THE CONCEPT OF PASSIVE OPTONAVIGATIONAL SYSTEM

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ABSTRACT

Thermovision is known physical phenomenon based on emission of electromagnetic fields by each body with temperature above than absolute zero. This emission is called, for the sake of the length of the wave, infrared emission and for the sake of its property – thermoemission. Intensity of thermoemission is proportional to the temperature of the body. So, during measurement of infrared emission of the body there is possible to indirect measure its temperature.
Characteristic application of the thermovision can be usage of thermoemission radiated by moving object for its localization. In this paper the concept of passive navigational system working on the basis of thermovision cameras has been presented. There has been assumed, that at least two cameras placed on the land are used for detection and tracking objects emitting infrared waves.

INTRODUCTION

The optionavigational system will be the positioning system, which works (determining the position of the object with passive method) on the basis of using at least two thermo vision cameras. These devices enables objects' detection regardless of day or night time and weather conditions.
During designing the optionavigational positioning system, there has been assumed, that at least two thermo vision cameras placed on land will be used for detection and tracking objects, which are the sources of infrared waves.
In reduced variant of the system there is possible to use photogrametry cameras, which limit detection of the objects to day time and good weather conditions (without the fog and precitipations).
During designing the model of the system there is necessary to work out following stages of its operation:

- **detection – on the basis of object's thermovision features,**
- **canvassing (automatic) – when the object is in observation sector of the camera – initiation of the tracking begins without operator's action,**
- **tracking – determination of the position and the moving parameters of the detected object for visualization,**
- **visualization – presentation the symbol of the detected object and its moving vector in dedicated ECDIS – Electronic Navigational Chart and Information System.**

GUIDELINES

During designing the optionavigational system there will be worked out following issues:

Main guidelines for creating the optionavigational system using optical sensors. As sensors can be used photogrametry cameras, which limit detection of the objects to day time and good weather conditions. For detection the object in limited visibility condition and night time, there is necessary to use thermo vision cameras.

Working out the algorithm of detection and identification the detected object and its (algorithm) computer implementation (client application). As the source of information will be used the thermo vision camera. Worked out detection algorithm will be designed for canvassing and tracking detected object of thermal radiation, and computer application will be universal for all (no less than two) sensors.

Working out the algorithm of data transmission from client applications to visualization system (server application). In connection with distracted location of sensors, there is necessary to transmit data in the form of pictures or position and moving parameters of detected objects to application designed to data presentation of detected and tracking objects.

Determination working and accuracy areas of the optionavigational system. There is assumed, when location of sensors and orientation of their axis are known, there will be possible to determine the position of detected objects in optical – azimutal system. For maximizing positioning accuracy, there is necessary to optimize sensors' location and to determine working and accuracy areas.

For designed model of the system the prototype will be done. Sensors located in position determined during working out working and accuracy zones with client applications and server one will be used.

Working out the visualization system. Obtained navigational information from sensors will be presented in dedicated ECDIS – Electronic Navigational Chart and Information System. There will be worked out presentation system with the module for recording data for analyze.

Testing the system. For comparing tests can be used AIS – Automatic Identification System as the system transmitting in real time position, moving parameters and other static and dynamic parameters. This system can be treated as reliable source of data in accuracy limits of positioning system used by individual object.

Verification and correction the model. Data from designed system and AIS should be compared. Accuracy of positioning and moving parameters determination should be estimated and comparing criteria should be determined. In case of discrepancy, the model of determination the position and moving parameters of detected object with passive method using information about thermal field radiated by the object will be verified.

Fig. 1. Detected object and its thermovisual image.

PIROMETER SELECTION CRITERIA

Pirometer – measurement device for touchless temperature measurement. It works on the basis of analyze of thermal radiation of the object and it is used in thermo visual cameras.

Before selection suitable pirometer, following issues should be determined:

- **working variant: portable or stationary,**
- **temperature measurement range,**
- **minimum measured area of the object (diameter) and minimum measured range – it is important for determination the pyrometer resolution,**
- **measured surface – it is important for determination pirometer's emission coefficient – constant (usually 0.95) or changeable,**
- **additionally, for stationary pirometer, there is necessary to determine output signal type and environment conditions: air temperature, smoke, dust.**

The most important technical parameters of the pyrometer (thermovisual camera), from designing the system point of view, are:

- **optical resolution,**
- **emission coefficient,**
- **observation sector.**

Optical resolution

Pirometer measures mean temperature of measured field called pirometer's optical resolution. Optical resolution is one of the most important parameters of each pirometer. It describes the scale of measured field depending on the distance the pirometer from measured object and usually is expressed as D/S ratio (Distance/Spot). Optical resolution is not constant parameter and depends on the distance. D/S parameter describes in focus point of lens and decreases, when the distance increases.

Emission coefficient

Emission coefficient describes ability of individual object for emission its energy. This coefficient is the number from 0 to 1 and the measure is easier and more precisely, when the coefficient is close to 1.
Below main technical parameters of selected thermovisual cameras have been presented.

Table 1. Main technical parameters of selected thermovisual cameras

	lens	resolution	Spot
ThermaCAM SC3000		320 240	
ThermoVision A40M		320 240	45 34
ThermaCAM Phoenix	13 mm	320 240	40 33
ThermaCAM Merlin	13 mm	320 256	41 31

OPERATION AND ACCURACY ZONES

During designing the system, there is necessary to determine the operation zone and the accuracy one. Determining the zones is well known issue in radionavigation. For optonavigational system using cameras (device with sector observation area), the operation zone decreases with relation to round (radionavigational) devices.
Below hypothetical operation zones have been shown.

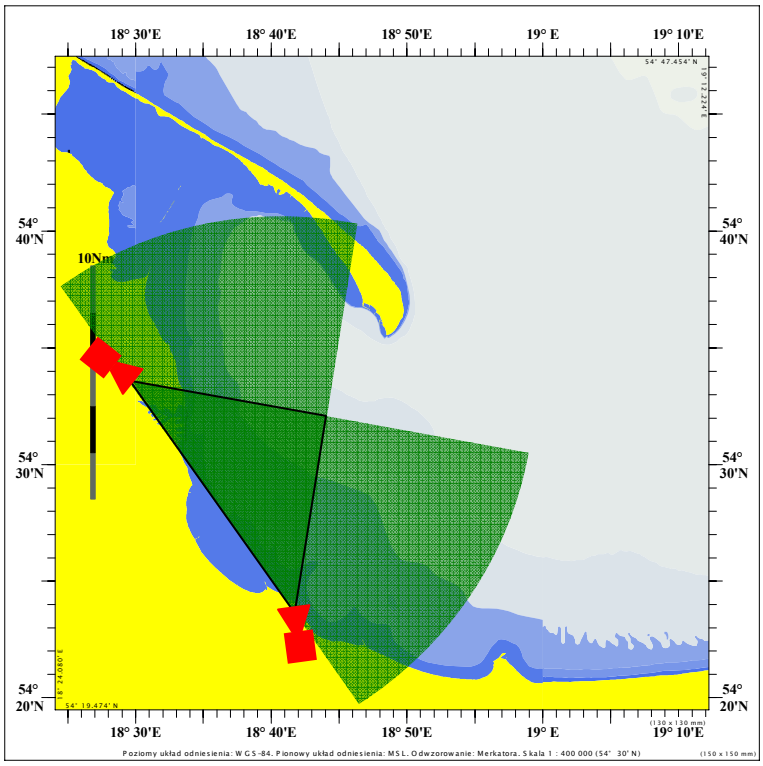

Fig. 2. Observation sectors of thermovisual cameras and working zone.

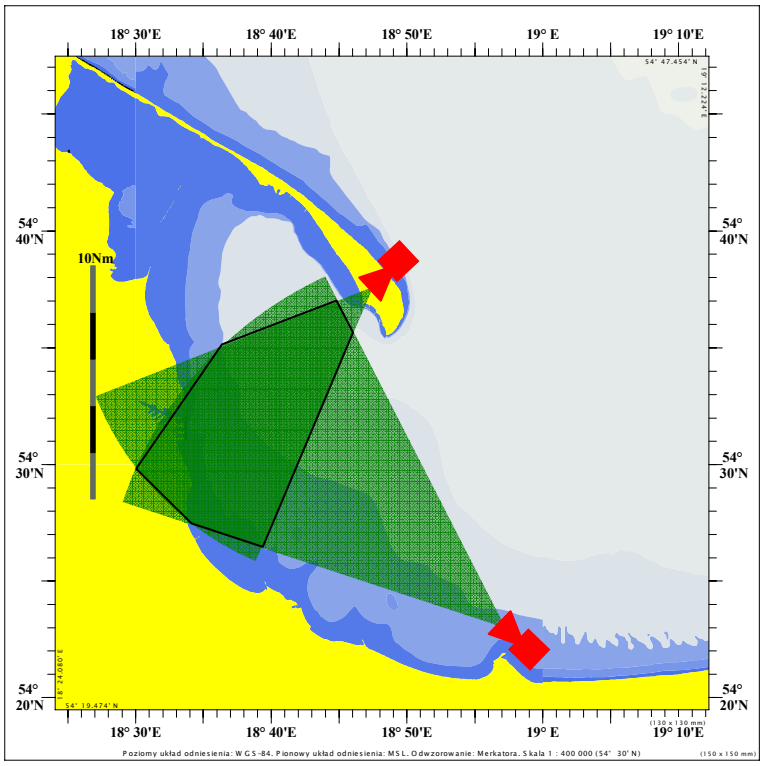

Fig. 3. Observation sectors of thermovisual cameras and working zone.

CONCLUSIONS

Passive optionavigational system can be the replenishment for AIS information for VTS. On the one hand, the system is passive one, so objects can be detected secretly. On the other hand, the system can be the replenishment the radionavigational system and radar one and can detect small objects, which are the sources of thermal radiation.
The essential issue, from among tasks awaiting for realization, is determining operation zone and accuracy one for obtaining specific accuracy of determined position and specific operation zone.

REFERENCES

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