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Enhancement of monitoring systems for the transport of dangerous goods by road

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Abstract. Methods to improve the safety level of the transport of dangerous goods by roads through the introduction of advanced information and satellite technologies are considered. The common architecture and components of the proposed system are described. The proposed system allows to reduce the response time to car accidents with dangerous goods by automatically providing a real time information about the accident.

1. Introduction
Road transport in Russian Federation plays a leading role in terms of goods traffic. Leadership of road transport in the amounts of goods transportation is attributed to its high maneuverability and the capability of "door-to-door" goods delivery as urgent as necessary [1].

According to the global experience, motorization, along with its undoubted positive impact on the social and economic development of the state, also poses negative consequences associated with a large number of road traffic accidents, dead and wounded, enormous material damage, and negative impact on the ecological state of the environment [2].

As for environmental safety, of particular concern are accidents with dangerous goods [3, 4], especially with hazardous chemicals, occurring within the boundaries of big towns and settlements. The damage caused by such emergency situations is usually of great size, since, in addition to eliminating the aftermaths of the accident itself, we have to deal with the secondary damaging effects. The accidents distinctive feature associated with the release of hazardous chemicals requires to take urgent measures aimed at people protection and localization of the pollution source [5].

2. Theoretical analysis
Classically, the management cycle of emergency response and the administrative and technical activities include:
- transferring (receiving) of information about the vehicle accident;
- clarification of the problem and assessment of the situation;
- making decisions on emergency response, assignment of the forces and facilities involved;
- giving orders to perform emergency response tasks;
- march of forces and facilities to the emergency area;
- emergency response activities.

The presented list of activities clearly demonstrates the importance of timely informing the management body in charge of emergency response. The sooner the accident is reported, the earlier the emergency response activities will be started, since the duration of the management cycle (the making of administrative and technical decisions) is relatively constant for the corresponding levels of the EMERCOM hierarchy. Thus, the response promptness of the forces and facilities aimed at localization of the pollution source depends primarily on the time for the information about the emergency situation (about the accident with the vehicle of increased danger) to pass from the accident site to the management body.

Hence, the rapid transferring of information about an emergency situation should be carried out automatically [6-8] and in real time directly from the vehicle. Information coming from the sensor should include:

- information on hazardous chemicals (name and amount of the substance);
- the time of the accident;
- geographical coordinates of the accident site;
- consignor and consignee;
- state registration number of the vehicle;
- vehicle owner (transport company delivering goods)

3. Practical implementation

Information sensors monitor the state of a vehicle of increased danger during its movement and parking and provide a signal of an emergency event occurrence when a vehicle overturns or a tank containing hazardous chemicals is depressurized (in case of a pressure drop inside the tank to atmospheric levels).

At the same time, information sensors located on a vehicle must be customized to be able to work in advanced information technology systems, including satellite technologies. Transfer of a signal from the accident site to the EMERCOM Control Center through special sensors of GPS or GLONASS satellite systems [9, 10] will allow managers and specialists to quickly assess the situation and determine the plan of operations for the response of an emergency situation with dangerous goods.

The receipt of a signal of an emergency situation (accident) with the vehicle of increased danger by the management body is the basis for making calculations to forecast the chemical situation in the accident area.

The calculations are carried out in accordance with existing guidance documents and methodologies [10-13]. The name of the substance, its quantity in tons, air temperature, wind speed in the surface layer and the degree of vertical stability of air are necessary to perform the calculations. To display the area of possible pollution on the map (screen) of the operations duty officer, the topographic coordinates of the accident are necessary [14, 15].

The system includes several modules (figure 1).

1. Module "Database" collects data from sensors and perform data storage and processing. Data collection is carried out in real time [16]. The database is stored on the local MySQL server. The advantage of this server is provided by its operational stability and cross-platform (multi-OS) support [17].

2. The module of the cartographical service provides representation of the terrain map, the paths of vehicle traffic and the scale of pollution in case of an accident. Google Maps and its API libraries are used as a map service [16, 17]. The service is accessed via an Internet connection.

3. The module for automatic forecast of the chemical pollution scale calculates the forecast of the pollution spread or the environmental damage by means of existing methods.

4. The module for acquisition of the weather conditions performs the automatic collection of information on weather conditions in real time (air temperature, wind direction, wind speed, etc.) in the area where the accident occurred, accessing available weather Internet services such as GISMETEO.RU. In addition, the module determines the degree of vertical stability of the air at the site of an accident, which is necessary to forecast the scale of chemical pollution.
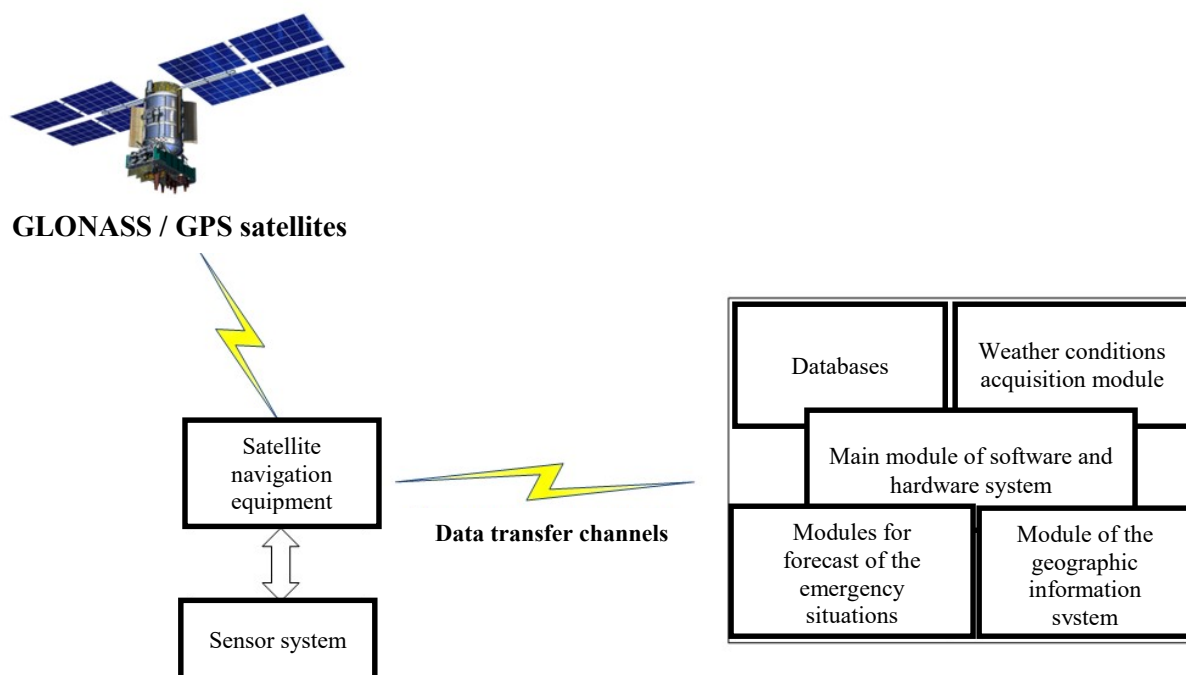
Figure 1. System configuration.

The interaction of all modules is carried out by the main module of the system [20]. It monitors the data flow from sensors to the database; displays the map of the tracking object movement using Google Maps; visually provides all the necessary information about the object [21]. As soon as the signal of a vehicle accident is received, the module automatically requests the weather conditions of the area where the accident occurred. These data are transferred to the module aimed to forecast the scale of chemical pollution. Then the results of the forecast are displayed on the map as an area of possible chemical pollution. The module performs all operations instantly, which allows the operator to correct activities aimed at elimination of the accident aftermaths as quickly as possible and promptly inform the regional EMERCOM management bodies of the necessity to evacuate the population of those settlements that are situated the chemical pollution area.

4. Conclusions

This low-cost system reunites all the latest available GPS / GLONASS, Google Maps and GISMETEO.RU technologies. The system effectively solves the problem of responsiveness to the aftermaths of accidents with the transport vehicles carrying hazardous chemical goods.

The need for a permanent stable Internet connection should be noted as a disadvantage of the proposed system, but the modern infrastructure of the telecommunications network and the Internet communications of the Russian Federation has sufficient reliability and stability.

The proposed implementation of the monitoring enhancement will expand the capabilities of the existing information and control systems of the duty dispatcher services of the Russian Unified Emergency Rescue Service of the EMERCOM of Russia. This system takes into account the distinctive features of the emergency situations that occurs with the road transport delivering the dangerous goods, providing the decision-makers with the necessary real-time information for making management decisions on emergency response. This leads to increased responsiveness of emergency services and effective emergency response.

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