AEROSPACE RESEARCH OF WATER SURFACES POLLUTION BY THE MEAN OF LASER LOCATION

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The paper deals with in compare with traditional contact methods of obtaining of information, the remote sounding provides the broad possibilities of operative collection of data with high spatial. spectral and time solution, and also with high speed of transferring of information to the processing centers. Prognosis shows that the volume of information transferred via space satellites will achieves such values in the near future, that the superhighspeed operating system would be needed for transferring of them.

Oil and product of its processing are most spread substances, which harmfully effects to the sea flora and fauna, what is especially important for Azerbaijan, which is sea and oil producing state.

As it was shown in the nature investigations, the most area of water in the Azerbaijan shore of Caspian sea is covered by oil film, the square of which depends on direction of wind, and for example, equals in the region named as Oil Stones, to 240km^2, in the region of island named Bulla - 11km^2 and in the region of bank named after Mackarov – 8 km^2 [1].

The existence of oil film in the surface of water changes the proceeding of physical-chemical processes in the border "Water-air", substantially effects to the amount of dissolved oxygen in the water, which could bring to decrease and disaster of fish resources of sea.

The solving of problems of protection of environment and rational using of natural resources in signification level depends on development and applying of technical means of control of parameters of ecological media.

The research of pollution's of environment by the mean of optical apparatus of remote sounding, mounted on the board of flying apparatus or space satellites, is one of intensely developing directions.

In compare with traditional contact methods of obtaining of information, the remote sounding provides the broad possibilities of operative collection of data with high spatial, spectral and time solution, and also with high speed of transferring of information to the processing centers. Prognosis shows that the volume of information transferred via space satellites will achieves such values in the near future, that the superhighspeed operating system would be needed for transferring of them. For example, during remote sounding of Earth from space satellite flying on low orbit; to transfer the image with solution 10m in the ten spectral bands with solution equal to 8bits, the system with the speed of transferring no less than 1Gbit/s is needed.

The development of systems with such speeds of transferring of information by the mean of radio apparatus is a problematical task. Using of optical band of electromagnetic waves can solve this task. Besides, the optical link is not sensitive to the ionization of atmosphere and has higher protection from interference and higher directivity of radiation. Indeed, in the circular antenna with diameter 3m in the SHF-system of 3 cm band, the angle of beam's divergence is equal to 10 mrad, which is considered as sufficiently low for SHF band.

In the optical band, if the wavelength is equal to 0,5μ, the diameter of receiving antenna is equal to 10cm, the theoretical value of divergence angle γ_a=5 mcrad and in order to provide the same level of received powers it is sufficient to use the transmitter having power of radiance less than 66 dB in comparison with power of SHF transmitter [2].

The theory of measuring of oil film's thickness by the help of laser location in detail described in [3]. The principles of straight-line spreading of electromagnetic waves, reflecting of electromagnetic energy by objects and constant speed of their propagation are laid in the basic of location. The capability of ecological objects to diffuse the electromagnetic wave fallen to them, is estimated by effective square of scattering, (ESS), which should be considered as factor of proportionality between power of wave P_D, diffused by object of location observation, and density of power stream P_S, of wave fallen to it [3].

$$P_D = ESS \frac{P_S}{4\pi L^2}, \qquad (1)$$

where L - the distance between receiving antenna and ecological object. While using the non-directed antenna, the density of power stream on the distance L from station could be found by dividing the radiated power P_I to the square surface of sphere.

$$P_S = P_I / 4\pi L^2 \qquad (2)$$

For directed antenna the density of power stream in the direction of maximal pulse radiation P_I should be multiplied to the factor of directed effect G of transmitting antenna.

$$P_S = GP_I / 4\pi L^2 \qquad (3)$$

If the ecological object is situated in the direction of maximal radiation of antenna, the diffused by object power should be determined by formula:

$$P_D = ESS \frac{G \cdot P_I}{16\pi^2 L^4} \qquad (4)$$

Indicated the effective square of receiving antenna as S_a, we find the power of reflected signal, which received by antenna of location station.

$$P_R = ESS \frac{G \cdot P_I \cdot S_a}{16\pi^2 L^4} \quad (5)$$

The main equation of location shows the dependence of power of reflected signal from parameters of station, character of ecological object and distance up to it.

Among the active methods of control of ecological media's parameters the widely used one is method of laser location, where the information about the distance up to investigated object is contained in the parameters of reflected (diffused) optical radiance.

The magnitude of signal while reflected from oil film on the water surface is determined by equation (5) which taking into account the feature of laser beam's propagation, is transformed as (4):

$$P_R = ESS \cdot G \cdot P_I \cdot S_a \cdot K_{opt} \cdot T^2_{atm} \cdot T_C / 16\pi^2 L^4 \quad (6)$$

The fading of radiance in the receiving optical device is taken into account by factor k_{opt}, and the square meaning of factor T_{atm} denote the equal spectral admission of optical radiance for direct and reverse pulses, and T_C - is the factor of fading of reflected radiance by corrugated water surface,

$$T_C = 1 - exp\left(-\theta^2 / 4a_\Delta^2\right), \quad (7)$$

where a_Δ – parameter of corrugation. According to [5] the sea surface is characterized with following values of parameter of corrugation: a_Δ^2 =0,02 while the speed of wind 5 m/s, a_Δ^2 =0,04 while v=10 m/s. Because that, accounting of corrugation of water surface is important for remote sensing of pollution's. We have developed lidar for controlling of chemical pollution's of water surface, where helium-neon type laser "LGI-102" having power 3mW working in the pulse regime is used as beam radiator [6]. During the experiment the laser was mounted on the plain ground on the distance 1 meter from water surface. The prism was placed in the road of propagation of laser beam and used for direction of radiation under the angle 45° on water surface. Integral phototransducers on the basic of local films of mono-and polycrystallic silicon with linear output was used in the photoreceiving device [7]. Phototransducer was made in hybrid-film form on the basis of two crystals: photosensitive polysilicon film and unframed operational amplifier 740UD4. The minimal level of radiance power, detected in the spectral band 0,5÷1 μ was equal to 10 W/cm. The dependence of output voltage from illumination was of linear type till values of 6000lx, with sensitivity no less than 10mV/lx.

The signal from output of phototransducer was transferred to the input of processing device and then was registered by analyzer of high-speed processes, including oscillograph, millivoltmeter and indicator. The results of measuring of various types of water surface's pollution have been shown in the table 1, from which it is clear, that reflection powers of polluted and clean water differ 2-4 times.

Table 1. Results of lidar on the basis of laser "LGI-102"

Type of water surface's pollution	The voltage of registered signal, mV
1. Clean water	200
2. Condenser oil	300
3. Machine oil	420
4. Benzine	450
5. Oil film	570
6. Diesel fuel	800
7. Bitumen varnish	960

The presence of film of oil product in the surface of water increases the reflected signal due to two reasons. Firstly, the oil film increases the reflecting capability of water surface. Secondary, the oil pollution's stabilize the seaways and accordingly decreases the corrugation 2-4 times.

The results of estimation of effects of seaways to the value of reflected signal of lidar are shown in the table 2.

The data shown in the table 2 indicate that seaways bring to significant decreasing of reflected signal. From another side, on account of smoothing of seaways the signal, reflected from corrugated water surface covered by film, approximately 3 time more, than signal reflected from clean water. The tests had shown the possibility of using of lidar to identify the water surface pollution's in principle.

Table 2. The factors of decreasing of reflected radiance from water surface by seaways.

θ, mrad	V_{wind} = 5 m/s		V_{wind} = 10 m/s	
	absence of film	presence of film	absence of film	presence of film
3	0,11	0,34	0,05	0,16
6	0,45	1,36	0,23	0,67
52	33,6	98,6	17,0	50,2
100	117,5	315,3	60,5	171,3

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SU SƏTHİNİN ÇİRKLƏNMƏSİNİN LAZER LOKASİYASI ÜSULU İLƏ AEROKOSMİK TƏDQİQİ

Məqalədə ətraf mühitin çirklənməsinin təyyarələrdə quraşdırılmış optik distansion cihazların köməyi ilə tədqiqinə həsr olunmuşdur. Mə'lum üsullardan fərqli olaraq distansion zondarma üsulunun operativliyi və digər üstünükəri göstərilmişdir.

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АЭРОКОСМИЧЕСКИЕ ИССЛЕДОВАНИЯ ЗАГРЯЗНЕНИЙ ВОДНОЙ ПОВЕРХНОСТИ С ПОМОЩЬЮ ЛАЗЕРНОЙ ЛОКАЦИИ

Статья посвящена изучению посредством оптической аппаратуры дистанционного зондирования, установленной на борту летательных аппаратов или с ИСЗ, загрязнения окружающей среды. Этот метод является одним из интенсивно развивающихся в настоящее время. По сравнению с традиционными контактными методами получения информации дистанционное зондирование обеспечивает широкие возможности оперативного сбора данных с высоким пространственным, спектральным и временным разрешением, а также с высокой скоростью передачи информации в центры обработки. Прогнозы показывают, что объемы информации, передаваемые через ИСЗ, в скором будущем достигнут таких величин, когда для их передачи потребуются сверхбыстродействующие системы.

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