Remote sensing of environment on the base of the microavition

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Abstract – The technique of unmanned air vehicle/UAV/ using in Russia for shooting of environment/forest fires, slicks and some another accidents/ are described.

Physical principles of remote detecting carbonates on the water surface are discussed in the report. Laboratory and real life tests of finding out oil slicks by the remote unmanned air vehicle (UAV) have been listed. UAV is applicable for ecological monitoring industrial micro -districts , for controlling safety of oil gas pipe lines and et al.

Tactic-technical characteristics of UAV worked out in SPbSUASIM air technical modeling laboratory are mentioned below. Oil traces have been detected by microtelevision camera in visual and UV spectrum. Slicks diesel and motor oil have been registered by a ultra- -violet ray camera. The reflecting ability motor ones compared diesel and patrol is the highest and best seen in nearest UV part of the spectrum. There are spectral peculiarities of carbonate containing slickers not only within 300-420 nm ,800-950 nm but also within IR-area out of the stripe and at 1700 and 2350 nm length waves. Oil products reflect better than water in microwave region (3.4 and 12.5 GHz) are discriminated by IR cameras, IR-scanners and microwave radiometers. The last being too heavy and not reasonably power consuming. That is why microtelevision system of 400 tv-lines allowance and 30 angel view has been used during tests, but IR cameras was utilized only sometimes.

Keywords: unmanned air vehicle, environment, accidents, forest fires, slicks.

1. INTRODUCTION

Some advanced unmanned aerial vehicle (Bauer P. M., 1991*;* Ganin S.M.,Karpenko A.V., Kolmogorov V.V.,Petrov G.F. 1999) were based upon integration of traditional UAV and untraditional schemes with utilizing for their flight petrol, solar , microwave energy or electric energy accumulated in their airborne storage batteries . This UAV may use in peace aims for environment monitoring (Langford J. ,1990, Shustov A.V.,Serokhvostov S.V.,Ivanov S.V.,1997). Such UAV can be equipped with appropriate devices depending upon the task to be solved. For example, (Vorontsov P.A., Mixel V.M., Erler A.A. 1964) radio-operated avia models had been used for aerological investigations of atmosphere lower layer. It was very simple and a very low-cost UAV, but one was not reliable in wind weather. Application of powerplant with solar or microwave energy conversion is not comfortable in Russian conditions, that is why SPbSUASIM air technical modeling laboratory are constructing UAV with the petrol motors (Binenko V.I. ,Donchenko V.K.,Andreev V.L.,Ivanov R.V.,2001).

Large spills of oil and related petroleum products in the marine environment can have serious biological and economic impact. According to published facts, in 10 minutes after slicks of one ton 10 mm thick oil layer is spread on the 50 m radius large water area already momentarily. Then 1mm thick oil film covers area of 12 km^2. Ambient oil standard (AOS) for water subjects activity for using drinking-water or cultural- social water using according Russian normative can not exceed 100-300 ppm gramm per liter(μg/l) for oil of different type. Ambient oil standard oral emulsify solution in water is equal to 50mkmg/l for fish seas. There are as much as 0.05-0.1 mg/l oil products in upper layer waters of the Neva river.

In 2000 volume of raw oil transportation by sea reached 1 mlrd t/year. The oil loss during its working out on continental shelf [is 0.1 mlnt /year. In Russia a fifth of 215 000 km log oil pipe line is older than 40, a half being older than 30. Hence the older the oil pipe line there are the more oil pipe line accidents. Public and media scrutiny is usually intense following a spill, with demands that the location and extent of the oil slick be identified. Remote sensing is playing an increasingly important role in oil slick response efforts (Fingas M.F. and C.E.Brown 1997). With a knowledge about slick location and movement, response personal can more effectively plan countermeasures in an effect to lessen the effects of the pollution.

Regional problems of Saint Petersburg neighborhood ecological safety are connecting with: oil terminals of the new ports in Primorsk, Vysotsk, Ust'Luga and correspondingly possible a appearance of slicks in the Finland gulf, from oil tubes, traffic of a sea and land transport, forest fires and another ecological accidents. So oil is on one of the first places among numerous negative technical factors worsening environments as a result of both accident and incident slicks. Currently oil and gas cover more than 60% of world power needs. At building new oil terminals as well as the system of dikes in the Gulf of Finland ecological safety it is provided. The task can carried out on the base of complex ecological monitoring. Automatic flying device controlling within the 15 km radius area might be used to find out extreme situations at the oil terminals and tanker at early stages, to identify their geometric features, to map oil slicks and their spread tendency what assists the local authorities to limit the harm cost.

Requirements for the data gathering in a wide variety of different environmental conditions lead to searching of new opportunities in this field. Modern micro optic-electronic devices / with CCD (charge-coupled device) detectors/ provided much more sensitivity and selectivity than video camera. Another advantage of scanners is that signals can be digitized and processed before display. Such sensor, known as a push-broom scanner has evolved elements, each of which is directed to a different field of view on the ground. Newer technology , new composed materials has applied for constructing of more perfect UAV.

2. REMOTE SENSING SYSTEM

At the traditional way the TV and radio system into UAV and the land block of management by UAV is connected to the computer system inside the special equipped car. Functional scheme of the equipment of management point content GPS and SW antennas for geographic position of underlying surface and for transfer signals between UAV and ground or sea point of management. Figure 1 present management scheme of UAV radio piloted and principle environment monitoring On board avionics include: two TV system /first for piloting, second for environment monitoring/with telemetric information data link in TV signal structure, GPS navigation system, bar altimeter, electronic direction finder and radio beacon. Ground control station is

designed for information receiving and the control of system functioning parts. UAV control principle is manual within visual line of sight or with TV real-time picture transferred from UAV to GCS. The real-time GPS is logged to a user selected “Windows” file to PC for environment mapping procedures.

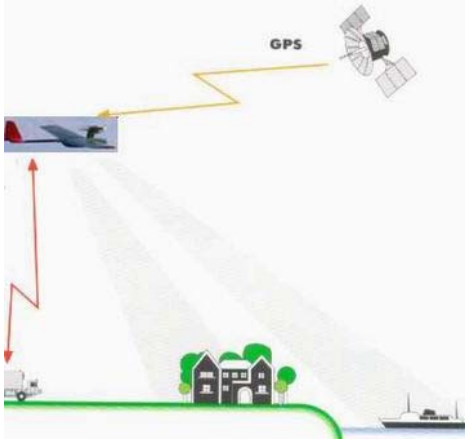

Figure 1. UAVmanagement scheme
and principle environment monitoring.

The microtelevision system of 400 tv-lines allowance and 30° angel view has been used during tests. The uncooled portable IR camera with spectral response from 7 to 14 mkm and field 12*9° was utilized only sometimes in order to inspection for leakage or overheatings, fire detection. The camera has thermally stabilized ferroelectric 320*240-pixel detector. This camera has full TV-standards with thermal sensitivities about 0.3 K.

Remote sensing flights were conducted on summer, winter-any season in morning, in mid and late afternoon with using the catapult for launching UAV. If it is using remotely piloted helicopter that one does not special prepared place and an arrangement.
Figure 2 demonstrates flying UAV and settlement neighbour of near St. .Petersburg.

3. CHARACTERISTCS TACTIC-TECHNICAL of UAV

SPbSUASIM air technical modeling laboratory are designing different remotely piloted aircraft and helicopter more 10 variants in during last ten years. Main tactic-technical characteristics of these UAV following:

Total mass	from 1 to 50 kg ;
Payload mass	0.1 - 7 kg ;
Flight altitude	0 - 1.5 km;
Flight speed	30 -60 km/h;
Lifting velocity	1- 2 m/s;
Wing span	1- 4.5 m;
Duration of flight	0.5 – 1.5 h;
Motor power	10 -100 kW;
Fuel outlay	1-5 l ;
Voltage	6 V;
Electric power	0.1 - 1 kW;
Landing	water/ground;
FM radio band	70-80 MG;
FM TV canal	700 – 800 MG.

Figure 2. Video frames of the underlying surface from UAV.

4. PHYSICAL PRINCEPLE of ACCIDENTS DETECTION

As it is known good, separate physical principles of remote detecting carbonates on the water surface and thermal anomalous from fire are connected with peculiarities of oil slicks reflection in UV and IR spectrum region, especially in second transparency window accordingly. As far as fire detection and mapping IR camera is able to see through the smoke on the base infrared remote sensing(Binenko V.I.,Dyachenko L.N.,Kondratyev.K.Ya., Chernenko A.P. 1972) Figure 3 demonstrates spectral reflectance of water and some spills on water and displays that possibility detecting of carbonate slicks better in UV region then visible and IR band.

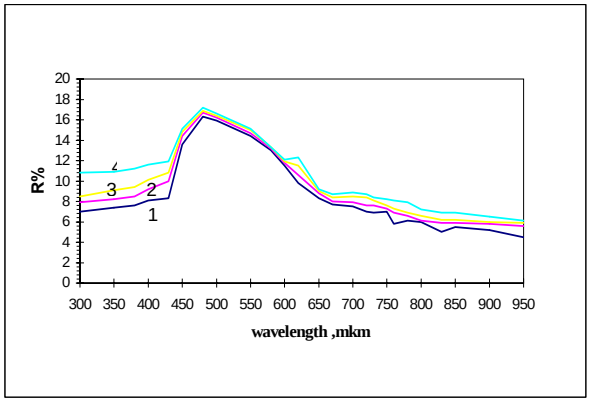

Figure 3. Spectral reflection R(%) water (1), petroleum A-76 (2) , diesel fuel (3) and motor oil (4) on water surface.

visible and near IR/ including and at 1700 and 2350 nm length waves/ may are used for detecting heavy spills also. Oil products reflect better than water in microwave region (3.4 and 12.5 GHz),that is why to detect oil spills on the base microwave polarization radiometry. Variety of microwave, optical, and acoustic techniques for measuring oil thickness has been investigated.. In particular, it is possible radar and laser-based remote sensors but its size and energy consumption do not allow using on the UAV mobile platform.

5. ENVIRONMENT REMOTE SENSING on the BASE of UAV

As we see in Fig. 4, first three frames display influence flight course and sun location on detection of oil spills, next frame demonstrate impossible of the forest fire screening smoke registration, last ones show controlling of situation on the stadium and also car motion on roads and agriculture fields at height less 50m.

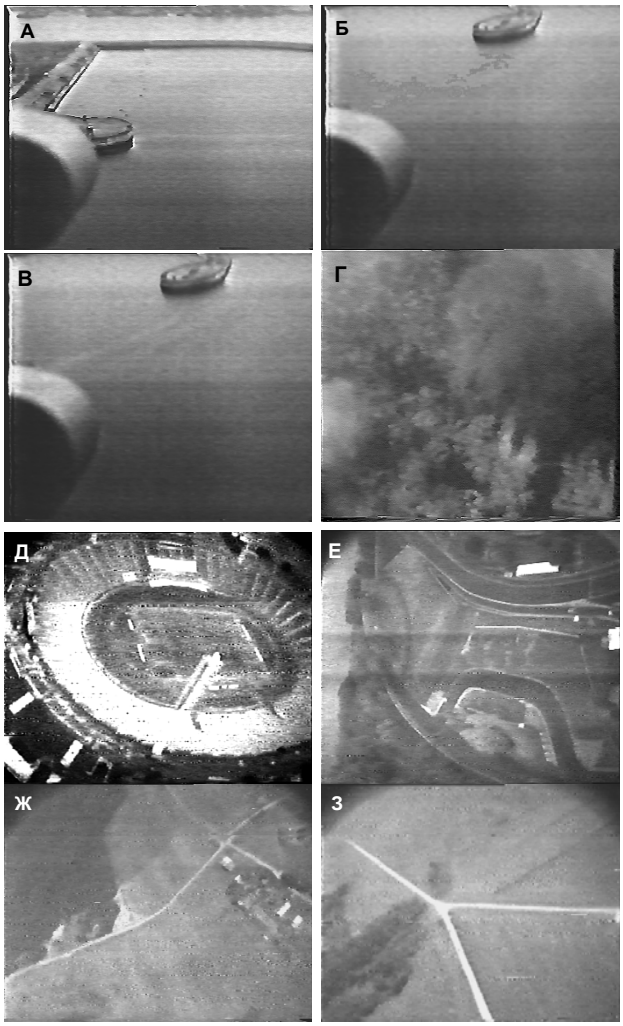

Figure 4. TV-frames underlying surfaces received by UAV.

As we see in Fig.5, first three IR-images/ received by IR camera/ allows to determine thermal anomalous underlying surface, fire centre, settlement and last UV-frame modeled of motor oil and diesel fuel spills on water surface. Black- white IR images /fig.5 and 6/ presented in the false colors. Fig. 6 demonstrate possibility mapping forest fire screening of the smoke cloud with using GPS data.

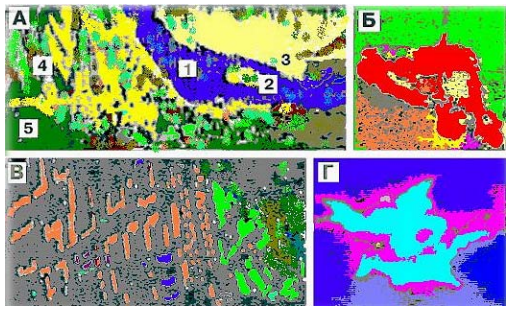

Figure 5. IR-images: landscape, fire centre, settlement, diesel fuel and motor oil slices on water surface (in UV spectral region)

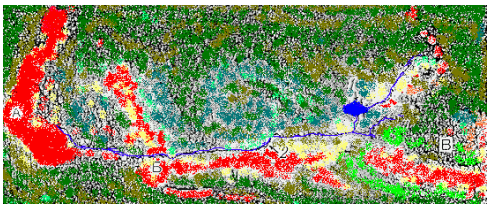

Figure 6. IR-image of the forest fire, river and lake

The UAV technique with special balloons into working compartment able allows to gather biogases over the town rubbish heap to be carry out gas monitoring of atmosphere to height at 10m to 1.5 km in order to determinate its emission from such probes in laboratory conditions. The methane concentration measurements showed emission CH_4 variability at 3000 ppb to 2000 ppb in dependence of flight height, day time and wind direction and wind speeds.

5. CONCLUSION

The method of environment remote sensing on the base UAV flying on the height about 50 m have large potential possibility for decided some regional tasks for :
detection of different oil slicks with using TV-camera sensed in UV spectrum region;
discrimination and mapping forest fires screening by smoke with using IR- camera and GPS;
measurements gases in the atmosphere and aerological characteristics;
control of ecological catastrophe areas, agricultural fields;
for ecological monitoring of industrial micro -districts ,
for controlling safety car motion on roads and oil gas pipe lines and et al.

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