.25	58.53	62.35	48.15	92.35
200	35.54	57.60	61.24	46.82	91.15
300	34.24	56.60	60.54	45.74	90.99
400	33.33	55.65	59.57	44.49	90.14
500	32.33	54.68	58.66	43.29	89.46
600	31.32	53.72	57.76	42.08	88.78
700	30.32	52.75	56.85	40.88	88.10

There is a mode to automatically turn off the radio after the ignition is turned off, as well as a warning about stopping the transmission of information from the vehicle. Information update rate - up to five objects per second. There are many programs that have less detailed capabilities, but are capable of tracking a relatively small number of vehicles

Black Box, with which you can plan a route, monitor driver performance, exchange electronic declarations and preliminary documents with customs, maintain contact with a centralized database, identify vehicle location and carry out two-way data exchange. The comparison of Black Box Management was shown in the Table.4.

Table.4. Black Box Management

Inputs	TCS	MLMA	MLCE	BNNFT	CAMM
100	42.41	64.83	62.87	49.94	94.96
200	42.08	63.33	62.28	48.07	93.92
300	41.75	61.83	61.69	46.20	92.88
400	41.42	60.33	61.10	44.33	91.84
500	41.09	58.83	60.51	42.46	90.80
600	40.76	57.33	59.92	40.59	89.76
700	40.43	55.83	59.33	38.72	88.72

It allows you to determine the location of an object with an accuracy of 10m, make a voice notification of hazards, restrictions, etc. maintain and fill a database on the selected route, enter the route in a memo. It maintains operational communication with the vehicle controls its location on an electronic map, monitors the status of the vehicle and cargo according to the data from sensors installed in the vehicle. The comparison of Logic Dispatch Management was shown in the Table.5.

Table.5. Logic Dispatch Management

Inputs	TCS	MLMA	MLCE	BNNFT	CAMM
100	40.74	62.22	61.30	47.24	93.79
200	39.60	61.84	60.09	46.33	92.83
300	38.46	61.46	58.88	45.42	91.87
400	37.32	61.08	57.67	44.51	90.91
500	36.18	60.70	56.46	43.60	89.95
600	35.04	60.32	55.25	42.69	88.99
700	33.90	59.94	54.04	41.78	88.03

Conventional automatic determination of the location of tracked objects, automatic receipt and storage of information, even if the sender is absent, the possibility of radio and telephone communication with the vehicle, the possibility of text communication, remote control. Vehicle and cargo parameters, giving and receiving warning signal in emergency situations.

5. CONCLUSION

The air trucking company profit maximization policy is structured in two directions: minimizing transportation costs and maximizing cargo profitability. Based on these tasks, the information system is open to all customers. That. This system provides maximum service to the customers by providing information about the progress of the flight. Information about the time and place of release of vehicles is sent to the dispatchers. The settlement services of the transport company inform the shippers and regular customers about the current availability of mutual settlements. The system allows you to send SMS messages about the location of the vehicle and the status of sensors, especially for transport subscribers at a cheap price and in a short time. A group call can be arranged, i.e. this includes sending messages to a group of vehicles, a target group of users, or a group located in a specific geographic area. There are many alternative satellite communication and navigation systems.

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