Секция 1. ИЗМЕРИТЕЛЬНЫЕ СИСТЕМЫ И ПРИБОРЫ, ТЕХНИЧЕСКИЕ СРЕДСТВА БЕЗОПАСНОСТИ

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DETECTING RADIATION CONTAMINATION WITH QUADCOPTER

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Abstract. The radiation monitoring system is proposed to include ground-based stationary measuring complexes, mobile – wearable, and UAV-based complexes united into a single measuring system with the functions of data accumulation and analysis, display of radiation situation in real time. Radiation monitoring system should provide detection of stationary and mobile sources of ionising radiation, provide spatial scaling of measurement information, implement mechanisms of warning and notification of emergency events through online services and mobile communication.

Keywords: radiation monitoring, UAV.

ДЕТЕКТИРОВАНИЕ РАДИАЦИОННЫХ ЗАГРЯЗНЕНИЙ С ПОМОЩЬЮ КВАДРОКОПТЕРА

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Аннотация. Предлагается система радиационного мониторинга, включающая наземные стационарные измерительные комплексы, мобильные – носимые, и комплексы на базе БПЛА, объединенные в единую измерительную систему с функциями накопления и анализа данных, отображения радиационной обстановки в режиме реального времени. Система радиационного мониторинга должна обеспечивать обнаружение стационарных и подвижных источников ионизирующего излучения, обеспечивать пространственное масштабирование измерительной информации, реализовывать механизмы предупреждения и оповещения о чрезвычайных событиях посредством онлайн сервисов и мобильной связи.

Ключевые слова: радиационный мониторинг, БПЛА.

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Radiation monitoring in the Republic of Belarus is based on a network of stationary measuring complexes. The objects of control are: atmospheric air, soil, surface and ground waters. In the area of BelNPP the automated system of radiation monitoring of the Ministry of Natural Resources and Environment has been functioning since 2017. In the Republic of Belarus, a radiation monitoring system has been established and is functioning as an integral part of the national environmental monitoring system.

The results of radiation monitoring are displayed online in the mode of statistical averages (https://chernobyl.mchs.gov.by/, https://www.nsmos.by/content/180.html) and in real time (https://rad.org.by/, https://remap.jrc.ec.europa.eu/Advanced.aspx). The frequency of measurements depends on the technical capabilities of the measuring station, regulations, the object of control and is, for example, for surface water, usually 4 measurements per year. Low frequency of measurements and point in time, local in space character of measurements are the main disadvantages of existing systems.

It is proposed to use an integrated system for monitoring radiation contamination using unmanned aerial vehicles and a system for storing, analysing and displaying data online in real time (Figure 1).

Figure 1 shows stationary measurement systems, mobile laboratories, mobile measurement systems and flying measurement laboratories. Stationary measurement systems use wired and wireless measurement data transmission channels. Mobile laboratories, mobile measurement systems and flying measurement systems use wireless data transmission systems and indicator devices for data display. The following communication channels are used for wireless transmission of measurement data: radio channel, with transmission range over 300 metres; Wi-Fi channel, with transmission range up to 100 metres and IR, Bluetooth, with distances of 5–10 metres, cellular communication (internet, sms, IoT).

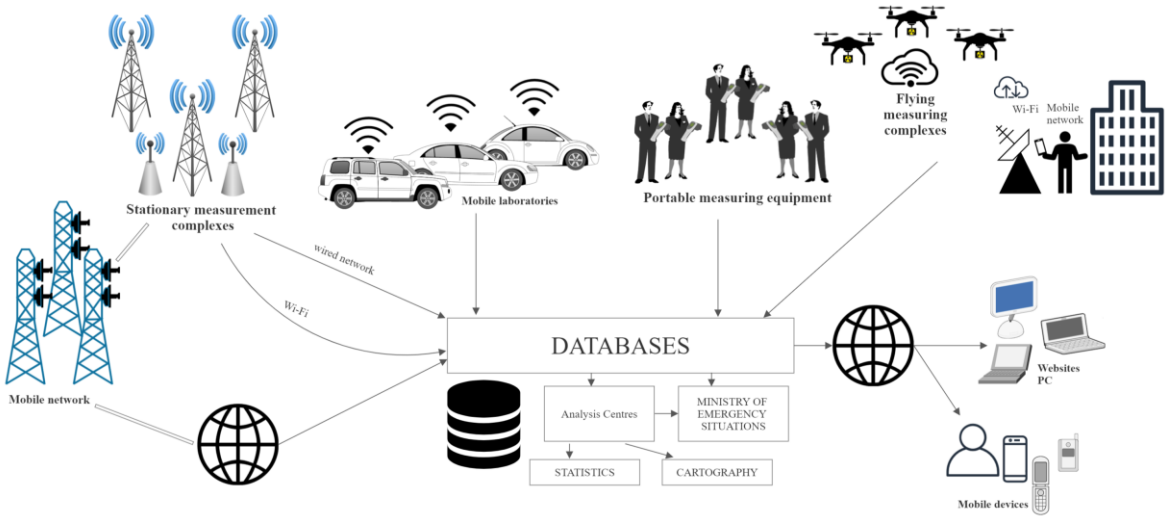

Figure 1 – Structural diagram of integrated system for monitoring radiation contamination using unmanned aerial vehicles and a system for storing, analysing and displaying data online in real time

Measuring information forms databases, which are further transferred to analytical centres and the Ministry of Emergency Situations.

The workability of the system is ensured by a large number of personalities, which are subdivided into levels and which interact with each other. The first level – "Meters" – whose task is to make measurements, control the measurement data and transmit them to the next level. Meters have access only to read and view their measurement data, which they receive and send at the time of measurement. The next level is "Developers", whose task is to optimise systems and develop new solutions. They have access to read and view data from all Meters in the system, and they prepare reports based on the data they receive, which, together with the data from the Meters, are passed on to the next level. "Technicians" – the level whose task is to adjust, repair and verify the equipment. On the basis of the files received from Developers and Meters they analyse the system and identify inaccuracies. Technical specialists have read-only access without modification and on the basis of the performed data analysis, transmit reports to the next level of the "Analytical Centre". The Analytical Centre performs statistical processing of data and provides data for cartography. The analytical centre, as well as the previous level, creates backup copies of the processed information, as well as sends the obtained statistical data and maps to the next level. "Site Administrator" – has access only to what has been granted access and further regulates the access of the "User" to the information on the site.

Radiation detectors allow to expand the range of application of unmanned aerial vehicles: in monitoring of radiation contamination zones, deposits, as well as objects (dumps, hazardous waste disposal sites, etc.), where exceeding of permissible concentrations of radioactive pollutants can be observed. The use of unmanned aerial vehicles (UAVs) to measure the spatial distribution of radioactive concentrations is of great interest. UAVs are currently used for a wide range of applications, from mapping to surveillance, from reconnaissance to verification. A feature of the most advanced quadrocopters of the DJI series is the possibility of controlled flight and hovering at a point with specified GPS coordinates [1].

Mobile high-sensitivity gamma radiation detectors are produced in the Republic of Belarus on the basis of a scintillation detector based on a silicon photomultiplier tube (PMT).

The peculiarity of the domestic detector is the method of temperature stabilisation of the scintillation detector parameters, which allows to create fast, energy-efficient mobile measuring complexes on its basis [2]. Measuring information from unmanned measuring systems allows to record time, altitude, nature and trajectory of movement, GPS coordinates of the quadrocopter, which is the basis for building 2D and 3D maps of radiation background. The use of mobile flying measuring complexes will expand the capabilities of radiation control systems in terms of operational monitoring of the area.

The proposed development and creation of cheap and effective flying measuring stations for radiation background control will find application for remote detection of radiation contamination, its localisation and analysis near industrial complexes, sources of anthropogenic and natural contamination, in places of human activity associated with health hazards.

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