Process Optimization of Pointing of the Onboard Weapon of a Robotics Complex with Use of Intellectual Optical-Electronic Station

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***Abstract*— In this article the technique of process optimization of pointing of the onboard weapon of a robotics complex with use of intellectual means of optical-electronic station is described.**

Keywords*— *machine vision; target tracking; robotics complex

I. INTRODUCTION

One of the main tasks of a robotics complex consists in a possibility of defeat of sea, overland and air targets with the maximum accuracy for the minimum time frame. Use of radar stations for the purpose of receiving coordinates of object doesn't allow minimizing size and weight characteristics of robotics complexes considerably. Because of increase of a radar-tracking visibility of a complex his survivability decreases. To lower size and weight characteristics of a robotics complex and to increase his survivability till fire opening on the target use of passive optical-electronic stations (OES) which composition includes telethermovision optical and computing devices (video signal processing system) allows.

Until recently time response characteristics and guidance accuracy of the onboard weapon on the target depended on the following pacing factors: type of drives by means of which OES rotation in the horizontal and vertical plane is carried out in case of pointing on the target; resolution capability of a matrix of the optical device which is a part of OES; qualification and speed of response of the operator.

II. PROBLEM STATEMENT

Influence of a human factor on process of pointing of the onboard weapon in robotics systems seriously limits productivity of execution of the fighting task. Therefore the problem of automatic execution of fast and exact pointing of the onboard weapon of a robotics complex on different mobile objects with use of intellectual means of passive optical-electronic station is actual. The existing scientific and technical backlog in this data domain allows to speak about appearance of possibility of the solution of this problem.

Transition from automated pointing of the onboard weapon on the target to automatic and appearance of the television and thermovision devices registering images with HD resolution, superimposes additional conditions on algorithms of functioning of OES of a robotics complex. These conditions concern ability of OES to process the maximum quantity of frames in one second (high-speed performance of OES) and possibility to select thus necessary informative signs on the image, without looking at a noise component (high noise immunity of OES).

In case of automatic detection, recognition and tracking of dynamic objects by the informative signs on the image are: coordinates of the found target, class of target, a path of movement of the target and other signs which are necessary for making decision on target defeat, type of the striking weapon, azimuth and an angle of a place of the weapon at the moment for time.

The process model of automatic pointing of the onboard weapon of a robotics complex with use of intellectual optical-electronic station is provided on fig. 1.

III. PROCESS DESCRIPTION OF AUTOMATIC POINTING

In processing system of video signal the source image received in any range of lengths of waves arrives. Then according to different techniques of binarization of the image [1] two binary cards which move on an input to the unit of determination of the scyline are created.

In many existing passive systems of detecting of the dynamic targets for finding of mobile object the method of segmentation of a picture on the basis of an interframe difference [2-3] is used. After this approach, from the general object list which are present in a picture, those which situation on sequence of frames undergoes change are selected only.

During detecting of the targets by a method of an interframe difference there is the significant amount of noises. Filtering procedure is necessary for their exception. Methods which exclude from reviewing small dynamic objects (branches of trees etc.) [4-5], and objects of the considerable sizes (armored machinery) can't realize effective filtering the objects moving with constant and variable speed since at image predesign stages they intend for elimination of the false targets which path of movement is periodic.

Application of a method of segmentation on the basis of an interframe difference for the purpose of selection of dynamic objects enters essential temporal time delays in system operation. In case of the sizes of a picture coming nearer to

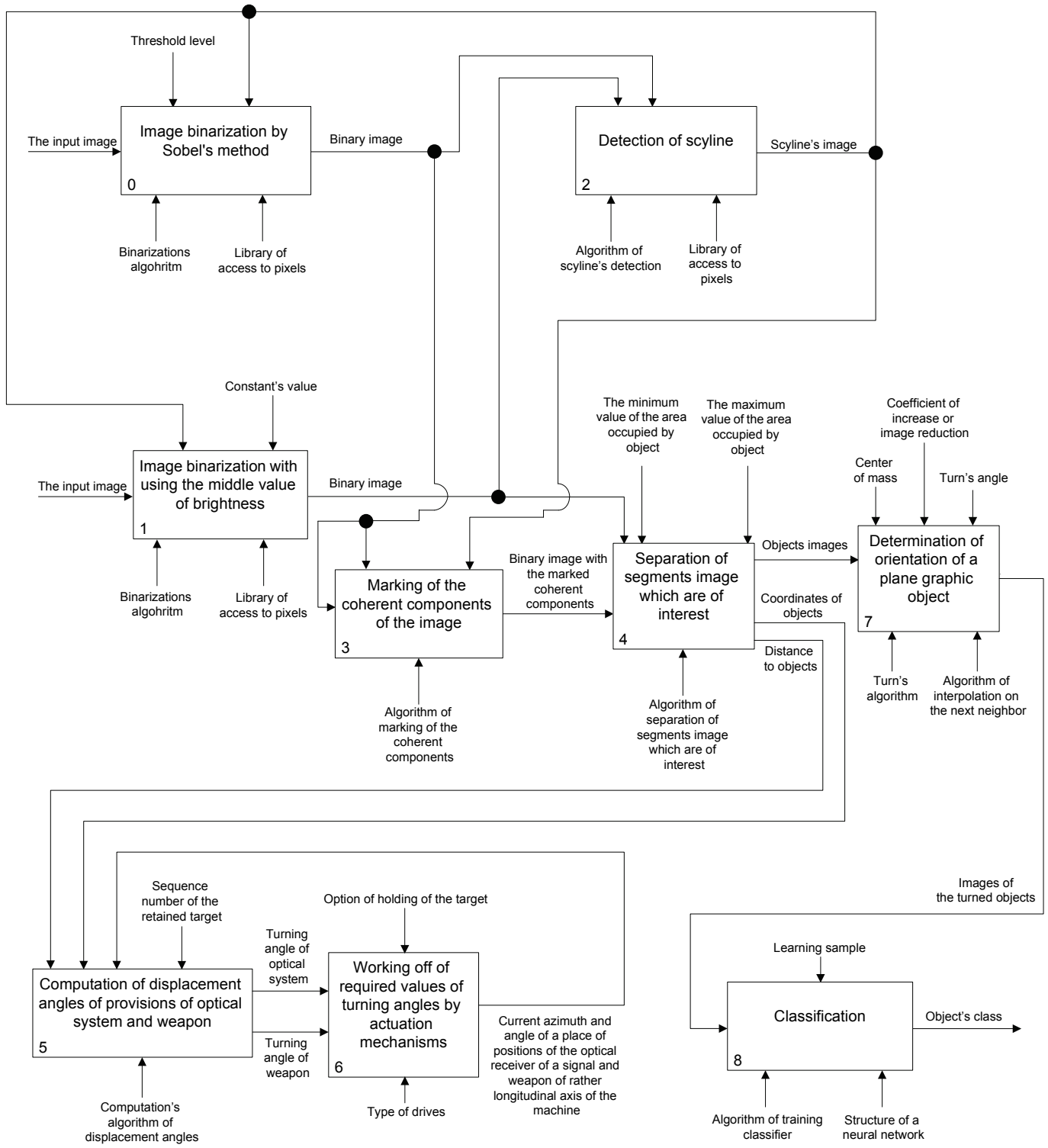

Figure 1. Class IDEF0 model: process of automatic pointing of the onboard weapon of a robotics complex with use of intellectual optical-electronic station

1280 x 1024 pixels time which is spent for filtering different noises appears within 2-3 seconds for each frame.

About high-speed, exact detection and target tracking, considering information given above, it is impossible to speak. The segmentation of one binary image taking 2 seconds, won't allow to function to video signal processing system on the scale of real time, not to mention the errors arising during this procedure. Therefore inclusion of the unit of determination of an interframe difference of binary or monochrome (multispectral) images before procedure of isolation of the coherent components of the image is inexpedient.

For filtering any kind of the noises arising on an earth surface or in air during functioning of a complex, it is necessary to apply the adaptive technique of position fix of the scyline in a picture [6]. Application of the developed technique of search of the scyline on the image allows to increase noise immunity of OES and considerably to reduce temporal costs of separation and attending both terrestrial, and air targets by an intellectual exception of an earth surface or a celestial hemisphere of reviewing at a certain stage of execution of algorithms of digital signal processing.

After determination of the scyline procedure of segmentation of the image which includes units of marking of the coherent components of a picture and separation of segments of the image which are of interest is executed. In case of execution of these procedures it is necessary to apply algorithm of segmentation of the binary images [7], allowing for finite and small, in comparison with known techniques of segmentation, a period to process binary images of any topology and size.

Knowing situation and viewing angle of the optical device which is set onboard a robotics complex, it is easy to find coordinates (the true azimuth and a place angle) the detected target. The distance to object is defined proceeding from its approximate linear length, the size which is occupied by an object projection on a matrix of the receiver of radiation, and focal distance of a lens. This distance is specified on the optical device (in millimeters).

After execution of procedure of segmentation of the image the processing system of video signal gives out azimuth, an angle of a place and approximate value of a distance to objects in a picture. These characteristics arrive on an input of the unit of computation of displacement angles of provisions of optical system and the onboard weapon. If in a picture there are some potential targets video signal processing system, depending on option of holding of the target, sequence number and a target class, give a signal to drives for working off by actuation mechanisms of required values of turning angles of optical system and the weapon. Working off of required values of turning angles by actuation mechanisms is executed according to the exchange protocol by information of an onboard computer with drives. Speed and an error of working off of the preset values is regulated by type of drives.

For class definition of the detected targets for the purpose of inspection of the most dangerous it is expedient to use the qualifier on the basis of a multi-layer neural network which is trained according to the developed heuristic technique [8] which application allows to reduce frequency incorrect recognition of a class of the target. Information of a class of the target can be used also for filtering the objects which are not of interest.

After the completion of processing of the current frame of a video stream the system transfers to the following.

IV. RESULTS

Researches showed that optics application with the megapixel detector and a notebook with the Intel® Core™ 2 Duo CPU (3 GHz) onboard a robotics complex will allow to function to the processing system of video signal implementing sequence of functions, provided on fig. 1, on the scale of real time. Possibility to realize the protected data transfer [9], processed by a robotics complex, on command point will allow by means of the small mobile robot equipped with optical means of investigation, quickly to track a changing background situation on terrain.

Process optimization of pointing of the onboard weapon of a robotics complex with use of intellectual means of optical-electronic station by application of an automatic method of receiving coordinates and distance to the objects which are present on the image which is registered by OES of a robotics complex, allows to increase accuracy, speed of pointing of the onboard weapon and survivability of a robotics complex.

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