Forest Fire Monitoring System Using Remote Sensing Data

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Abstract: For forest fire monitoring in relatively cool area like Siberia, design of Decision Support System (DSS) is proposed. The DSS is consisted of three different algorithms to detect potential fires from NOAA AVHRR image. The algorithm developed by CCRS (Canada Center for Remote Sensing) uses fixed thresholds for multi-channel information like one by ESA (European Space Agency). The algorithm of IGBP (International Geosphere Biosphere Program) involves contextual information in deriving fire pixels. CCRS and IGBP algorithms are rather liberal compared to more conservative ESA algorithm. Fire pixel information from the three algorithms is presented to the user. The user considers all these information in making decision about the location fire takes place.

Keywords: DSS, AVHRR, Fire Monitoring, Fire Detection

1. Introduction

This paper describes a conceptual design of basic structure for development of a Forest Fire Monitoring System (FFMS) based on AVHRR (Advanced Very High Resolution Radiometer) image from NOAA (National Oceanic and Atmospheric Administration) sensor. Up to now, many researches about algorithms for detection and monitoring of fires with different sensors over the earth have been proposed. Among these, NOAA's AVHRR image has been used most widely. One of its advantages is that images of proper resolution (1km) are available for the whole earth on daily basis. Its spectrum ranges from visible, near-infrared, middle-infrared to thermal infrared.

For real-time operation of the monitoring system, semi-automated forest fire detection is desirable. The automated part is consisted of expert system while manual part involves image interpretation procedure. The two parts are combined into a Decision Support System (DSS) to achieve both high accuracy and convenience.

2. Fire Detection Algorithm

Forest fire detection algorithms have been developed in a number of ways, resulting in unequal performance according to regional climate. In this paper, we confine our discussion in relatively cool region such as Siberia.

Multi-channel algorithms were used in actual fire detection. They contain filters that discriminate actual fire from hot surfaces or clouds. Three algorithms developed respectively by Canada Center for Remote Sensing (CCRS) [4], International Geosphere Biosphere Program (IGBP) and European Space Agency (ESA) [5] are employed. The procedure of each algorithm is presented in Figure 1 and 2. The thresholds in ESA are presented in bracket. ESA gives most conservative outcome, minimizing commission error with the cost of missing real fire pixels. In contrast, CCRS and IGBP algorithms are liberal in that they may produce false alarms.

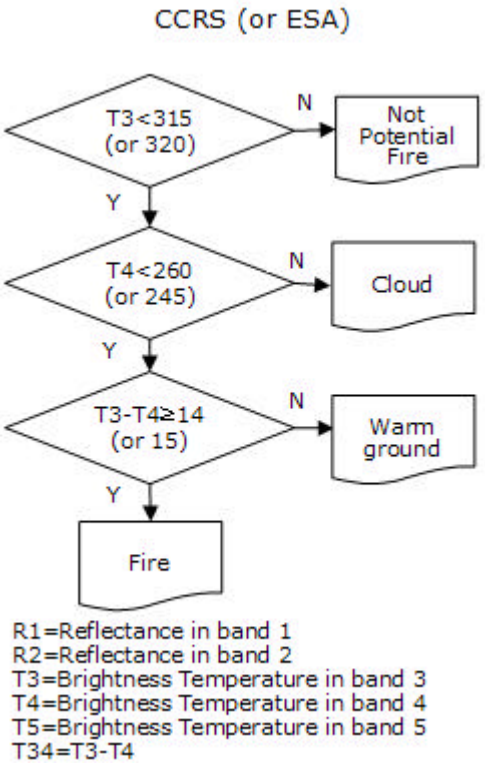

Fig. 1. CCRS, ESA algorithms

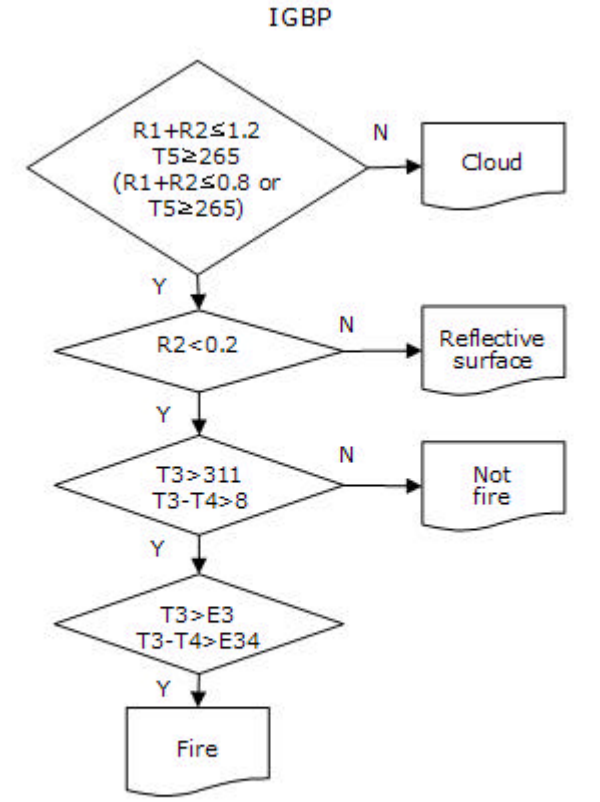

Fig. 2. IGBP algorithm

3. Structure of the FFMS

The FFMS structure takes all three fire detection algorithms in consideration. To avoid missing actual fire that has just begun, the two liberal algorithms are used. CCRS, developed specially for Canadian forest, uses fixed thresholds like ESA. IGBP determines fire pixels by incorporating contextual information in 3×3 to 15×15 windows.

The AVHRR image is processed by the three algorithms independently. Then the regions detected as active fire are presented. The outcome of each algorithm may not agree. The FFMS has to inform any inconsistency to suggest the possibility of false alarm, providing all the potential fire pixels. For efficiency of monitoring fire, human image interpretation is followed for the potential fire pixels that exhibit disagreement among algorithms. Thus this is not an entirely automated system. It is a simple realization of DSS in that it allows support for decision making about burning region.

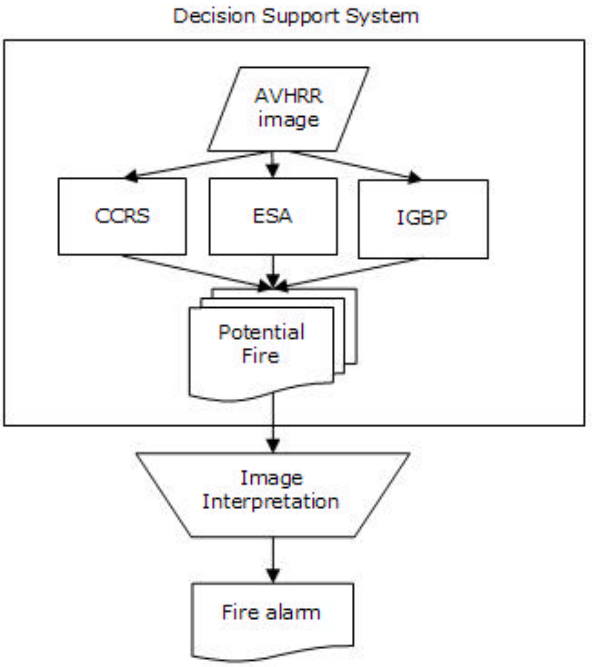

Fig. 3. FFMS structure

4. Conclusion and Suggestion

This paper exhibits concepts of DSS that functions as basis for FFMS design. To take advantage of the FFMS in actual practice, each threshold should be tuned according to characteristic temperature and vegetation of the target region. Seffino et al. [8] proposed workflow based SDSS (Spatial Decision Support System). At the mentioned research, its interface allows users to modify the process, called workflow. As a result, more flexibility are gained while losing simplicity. The degree of users' involvement in adjusting internal process varies case by case. In ideal situation, users with expert knowledge and experience can maximize the capacity of FFMS in monitoring forest fire.

The use of data is limited to only AVHRR image. In fact, ancillary information can be helpful in analyzing the character of fire and predicting its consequences. For example, information about flammable materials (i.e. dry lumbers) or wind direction is helpful for understanding the behavior of fire. Also, for further study, fine tuning of the proposed combination of fire detection algorithms is of prime importance.

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