AEROSPACE INFORMATION PROCESSING METHODS IN MONITORING AND CONTROL SYSTEMS

Labokha A.K., Shulitski D.S., Arzumanyan A.S.

Belarusian State University of Informatics and Radioelectronics
Minsk, Republic of Belarus

Rogachevskaya A.I. – senior teacher

This article analyzes the benefits of using remote sensing for monitoring and control systems. Based on the analysis of the created fire hazard assessment systems in forests, conclusions are drawn about the features and tasks in implementing such a system in Belarus.

A high level of reliability and relevance of remote sensing data, as well as its availability, can significantly improve simulation results and optimize costs of monitoring and control systems. The existing system for determining fire hazard in forests has low accuracy due to the lack of baseline information for modeling and low spatial resolution. Adding Earth remote sensing data into the functioning of the indicated modeling and control systems will allow to evaluate the effectiveness and expediency of using aerospace data in such systems. Remote sensing platforms are quite often useful in acquiring data at an improved spatial resolution in a timely manner, and have already been proven to be an effective method of monitoring and forecasting fire danger conditions.

An experimental system for assessing fire hazard in Canadian boreal forests using aerospace images was created in 2015 [1]. Its objective was to develop a daily-scale forest fire danger forecasting system (FFDFS) using remote sensing data in order to address the temporal resolution (i.e., 8-day scale) issue of the earlier developments and implement it over the northern part of Canadian province of Alberta during 2009–2011 fire seasons. Researchers employed MODIS-derived 8-day composite of TS, NDVI, NMDI and daily perceptible water PW as a surrogate of precipitation/humidity related variables.

Due to a rather high degree of average cloudiness [2], a special algorithm [3] was adopted and implemented to fill in the missing data for further modeling. Despite the usage of an 8-day composite of images, the results demonstrated that all the gap pixels couldn't be in-filled after implementing the gap-filling algorithm. Nevertheless, a significant reduction in gaps in the initial data for modeling significantly improves its quality. It is worth noting that the issue of cloudiness and cloud shadow is of great importance for the territory of Belarus. So, for the summer of 2019 for the Volozhinsky district, only 16 out of 72 remote sensing images taken by the Sentinel system had a cloud cover percentage of less than 20 percent [4] (4 images are needed to fully cover this area). Therefore, it is important to use the remote sensing data of various satellite systems, since shooting on different days increases the probability of obtaining a remote sensing image of the terrain, rather than clouds. This allows us to partially solve the problem of cloudiness of data by combining images of remote sensing data, which together with the gap-filling algorithm increases the completeness of the source data.

Testing results of the created system have demonstrated that forecasting based on only one parameter or vegetative index is not effective, since the probability of successful forecasting remains around 50%. However, according to a Canadian study [1], building a forecast using a combination of parameters can significantly increase its accuracy to 95%. But many different vegetation indices can be obtained from remote sensing images, and at the moment the world has not developed a unified approach, which of them can indicate the hanging probability of a forest fire. Depending on the type of green space, different indices may have a key influence on decision making; thus, only the NDVI and NDWI indices were used in both the Canadian [1] and Iranian [5] fire hazard classification systems. Therefore, when building such a system in Belarus, it is important to contact with interested organizations, since they can share specific information on vegetation indices and statistics.

In the work of Canadian scientists, fire statistics were used to verify the assessment of the constructed system. However, statistical data may also indicate historically the most dangerous areas: suburbs, recreational and walking zones, parking in the major roads... Therefore, statistical information and the human factor can be added to the fire hazard assessment system in forests. Moreover, an assessment of the effectiveness of the system can be performed on new data on forest fires.

The consistent implementation of the points described above make it possible to develop a comprehensive and effective fire hazard assessment system in our country.

References:

1. Chowdhury, E.H.; Hassan, Q.K. Development of a New Daily-Scale Forest Fire Danger Forecasting System Using Remote Sensing Data. Remote Sens. 2015, 7, 2431-2448.

2. Global cloud cover | Eclipsophile [Electronic resource] – 2016. – Access mode: http://eclipsophile.com/global-cloud-cover/. – Access date: 2020/03/20.

3. Chowdhury, E.H.; Hassan, Q.K. Use of remote sensing-derived variables in developing a forest fire danger forecasting system. Nat. Hazards 2013, 67, 321–334.

4. Copernicus OAH [Electronic resource] – 2020. – Access mode: https://scihub.copernicus.eu/dhus/. – Access date: 2020/03/12.

5. Ostad-Ali-Askari, Kaveh & Eslamian, Saeid & Singh, Vijay. (2018). Predicting Fire Hazard Areas Using Vegetation Indexes, Case Study Forests of Golestan Province, Iran. Journal of Geography.