МАШИНОЗНАВСТВО

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APPLICATION OF INFORMATION TECHNOLOGIES IN CARRYING OUT SPATIAL IDENTIFICATION OF MOTOR VEHICLES

In the research, it was noted that the identification of a vehicle, equipment and cargo is a means of identifying one or more objects or subjects based on a number of important characteristics. The main characteristics of an object (subject) can be placed on a certain physical carrier, which are special devices that have the signs of an object or subject (silhouette (drawing) of a vehicle, its number sign, fingerprints of a person) or identification information (magnetic card, electronic key). A set of characteristics that define an object or a subject within a certain identification system is called an identifier; also, an identifier is understood as a physical device containing identifying information.

The identification process is carried out by determining the identification information of the object (reading from the identifier) and comparing it with the information known in the system; as a result of this comparison, it is determined that the object belongs to a certain group. One component of object recognition is its identification, the purpose of which is to confirm that the identifier actually belongs to a recognized object.

In the research work, automatic identification devices were used to remotely monitor and control the route of movement of the car, as well as its location in any coordinate system is regularly determined. To solve the problem of determining the location of the car while it is in motion, it is equipped with a set of sensors that automatically record movement parameters with a certain interval, transmit them to the center to control movement and determine the current location. Relative or absolute parameters were used to determine the location of the car. The article emphasized that most vehicles are equipped with sensors to determine relative or absolute parameters.

Key words: *transport, road, coordinate system, tracking, relative parameters, absolute parameters, sensors.*

Introduction. Automatic identification of objects of motor transport systems significantly expands the possibilities of monitoring and managing transport and logistics processes [1]. Electronic identification technologies make it possible to track goods in real time both at the stage of their storage and during transportation, which makes it possible to plan and manage cargo flows with maximum efficiency [12]. Global positioning technologies facilitate vehicle route monitoring procedures, including traffic management on toll road sections. Obtaining the most efficient automatic identification, as well as appropriate technical equipment, selection and use of economical information iechnologies is an important issue in the activities of a motor transport company [3].

Means of automatic determination of the parameters of motor traffic flows are an effective basis for organizing and regulating traffic flows based on the current situation on the road. This is especially important for large megacities, which do not have sufficient passability in the urban road network [10].

In order to remotely track and control the route of movement of the car, not only automatic identification is required, but also its location is regularly determined in any coordinate system. To solve this problem, the tools are equipped with a set of sensors that automatically record movement parameters at certain intervals, transmit them to the center to control the movement, and determine the current location (which is most often presented as the coordinates of the object) [5]. The parameters, the current location of which is determined, can be relative or absolute (Figure 1); most vehicles are equipped with sensors to determine the parameters of both types.

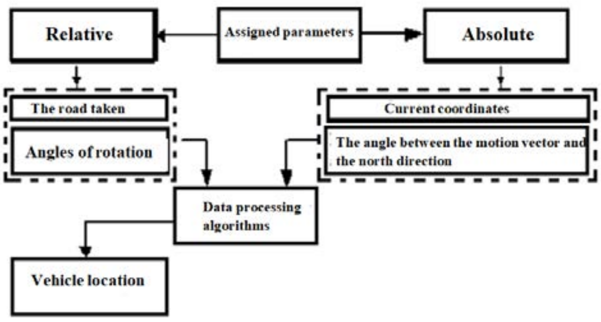

Fig. 1. The procedure for determining the current state of the car

Relative parameters make it possible to calculate the change of coordinates for a certain period of time; adding this change to the initial coordinates, they get the current coordinate of the vehicle. The occurrence of an error in the calculation process is inevitable, and this increases with an increase in the distance traveled. For this reason, periodic synchronization is required: errors accumulated as a result of accurate determination of current coordinates by any other methods and methods are reduced to zero; but after that the calculation starts again based on the initial coordinates. Determination of relative parameters, as a rule, is carried out by means of the moving object itself, without resorting to third-party information systems.

Absolute parameters allow to calculate current coordinates directly and continuously with high accuracy, but require communication with systems located outside the vehicle.

Research methods. Relative parameters in determining the current location require synchronous determination of most travel distances, turning angles and, moreover, with very short time intervals between measurements. To determine the distance traveled, distance sensors on the transmission case and tires are used [14]. *Electromagnetic transmission sensors* generate a voltage proportional to the speed of rotation of the transmission element. Moreover, the relationship between the speed of rotation and the resulting voltage is not always linear, and in addition, the spread of voltage at low speeds can be unacceptably large. *Holl sensors* are related to transmission and are characterized by high accuracy, but require protection from temperature and magnetic fields, as well as accurate installation and the absence of displacements during operation; these requirements limit the scope of transmission sensors. *Tire sensors* are very easy to install and maintain; *rotation sensors* create tension linearly with the speed of the tire, and *impulse sensors* give a single impulse at each complete rotation of the tire (the distance traveled is determined by the number of pulses recorded). The angle of rotation is determined using *gyroscopes*, which have different principles of action; vibration-type gyroscopes are more common in motor vehicles.

The absolute parameters of positions are usually coordinates derived from global positioning systems [9]. Currently, there are GPS (Global Positioning System) and GLONASS (Global Navigation Satellite System) systems in our country. The basic principle in determining the current location is to compare the reception time of signals from several satellites operating in the corresponding system and generating stable and synchronous signals corresponding to each other. Based on the analysis of the time between the reception of the signal from different satellites, the position of which is known, it is possible to determine at what point on Earth the intersection of the rays occurs – the signal trajectories; this is equivalent to determining the coordinates of a particular point. Based on the analysis of the time between receiving the signal from different satellites whose position is known, it is possible to determine the signal trajectories at which point of the Earth the rays intersect; this is equivalent to specifying the coordinates of a certain point. Typical GPS positioning error for 2016 is 2–4 m; for GLONASS, this indicator is slightly higher (from 3 m to 6 m), the error is expected to be reduced to 0.6 m by 2021.

Despite the convenience of using absolute positioning parameters, their determination can be achieved with temporary difficulties. In unfavorable conditions (in a tunnel or under dense foliage, low cloud cover, interference from particularly strong magnetic storms), signals from satellites can come with significant deficiencies (up to complete loss) [11]. Therefore, the most appropriate is a combination of relative and absolute parameters that guarantee acceptable accuracy of the vehicle position when determining the current position of the vehicle in any situation. This approach is applied to *current positioning integration systems* based on motion and rotation sensors, two independently identified and used in the global positioning system, the results are compared (usually based on a mathematical tool that applies a Kalman filter) and then finally the corrected coordinates are calculated. If the sensors on the vehicle cannot be used for any reason, a different *current positioning system* can be implemented that receives signals from both satellites and the base station. Such a known and invariable (different from satellites) coordinating support station is used to refine and correct the coordinates established in the global positioning system.

Spatial identification of vehicles is often carried out when using toll areas of highways [10]. Payment systems based on automatic identification provide significantly higher flexibility for their customers compared to traditional systems that provide physical control of vehicle access to toll roads. In addition to location identification, automatic tariff payments are made, including determining the type of vehicle, calculating the amount of payment, making settlements and conducting appropriate financial transactions [11].

An example of a system using DSRC (Dedicated Short Range Communication) technology and successfully operating in a number of European countries is shown in Figure 2. The initial section of the toll road (zone I) is equipped with means for recording the fact of the passage of the vehicle and determining its type(the size of the subsequent toll depends on it); in this area, video equipment with image recognition software is also used, along with motion sensors installed inside the road [2]. In the next part (zone II), communication in different ranges is carried out with the car's on-board device: microwave (data exchange rate up to 0.5 Mbit/s) or infrared (up to 10 Mbit/s). After establishing a connection, the vehicle is identified, its compatibility with the parameters defined in zone I is checked, the payment information is determined and the payment is made automatically. If automatic payment is not allowed by the user, an invoice is created in the system and sent by the on-board device to the address specified in the process of data exchange, at which time the deferred payment procedure is used. If it is not possible to contact the on-board device, Zone III takes a photo and recognizes the vehicle number, after which the owner of the vehicle is identified from a single database and a payment invoice is sent to him [6].

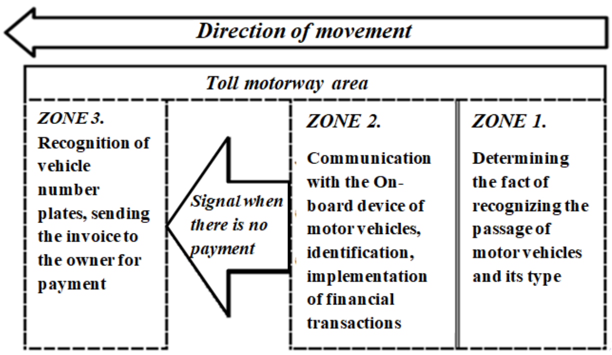

Fig. 2. Scheme of use of toll roads on DSRC technologies

Scientific novelty of the research work. The use of DSRC technology requires equipping all toll areas with appropriate devices for organizing communication and recognizing moving objects [4]. GSMC (Global System for Mobile Communication) technology is free from this deficiency, when information is obtained about the position of the vehicle in global positioning systems, and on-board devices exchange information through mobile networks. Payment is made in deferred mode. This technology is effective in the event of a small number of vehicles not equipped with on-board support devices; for such vehicles, a small network of mobile control posts or DSRC posts is envisaged. This technology is used in Germany; this allows to differentiate the amount of payment depending on many factors (number of vehicle axles, category according to environmental standards, etc.) [8].

A very advanced system of indicators that is taken into account when determining the amount of payments is the LVSA technology, which is also widespread in Switzerland [12]. Here, at the same time, the on-board device is equipped with a tachograph that measures the distance covered by the paid moving part; its readings are automatically checked by the integrated global positioning device. The distance traveled is periodically determined and, based on it, the amount of payment is determined. The determined amount of payment is stored on a special card of the owner of the vehicle. The cardholder is obliged to periodically transfer the accumulated data to the system control center, where the correctness and completeness of payment for the use of the toll road is monitored.

Another direction of the widespread use of automatic identification is road traffic management. Personal identification is not required here at all, it is enough to determine the fact and time of the passage of the car through a certain section of the road, and possibly add its type. For this purpose, sensors are used that can be installed both on the side of the road and under the road. According to the physical principle of their action, the sensors installed on the road are electromechanical, magnetic, pneumoelectric and inductive; the latter type is more widespread. The inductive sensor is made of high-frequency (up to 200 kHs) alternating current conductive material and fixed in a certain shape; the circuit diagram of inductive sensors and the scheme of their various connections are shown in Figure 5.5. During the movement of a heavy metal object, the density of oscillations on the sensor changes, which is recorded by the controller. The sensitivity of the sensor, as well as its shape, is affected by the mass and speed of the object passing over it, so sensors with the most suitable shape are used to detect all kinds of vehicles. (Figure 3, b).

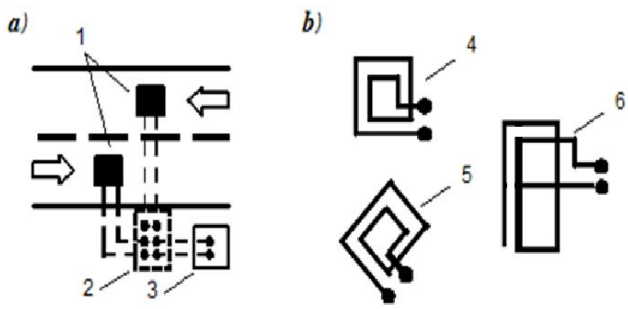

Fig. 3. Road measuring devices:
a) the scheme installed on the road; 1 – measuring devices; 2 – installation well; 3 – controller;
b) types of measuring devices; 4 – measuring devices for the car; 5 – measuring devices for bicycles;
6 – measuring devices at the railway crossing

The detection area of inductive sensors can be small (a short circle for identifying vehicles passing through a certain section of the roadway) and large (several long and wide areas that determine the presence of a vehicle in a control zone up to 20 m long). In the traffic management system, inductive sensors (determined according to the queue lengths at the traffic lights) are used to determine the characteristics of the traffic flow (its intensity and volume of traffic), to identify traffic jams and to adjust the traffic lights according to the actual traffic situation [13].

Sensors installed on the road are divided into acoustic, infrared, radar and video detectors according to the principle of movement. The detectors installed above each lane and combined have a wide range of possibilities to identify vehicles. Here, various types of sensors are used to determine a wide range of traffic flow parameters. The speed of movement is measured with the help of microwave radar [12]. U The ultrasound detector scans images of vehicles and classifies them by type, as well as registers stationary objects.

Multichannel infrared detectors calculate the switching on and off of the radar, as well as the degree of occupancy of the lanes and the intensity of movement.

Conclusions. The conclusion from the research suggests that for remote tracking and control of a vehicle's route, automatic identification alone does not fully satisfy the requirement, and its location in any coordinate system must be determined regularly for accuracy. To solve the problem, a set of sensors was used, which automatically record movement parameters at certain intervals, transmit them to the center to control the movement, and determine the current location (which is most often represented as the coordinates of the object). At the end, relative or absolute parameters were taken as parameters that determine the current location of cars. For the determination of the mentioned parameters, it is imperative to install the selected sensors on most vehicles.

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Гахраманов С.А. ЗАСТОСУВАННЯ ІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ ПРИ ПРОВЕДЕННІ ПРОСТОРОВОЇ ІДЕНТИФІКАЦІЇ АВТОТРАНСПОРТНИХ ЗАСОБІВ

У дослідженні було зазначено, що ідентифікація транспортного засобу, обладнання та вантажу є засобом ідентифікації одного чи кількох об'єктів чи предметів за низкою важливих ознак. Основні характеристики об'єкта (предмета) можуть бути розміщені на певному фізичному носії, що є спеціальними пристроями, що мають ознаки об'єкта чи суб'єкта (силует (малюнок) транспортного засобу, його номерний знак, відбитки пальців людини) або ідентифікаційна інформація (магнітна картка, електронний ключ). Ідентифікатором називається сукупність характеристик, що визначають об'єкт або суб'єкт у певній ідентифікаційній системі; також ідентифікатор розуміється як фізичний пристрій, що містить ідентифікаційну інформацію.

Процес ідентифікації здійснюється шляхом визначення ідентифікаційної інформації об'єкта (зчитування з ідентифікатора) та її порівняння з інформацією, відомою в системі; в результаті цього порівняння визначається приналежність об'єкта до певної групи. Одним із компонентів розпізнавання об'єкта є його ідентифікація, метою якої є підтвердження того, що ідентифікатор дійсно належить розпізнаному об'єкту.

У дослідницькій роботі використовувалися пристрої автоматичної ідентифікації, які дистанційно відстежували та контролювали маршрут руху автомобіля, а також регулярно визначали його місцезнаходження в будь-якій системі координат. Для вирішення проблеми визначення місцезнаходження автомобіля під час його руху він оснащений набором датчиків, які автоматично з певним інтервалом фіксують параметри руху, передають їх у центр для контролю руху та визначення поточного місцезнаходження. Для визначення місця розташування автомобіля використовувалися відносні або абсолютні параметри. У статті підкреслюється, що більшість транспортних засобів оснащені датчиками для визначення відносних або абсолютних параметрів.

Ключові слова: *транспорт, дорога, система координат, стеження, відносні параметри, абсолютні параметри, датчики.*