CHINA RESOURCES AND ENVIRONMENT REMOTE SENSING SATELLITES' APPLICATION IN MONITORING BUSHFIRE IN VICTORIA IN AUSTRALIA

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ABSTRACT:

The utilization of remote sensing satellite data for fire monitoring has been more than a decade, and currently mainly relies on the EOS/ MODIS satellite series. MODIS has specialized thermal infrared channel to catch the launch characteristics of the fire geothermal energy, of a high capture efficiency of fire point. China resources and environment remote sensing satellite constellation, Launched in 2008, is the first small satellites constellation for the purpose of environmental and disaster monitoring and forecasting, with a wider monitor band, higher ground resolution. In March 2009, a bushfire took place in Australian south-eastern region, the fire orientation changes frequently, raised an urgent need of remote sensing monitoring. In this paper, choose three band images of China resources and environment remote sensing satellites for process and integration, by comparing and analysis of the data source, on this basis, a fire zone classification map rapidly established. In comparison with NASA's MODIS provided data, our results in the fire zone with a higher recognition accuracy. The research result has been sent to the Australian for the fire monitoring and rescue, and achieved good economic advantages. It but also provides a new technical route for future remote sensing fire monitoring.

1. INTRODUCTION

February 7, 2009, Australia's most densely populated south-east have experienced the highest temperature since meteorological records.

Accompanied by strong dry winds and heat in Victoria, a number of bush fires occurred, in the evening, February 8, has confirmed that 84 people were killed; the death toll far exceeds the state's February 16, 1983 bush fires (known as Ash Wednesday, resulting in 47 deaths). Till 13 o'clock on the February 9, 2009, 131 people have been killed and 750 houses burned down, the death toll is still rising. The fire covers 3,000 square kilometers area, if the fire was not controlled in time, it will result in significant loss of lives and property. The main obstacle to fire fighting is the wind, makes hard to predict fire direction and reinforcement deployment.

Therefore, whether monitoring of the fire accurate and in time or not is the key issue of disaster emergency response. At this time, Australia government appeal for assistance all over the world, in China, the fire also makes the Chinese Academy of Sciences, Ministry of Science and Technology, Ministry of Civil Affairs and other units for Disaster Reduction of great concern. We proposed to use remote sensing instruments as a technical advantage, on the monitoring and analysis of current fire, scope, trends, and settlements in the vicinity, to provide technical assistance timely to the people of Australia. This article is a summary and record of research work at the time.

2. DATA SOURCE SELECTION

The use of NOAA, FY satellites and EOS / MODIS satellite data series in forest and grassland fires monitoring have been more than a decade, and is currently mainly depends on the EOS / MODIS satellite series, namely, the Earth Observing System, which launching in 1999. The reasons include: ① MODIS has specialized thermal infrared channel to catch the launch characteristics of the fire geothermal energy, of a high capture efficiency of fire point, it is saturated 12 bit data for the relatively high temperature; ② band covers long range, and can combine data from different wavelengths thermal analysis; ③ high temporal resolution, per day respectively two set of the day and night images of global coverage; ④ NASA open the global MODIS data receiving, and the data used for direct broadcast transmission free of charge, data acquisition convenient and quick. But the MODIS satellite sensor is the level of the last century 90s, already cannot adapt to the environment, disaster monitoring accuracy.

September 2008, China began to launch environment and disaster monitoring and forecasting small satellite constellation, which composed by two optical satellites and one small synthetic aperture radar satellite, it is the first small satellite constellation for the purpose of environmental and disaster monitoring and forecasting. Two optical satellites in orbit are equipped with wide-coverage multi-spectral visible light cameras, capable of a 48-hour global coverage of a ground resolution of 30m and Infrared Camera 96-hour global coverage of a ground resolution of 150m. They provide a scientific basis for timely reflect the ecological environment development process and disasters changes, and to carry out rapid assessment of the disaster, for emergency response, disaster relief and reconstruction efforts.

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3. RADIATION CHARACTERISTICS OF FIRE POINT

According to Wien Displacement law, the radiation wavelength peak λmax moving to the short-wave with temperature rises:

λMAX (T) = 2892 / T (λ: μm, T: K)

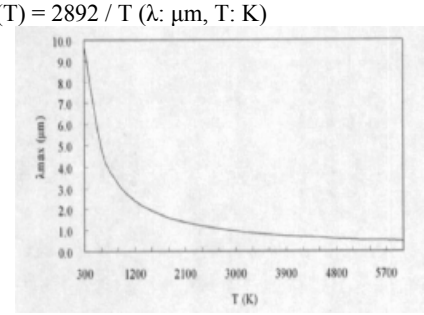

Figure.1. The curve of relationship between blackbody radiation spectrum wavelength and temperature[1]

Figure 1 shows the peak radiation changes with temperature. Statistical data shows that the temperature of bush fire between the range of 500K ~ 1000K, so the radiation energy should be mainly concentrated in the 2.8μm ~ 5.7μm span. Through the ground experiments proved the results, that including bush fires, including high temperature combustion flame have characteristics similar in the spectrum of radiation, the radiation concentrated in two discrete regions, strong band in between 3.5 ~5μm, the weak band in the 1.5 ~ 3μm, the other spectrum bands radiation is relatively small.

Table 1 the sensor parameters of in-operation China resources and environment remote sensing satellites

platform	payload	band Name	spectral range(μm)	spatial resolution (m)
HJ-1A	CCD camera	B01	0.43-0.52	30
		B02	0.52-0.6	30
		B03	0.63-0.69	30
		B04	0.76-0.9	30
	Hyper spectral Imager	-	0.45-0.95	100
HJ-1B	CCD camera	B01	0.43-0.52	30
		B02	0.52-0.6	30
		B03	0.63-0.69	30
		B04	0.76-0.9	30
	Infrared multi-spectral camera	B05	0.75-1.1	150(Near infrared)
		B06	1.55-1.75	
		B07	3.50-3.9	
		B08	10.5-12.5	300(10.5-12.5μm)

Table 2 Fire detection relevant sensor parameters in MODIS

Band name	wavelengt h/μm	resolutio n/m	spectrum
ch1	0.62～0.67	250	visible light(red light)
ch2	0.84～0.87	250	Near-Infrared
ch6	1.62～1.65	500	Near- Infrared
ch7	2.10～2.13	500	Near-Infrared
ch20	3.66～3.84	1000	mid-infrared
ch21	3.92～3.98	1000	mid-infrared
ch22	3.92～3.98	1000	mid-infrared
ch23	4.02～4.08	1000	mid-infrared
ch24	4.43～4.49	1000	mid-infrared
ch25	4.48～4.54	1000	mid-infrared
ch31	10.7～11.2	1000	far-infrared
ch32	11.7～12.2	1000	far-infrared

According to the sensor parameters of in- orbit environmental monitoring satellites, it is obviously that, compared with the MODIS sensor, B06 has better ability to capture the weak radiation of bush fire, B07 can capture the strong radiation band of bush fire better. For the same amplitude, MODIS need three-band: CH6, CH20,CH21 to cover, with a maximum resolution of500 meters. Clearly, the use of satellite resources BO6, BO7 band to monitor bush fires, can achieve a higher degree of resolution than MODIS data, is more suitable for radiation monitoring of bush fires. Therefore, in the fire zone monitoring in Australia, the adapt data source is China's environmental satellites, bands B06, B07.

4. IMAGE FUSION

Remote sensing image fusion from multiple sensors are interpretation technologies to obtain images of the same scene or the same sensor at different times of the same scene to obtain image data and spatial or temporal image sequence data, and then using a certain algorithm combine the complementary strengths of the image data or serial data to generate new image data or scene.

By a single sensor as a result of diffraction of light energy and the decision to distinguish the limits of the imaging system modulation transfer function, signal to noise ratio of three constraints, it is necessary and very difficult to obtain spectra at the same time, high-resolution space and time. Multi-sensor image fusion technology can be effective as a result of the use of multiple images provides complementary information and redundant information, therefore the integration of the image after the description of the scene than any single source image are more comprehensive and accurate.

Multi-source remote sensing image data can be divided into levels: pixel level (before the feature extraction), the characteristics of class (before the property description) and decision- making level (after the independent properties of

the sensor data identified). Therefore, image fusion can be a corresponding level in the pixel, feature level and decision-making level, which constitute the three kinds of integration. The level of integration of multi-source raw data determines the extent of pre-processing, and information processing in which the implementation of the integration level.

Pixel-level image fusion is a fusion algorithm based on space registration multi-source remote sensing image, after integration, the image feature and description attributes extracted. It is processing directly on the original image pixel point, is a minimum level of integration. However, the advantages of the pixel-level image fusion is that it maintained as much as possible the original image information, can provide the subtle information of integration of the other two do not have.

In monitoring the Australia bush fire, the various types of image data registration completely, differences only exist in resolution. On the one hand, infrared band capture the bush fire zone very effective, on the other hand, the four Multi-spectral bands, with high ground resolution will help to determine the surface and the degree of fire hazard. Therefore, the infrared and multi-spectral bands will be, respectively, integrated.

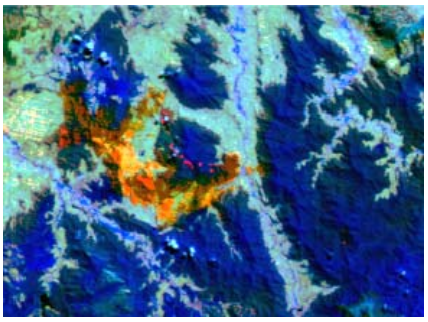

Figure. 2. The B06, B07 fusion map of eastern region of the fire areas

In the above image, the fire point signified by red light from the B07-band, orange-red spot from the B06 band, but also the region joined the DEM. Integration of the expression can show the fire district, to provide an accurate basis to determine the direction of the fire. Shortage is ground resolution not very high.

Figure. 3. Multi-spectral (B01, B02, B03, B04-band) fusion map of eastern region of the fire areas

Multi-spectral band of China resources and environment remote sensing satellites has ground resolution of 30 meters, the expression of ground targets can be well observed, ,as indicated in Fig3. Therefore, to provide an accurate determination of the fire district , trends and fire hazards, multi-spectral and infrared band will be mixed, and the outline of the fire area described by the vector to facilitate the firing line length and the volume of the fire area calculation shown in the following picture.

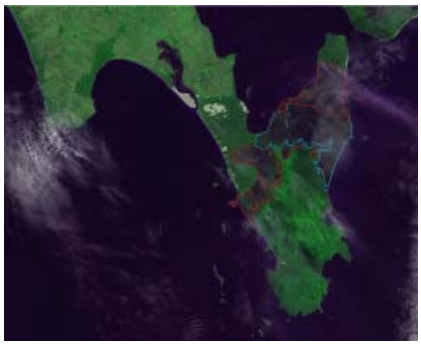

Figure. 4. The results of Wilson Kok National Park borders after integration

Area in the red border on the map is February 23 images reflected the fire scene, the blue range reflect the fire boundary of February 16. Calculated in February 16, 2009 Wilson Kok National Park, the fire area reaches 157 square kilometers, while February 23 has gone too far of 233 square kilometers area, the fire scene clear the expansion of the northeast and southwest, with an increase of 76 square kilometers.

5. RESULTS COMPARISON

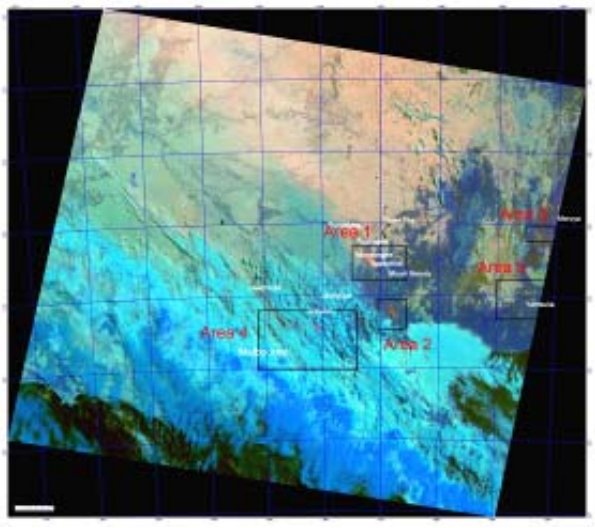

Figure. 5. February 10 monitoring results of china resources and environment remote sensing satellites

Figure. 6. February 10 NASA provided results of MODIS [6]

Our results based on china resources and environment remote sensing satellites did not accurately capture the (1) (2) (3) fire zones, due to different temporal phase, our obtained data in AREA4 region is too cloudy to classify the fire district. And in our results AREA2, AREA5 is absent in NASA's results. AREA5 region has a quite small size, there may be omitted by MODIS images resolution (1km), but in larger AREA2 region, NASA images also failed to identify, is likely to show is the lack of MODIS fire capacity.

In general, in the use of Chinese resources and environmental satellite data for bush fire monitoring, bands more in line with the laws of fire radiation, and with high resolution, easy to deal with fewer types of data, very suitable for rapid monitoring of bush fires. The practice of this study has provided the new technical route to monitoring bush fires; it fully proved the Chinese resources and environmental satellites have large-scale natural disasters, all-weather, all the time, dynamic monitoring and assessment capabilities to solve our country's space technology-based self-monitoring system disaster problems from scratch. Of course, the Chinese resources and environmental satellite constellations there is still a considerable deficiencies. First of all, for disaster monitoring, temporal resolution is an important indicator, repeated observations of the same places by broad multi-spectral coverage camera available within 48 hours, and the others remaining 96 hours obviously does not meet the disaster monitoring time resolution demands like refreshing data in several hours, In addition, the lack of optical payload mainly reflected in a lower spatial resolution data. The highest resolution of Multi-spectral is only 30 meters. It needs to continuously improve payload to achieve higher resolution image to accurately assess the disaster.

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