Systems of Spatial Orientation for Helicopter Scanners of Oil and Gas Pipelines

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Abstract. Now checking of oil and gas transportation by pipelines is a serious problem. For its solution it is widely will use thermo image systems fixed on helicopters. The greatest efficiency, in this field is expected from the developed air low-level adaptive infrared scanner, which provides the obtaining of high values of probabilities of discovery, recognition and coordinates defining of objects at change of parameters of an environment and helicopter's flight conditions. The design of this device is leading by Azov Optic Mechanical Plant and "NefteGazAeroCosmos" enterprise (Russia). The Rinavia" enterprise designs the system of definition of spatial position of scanned objects for this scanner.
At the creation of a system observation, it is offered to apply the oblique scanning of a looking matrix of receivers, for the fixed images (sub images) were periodically reshaped on a matrix, it would further be reshaped the full image with the help of digital processing. This way is called as the adaptive digital scanning

Thermo Images Systems for Pipelines

For the last time thw wide application of thermo images devices and devices for night vision is using for the solution of the different national economic problems. Especially actual problems are:
remote monitoring from helicopters the condition of pipelines with the purpose of defining the places of escape of oil, gas, water, etc.;
definition of places of unauthorized insets in oil and gas pipelines;
estimation of a thermal insulation and the places of outflow of a thermal energy from objects of energy complex;
day-night observation for the ecological and fire hazard objects;
protection of objects against the law breakers and so on.
Oil and the gas pipelines have heightened temperatured in contrast with environment temperature, therefore the thermal contrasts are reshaped for the registration even in the case of the underground gasket. It is considered to be, that the aerial thermo images of objects optimally must be fulfilled from small altitudes - 100-200м. The received image allows to define nuances of a thermal print of a pipe line. In particular, the places of leakages, insets and segments are picked out. The places of leakages look variously: - it is contrast very cold local segments for gas pipelines, more warmer segments in contrast with environment segments for oil pipelines.
In a figure 1 it is shown the place of the pipeline damage. In a figure 2 it is allowed to see the place of an underground fire, and in a figure 3 - lets of pollutions into a river.

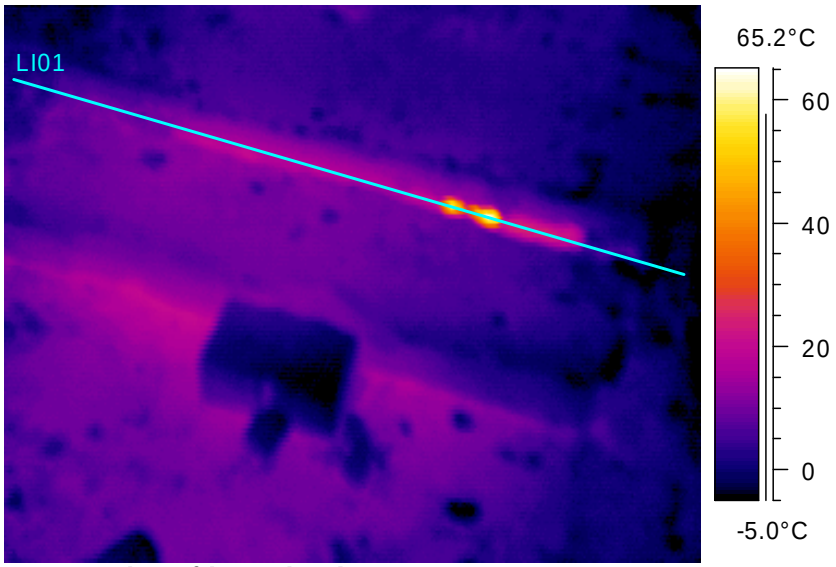

Figure 1: Place of the pipeline damage

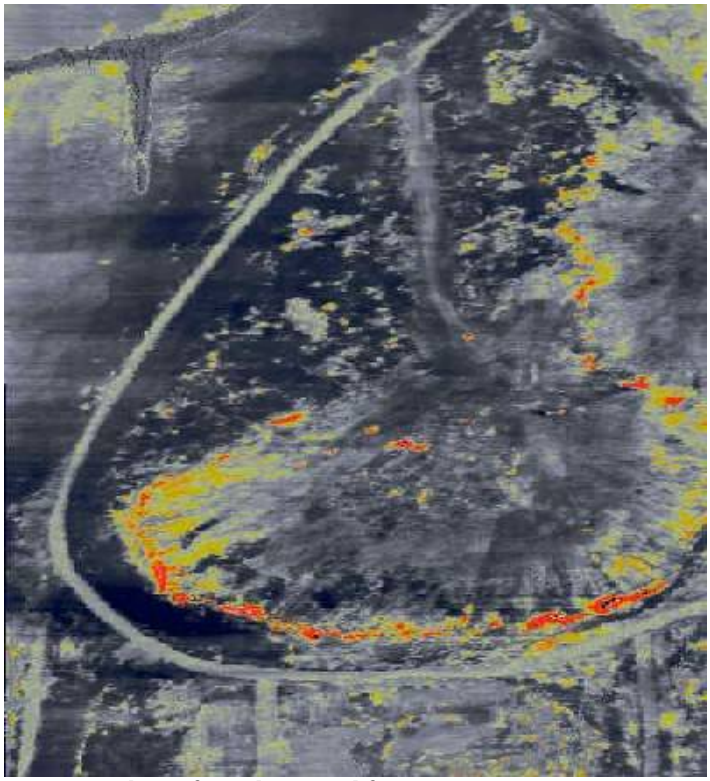
Figure 2: Place of a underground fire

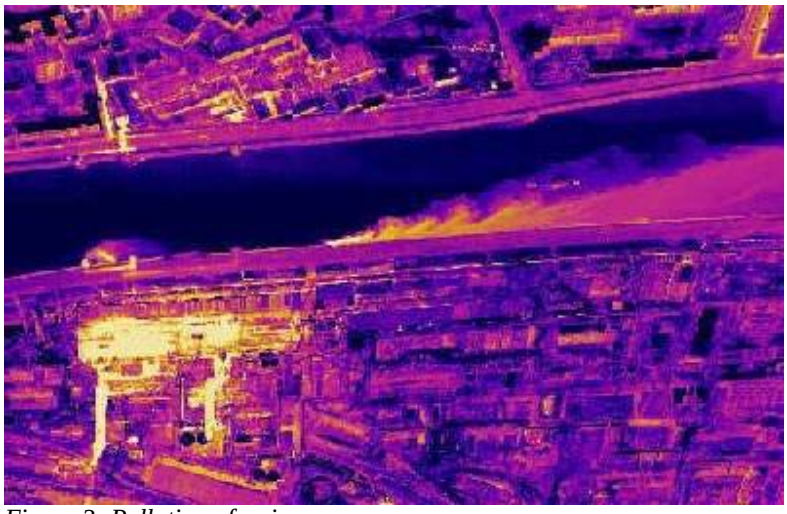

Figure 3: Pollution of a river

It may say, that for increase of efficiency of detection and recognition of objects with the help of thermo images, it is expedient to fulfill the following rules:

· detection of thermal objects is most effectively conducted during morning and evening inverse of thermal contrasts;

· to apply digital algorithms foshaping TV - thermal and - radar images;

· search for technological and anthropogenesis objects masked by a vegetative cover, and also the objects of an organic genesis (oil pollution, products of combustion and so on) to conduct on the basis of the analysis of spectra of luminescence of vegetation and other objects of an organic genesis.

However greatest efficiency, in the sphere of checking of oil and gas transportation is expected from developing at the present time air two-spectral low-level thermo imager with adaptive scanning - "looking" matrix. With the appearance of highly sensitive infrared matrix receivers at the present time the real ability of its realization in “iron” is appeared.

Thaeret is why at the creation of the device of observation it is offered to project on a looking matrix of comperatively small sizes (320 x 256 pixels) image of a surface through the scanner with the linearly - discrete changeable rules of scanning so that on a matrix the fixed images (sub images) were periodically reshaped on a matrix, ge with the help of digital processing. The rules of scanning changes with the help of the controlled electric drive depending on an alteration of speed and altitude of flight of the carrier, and also bank angles, pitch and drift. The motion of the scanner is measured by precise sensors of moving. For exception “smear” of the image in flight direction of the carrier, it is used the controlled member of the scanner "freezing" the image on given time on signals of velocity sensors, altitude and angular position of the carrier. The principle of oblique scanning (figure 4) is usedfor the simplification “seaming” sub images of the map in the scanner. In connection with this, the system tracks the change of a flight performance, the principle is called as adaptive digital scanning.

The application of this principle allows to give the view of an observed surface in a broad field of view and to get rid of the necessity of the use of wide-angle viewers.

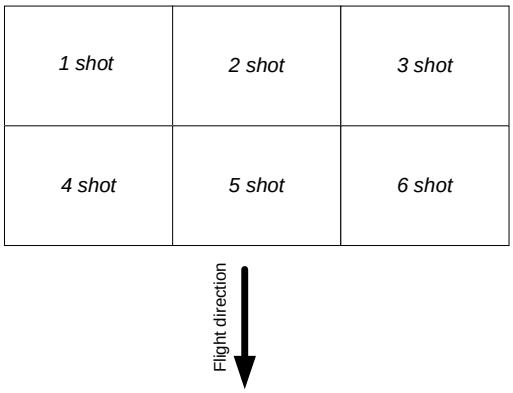

Figure 4: Scheme of shots arrangement

Spatial Orientation for Thermo Image Devices

The connection of this principle allows to give the view of an observed surface in a broad field of view and to get rid of the necessity of the use of wide-angle viewers. The connection of such devices with simple attitude-control systems, is not significant increase the coast of a system allows to conduct a record together with definition of attitude of the thermal receiver. It is necessary, first of all, for "seaming" the image. In fact, the given attitude control system doubles a part of the functions of an onboard flight-navigation complex.

The main problem at the designing of an attitude control system was to achieve reasonable accuracy in definition of the meaning of angles in 0,25 - 0,3 values of an instantaneous field of vision of instrumentation at the low cost and small sizes of the unit of orientation. Last time it became possible owing to the development MEMS technologies, permitting to change expensive gyroscopic instruments by cheap solid-state trace elements. The complexity of the application of low-coasting feeling components is in a low accuracy MEMS components. In order to apply them, there were designed mathematical models and optimal algorithms of filtration of a noisy signal, and also algorithms of signal conditioning from feeling components into the information about the position of the object in space, to fulfill the computer simulation of the system operation of orientation, to design the applicable calculator.

For creation of a mathematical model of the system operation of orientation, three S-functions, depicting activity of the constituents, were designed. The description of the model of the system is shown in a figure 5.

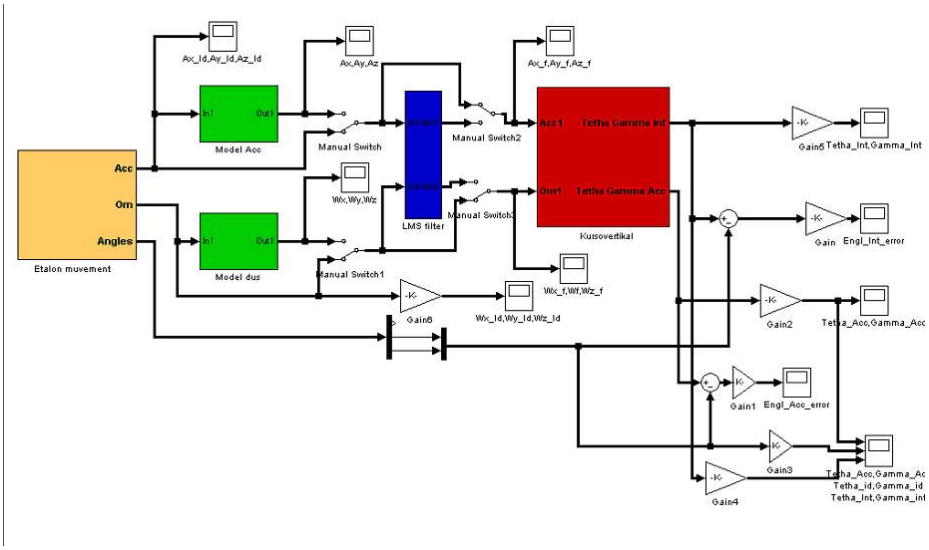

Figure 5: Scheme of mmathematical model of attitude system

The designed mathematical model has allowed to forecast accuracy of the characteristic of a system operation in conditions, when there is no a capability to make a correction of an angular position by external sources or by accelerometers. For simulation of aprocess of correction of a gyro horizon the applicable program module is entered into the structure of a mathematical model. The problem of digital processing of the advanced information acting from gyroscopic sensors, accelerometers, air pressure probes and the receiver of a satellite navigator was resolved in the calculator on the basis of the signal processor. The information about the current bank angles, pitch, course, altitude, speed computed on the basis of algorithms realised in the processor, was given to a customer in the format UART of the interface, that allows to switch on the own minidisplay. There are also three galvanic unloosened of the interface RS232 (for GPS), RS422, CAN in the calculator. The capability of issue galvanic unloosened both discrete commands, and signals of a pulse-width modulation is stipulated. The example of the monitoring interface of an attitude-control system on the personal computer is shown in a figure 6. The parameters, concluding on the separate minidisplay, are shown in a figure 7.

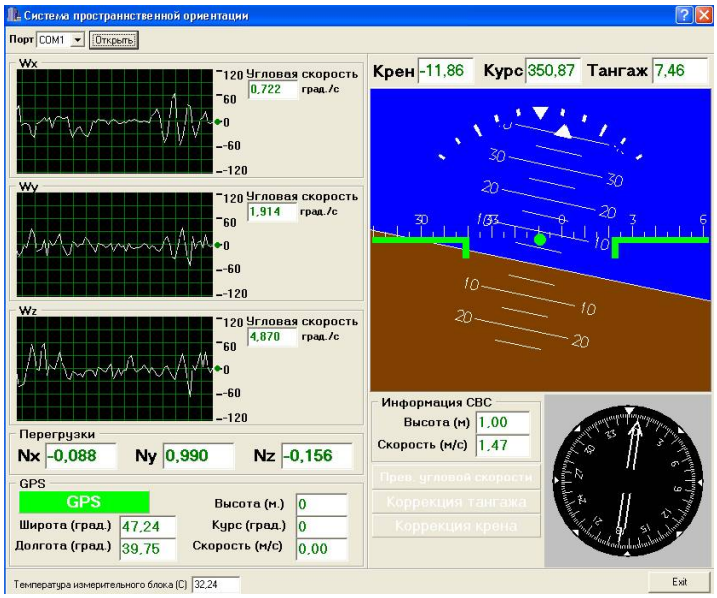

Figure 6: Monitoring interface of an attitude-control system on the personal computer

Figure 7: Minidisplay connecting with attitude system

Experiments confirm the adequacy this device to helicopter thermo image scanners.
It is necessary to expect, that in a near future thermo images system of oil gas pipelines checking will leave on a new quality level and will be able essentially increase safety and economic efficiency of hydrocarbon transportation.