A PASSIVE OPTICAL LOCATION WITH LIMITED RANGE

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Summary We know active and passive methods of a location. This article deals only with a passive location of dynamic targets. The passive optics location is suitable just for tracking of targets with mean velocity which is limited by the hardware basis. The aim of this work is to recognize plasma, particles etc. It is possible to propose such kind of evaluation methods which improve the capture probability markedly. Suggested method is dealing with the short-distance evaluation of targets. We suppose the application of three independent principles how to recognize an object in a scanned picture. These principles use similar stochastic functions in order to evaluate an object location by means of simple mathematical operations. Methods are based on direct evaluation of picture sequence by the help of the histogram and frequency spectrum. We find out the probability of unidentified moving object in pictures. If the probability reaches a setting value we will get a signal. The processing of dynamic pictures and their filtration are a significant part of work. Static objects, background (trees, buildings) must be filtered off before. This filtration is being also done by means of the probability function. Probability distribution of an object position is gained from a sequence of more pictures.

1. INTRODUCTION

The present state of the image processing with the target detection aim is orientated mostly on the security [6], robotics [7], medicine [8], astronomy [10, 11 and 14] or for example on ground target detection and recognition in the army area [9, 12 and 15]. Also there are other application areas [13]. Mostly the main problem to detect relatively large and slow objects on the static background and to recognize objects, faces etc. and to identify them. For example in robotics is image processing used for the robot orientation and navigation, eventually for some simple environment analysis, in the security area could be image processing used for the face detection and identification. In the medical applications it should be used in combination with CT or NMR methods. Army uses image processing for example in the radar technology where image is often restored from some data obtained with help of some active radar system and it is restored in the cylinder or in the spherical coordinates. The optical location is by army used for the target detection, identification and tracking etc. Our system solves different problem. We are trying to detect and track relatively very fast objects like plasma particles etc. In the first approximation we can test the device on the birds flocks. We suppose usage of the several basic methods bounded by the probability function for the movement detection and tracking in the image. The theoretical solution was published [2]. There were done the first tests of the proposed methods. These methods were tested in the MATLAB environment. Some of the solution aspects are described in the following text. The proposed methods were tested by the set of the testing images and the object location methodology was tested on the real video sequence. These methods are recapitulated and resumed from the view of the method efficiency, speed and the other parameters during the image processing. There is also summarized hardware used for the algorithm implementation, tests and on-line detection experiments in the text.

2. THE COMBINED DIFFERENTIAL IMAGES METHOD

The differential images method described in the [2] was combined with the image segmentation. The good properties of the both methods are used with an advantage and so we obtained powerful tool, which meets the high computational requirements and the low resolution ability of the recorded image. The MATLAB environment supports two basic principles of the image segmentation – The boundary detection method and the edge detection method, both described in [3, 4 and 5]. There was with an advantage used a *bwboundaries* function, implemented in the *Imagetools* package. This function is based on the boundary detection segmentation method. It can work on the binary image only. The searching process is following: from some automatically selected initial pixel its vicinity pixels are probed for their value and it is decided if they belong to the object area. This step is repeated for each pixel in the object vicinity. There was tested another function from the MATLAB *Imagetools* package – *bwtraceboundary*. This function uses the same principle as the *bwboundaries* function described above but it has in comparison to the *bwboundaries* function one significant disadvantage – user must specify the initial pixel for the image segmentation. Another tested segmentation method was based on the edge detection principle. This method had bad results during the testing. We weren't able to prevent the removing of some target objects or their significant parts. The combined differential images method uses several-step algorithm. In the first step are the important areas selected in the image by the image segmentation. Then in these selected areas the detailed tracking is performed with the time domain differences assistance.

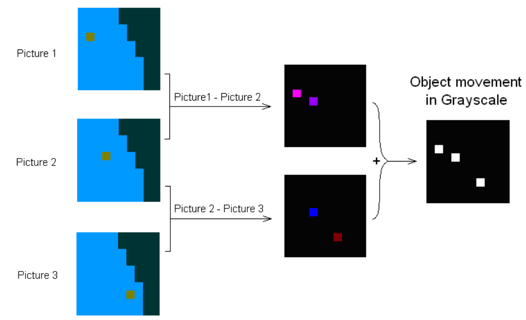

Fig.1. Differential images method principle

3. THE HISTOGRAM METHOD

The histogram is the statistical information. It shows the intensity distribution in the image. It can be said in the first moment this method is not capable of the target movement detection in the image. The reason for this is: If the object is moving above the quasi-constant background, it is very difficult to recognize target movement or its position.

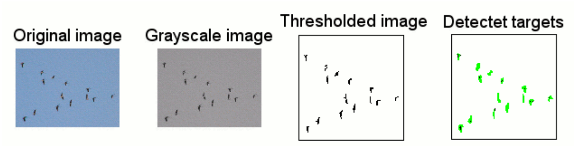

Fig.2. Image segmentation and target detection

4. THE SPECTRUM ANALYSIS METHOD

The next suggested method is the spectrum's analysis method. In the figure bellow is shown the spectrum's difference for the diagonal and the flat object move above the simple background. Particular spectrums are obtained by the 2D Fast Fourier transform algorithm – in MATLAB implemented in the *fft2* function. The lines direction in the amplitude spectrum difference is perpendicular to the movement direction. If there are changed background colours, is in addition similar pattern visible in the phase spectrum difference. In the similar test images sequences is solution simple. More complicated method application is in the real recorded sequences. Step order was: At first were selected potential target areas by the RGB space analysis (or the combined differential images method) – to the feasible pixels was associated white colour and to the others was associated the black colour. In the next step the spectrums were calculated. During the difficult testing was discovered that method of the spectrum's analysis method doe's not give usable results according to the entered parameters of the object velocity, its size and quality and the image sequence density. The tested objects were detectable only with big difficulty. More detailed problem description is in [3, 4 and 5].

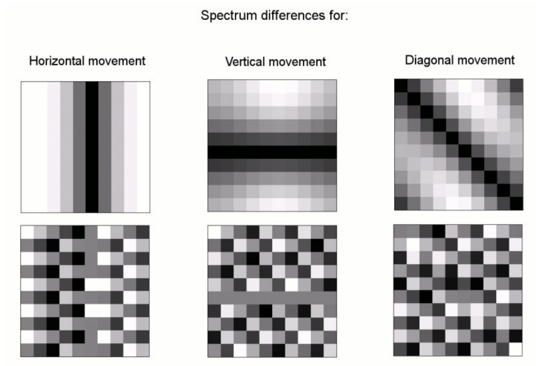

Fig.3. The FFT spectrums difference for the movements in different directions

5. THE METHODS SUMMARY

From the comparison of the suggested methods (The combined difference images method, the histogram method and the spectrum's analysis method) follows that the methods are applicable on the images with much higher intensity level according to the background. It was determined that the image segmentation method based on the edge detection is not directly usable for the hardware solution implementation. The MATLAB environment during the edge detection applies some threshold on the image and this can filter out the target or his significant part. In the opposite the boundary detection method (the *bwboundaries* function) looks like very powerful tool. This function works above the binary image and it is very fast. Disadvantage for this method is that we are loosing some information during the transformation from the RGB space to the binary space. This can result loss for the small targets. Still this disadvantage has lower dependencies than the corresponding effect for the edge detection method. Very efficient is threshold segmentation method but this method can give bad results according to the threshold selection. In addition, if we know the colour distribution in the RGB spectrum we can very simply filter the image before we try to detect the object and remove some redundant information. Then we can concentrate only to the reduced image area and detection progress can be faster. If we speak about the sensitivity and the precision of the elementary methods, big problem part lies in the fact, that the real image matrix is relatively very big according to the traced object. This disadvantage can be particularly removed by using the Subimaging. On these subimages is applied segmentation by the thresholding in the RGB space. Probable targets are processed by the suggested methods. (The combined difference images method, the histogram method and the spectrum's analysis method).

6. THE FALSE TARGET (BACKGROUND) FILTERING METHOD

Suppose that we have selected possible targets in the image. We can confirm or decline the correctness of the detected target using the object presence monitoring. Monitoring is done by the Kalman filter application [3, 4 and 5]. If the target movement shows some hint of periodicity, we can reject it as the false target (ground targets, false targets, etc.). The second possibility of the false target detection is finding of its connection to the image boundary. According to this information we can reject this target like false target or select it like the probable target.

7. HARDWARE AND THE DSP PROGRAMMING METHOD SELECTED FOR

For the experiments are selected following components -Camera: ST VS6724 with the x24 evaluation board, CMOS chip, Resolution of 2Mpix, Possibility of training with small and cheap camera chip and then chip exchange to some more reliable for application, Processor: TI TMS320C6416 with the TMS320C6416T DSK evaluation board. Processor is programmed with help of the Real-time Workshop and Simulink system using the Real-time Workshop target. After the principles verifying in MATLAB follows simple compilation of MATLAB (SIMULINK) code to the C language using special libraries for selected DSP and import to the Code Composer Studio. There can be the C code optimized, compiled and uploaded to the DSP.

8. IMAGE PROCESSING PREVIEW [5]

Fig.4. Original image

Fig.5. Segmented image – selected potential targets

Fig.6. Final detected targets selected by method

9. CONCLUSIONS

Basic theoretical methods were tested and owing to their suitable combination the method of dynamic object detection in the image was found. In the section 8 you can see the images sequence in the particular method phases. Fig. 6. shows the detected targets. More testing must be performed for the algorithm speed and accuracy tuning.

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