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IR Remote Sensor and Lidar for Environmental Monitoring in China Space Industry Ministry

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1. Introduction

The space-borne IR remote sensor and lidar is a difficult and applicable technology. It is combined together with the photo-electronics, computer, fine mechanics and space technique. With more than 30-year experience of the lidar development, China Space Industry Ministry (CSIM) has started to take interest in space borne lidar and IR Remote Sensor. With the economic development of China, the atmospheric pollution in big cities is becoming serious, where are characterized with high dense industries, heavy traffic and dense population. So it is necessary and important to develop IR-remote sensor and lidar to serve for the atmospheric monitoring.

In general the sampling analytical method on the earth surface is used to monitor the air environment of cities. This is not the 3-D real-time monitoring of the atmospheric environment over great areas. Since compact and efficient diode laser appeared after the end of 1980s and the diode pump solid laser has developed rapidly, it is possible to develop the lidar with low cost, compact and efficient systems.

2. IR remote sensor

The space borne IR remote sensor (SIRS) is a kind of servers for environmental monitoring and weather forecast. CSIM began to develop on IR technology at the end of 1950s. For more than ten years some satellites with SIRS have been launched. The FY-1 testing satellite, the FY-1(01) satellite and the FY-1(02) satellite were launched in 1988, 1990 and 1998, respectively. The FY-2 immobile meteorological satellites was launched in June 1997, and again launched in 1999.

The SIRS on the land resource satellite is different from meteorological satellites, with high spatial resolution, high optical spectrum resolution and accurate locating in space. We can see that there are great difference comparing with those of others countries, although it hasn't launched so far.

China has wide oceanic domain and long seacoast line. In recent years ocean pollution in China is very grave. The red tide often happened and took place with great area in South Sea. The sea ecological balance has been affected by the red tide. In order to monitor the ocean environment a new kind of ocean IR scanner is developing. It will be launched in 2000. Table 1 shows the main characteristics of the space borne IR-remote sensors.

Table 1 Main characteristics of the space borne IR remote sensors

Remote Sensor	VHPP	VHRR2	MCSR	IRMSS	OWCS	MRIS
Satellite	FY-1	FY-1(02)	FY-2	ZY-1	HY-1	
Waveband	3VIS,1NIR, 1TIR	6VNIR,2SWIR,2TIR	1VNIR,2SWIR,1TIR	1VNIR,2SWIR,1TIR	8VNIR,2TIR	16VNIR,3SWIR,2TIR
Resolution (mrad)	1.2	1.2	0.16	0.1	1.4	0.5~1.2

Sensitivity VL:SNR IR:NE Δ T(K) NE Δ P(%)	 >3 0.25	 >3 0.45	 0.65~1	 1.2 1	 0.2 0.1	 0.2 0.05~0.1

3. Development of lidar technology

In the beginning of 1970s the research of the Nd:YAG lidar and CO_2 coherent lidar started and the field experiments were tested in 1970s. The Nd:YAG lidar were successful, but CO_2 coherent lidar for remote sensing was failed.

As "the culture revolution" in China from 1966 to 1976, scientific research was disturbed. In 1979 Harbin Institute of Technology (HIT) firstly began to develop CO_2 coherent lidar, in 1990 Chengdu Univ. of Electronic Science and Technology started the work too. Afterwards lidar technique was promoted in some institutes. The lidar for the atmosphere was developed in Academe Sciences of China. Two kinds of the CO_2 coherent lidar were developed in HIT. Table 3 and 4 show the characteristic of the lidars. The CO_2 coherent lidar, diode pumped solid laser lidar and semiconductor laser lidar are developing in China. Now the experimental lidar systems have been built in many universities, academic institutes and some opening laboratory of the state and ministry.

4. Future activities and plans

- Lidar network of city environmental monitoring
- System composition development: two Mie lidars and one DIAL lidar. One of Mie lidar is used for measuring aerosol, the other one for wind measurement

Table 3 Parameters of CO_2 coherent imaging lidar

Wavelength	10.6μm
Power	5W
Frequency stability	10^{-8}
Detector	MCT(77K)
Bandwidth	200MHz
Telescope diameter	16cm
Scanner	Double-mirror 2D scanner Rotating hexagonal prism and swing-mirror program control

1) Micro pulse lidar system for Mie measurements.
2) DIAL lidar will measure the specific ingredients, such as O_3 at 0.28μm, SO_2 at 0.30μm, NO_2 at 0.45μm.
3) Semiconductor lidar for the detection of car tail gas.

References

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Table 2 Parameters of lidar systems

Lidar	Ruby Lidar	GaAs Lidar
Wavelength (μm)	0.6943	0.874
Energy or Power	0.41J, 1.3J	40W
Width (ns)	20, 25	140
PRF (Hz)	0.1, 1.0	
Divergence angle (mrad)	1.7	2.5
Telescope diameter (cm)	6, 40	15
FOV (mrad)	2.0, 1.8	
detector	PMT	APD
Max. range (km)	0.15-3	1.5

Frame frequency	0.2 frames/second
Imaging field	7° ×5°
Imaging pixel	128×98

Table 4 Parameters of the CO_2 coherent Doppler lidar

Wavelength	10.6μm
Power	4 W
Telescope diameter	5cm
Frequency stability	10^{-8}