

Workstation Software of Initial Intelligence Processing

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Abstract. The article is devoted to the software systems of aerial reconnaissance data processing, remote sensing and intelligence report control. Based on the analytical review the means of recording and ground processing of intelligence data mapping and Geographic Information System (GIS) are discussed. Often the specific conditions of photography don't make it possible to obtain image of high-quality. Image may be defocused and blurred, especially if it is made using equipment set on a unmanned aerial vehicle (UAV). UAV unlike manned aircraft may be used in adverse weather conditions and at low surface brightness. We consider the UAV aerial photography equipment to be multichannel in many cases. Suppliers of the UAV aerial photographs usually use software based on the fragment image «cross-linking».

Introduction

The article is devoted to the software systems of aerial reconnaissance data processing, remote sensing and intelligence report control. Based on the analytical review the means of recording and ground processing of intelligence data mapping and Geographic Information System (GIS) are discussed. There are special requirements to the software systems. Sometimes the area image must be recorded only once and rapidly. The specific conditions of photography often don't make it possible to obtain image of high-quality. Image may be defocused and blurred, especially if it is made using equipment set on a unmanned aerial vehicle (UAV). UAV using makes aerial photography to be most rapid and detailed [1,2]. UAV unlike manned aircraft can be used in adverse weather conditions and at low surface brightness. We consider the UAV aerial photography equipment to be multichannel in many cases. Suppliers of the UAV aerial photographs usually use software based on the fragment image «cross-linking». The task may be solved in various ways. In many cases it is resulted in loss of image quality. To solve the problem the software of initial intelligence processing should have some specialized tools.

1. Specialized software description of initial intelligence processing

Specialized software should include the following:

- Software of defocused images restoration,
- Software of blurring compensation,
- Software of noisy image filtering,
- Software of «cross-linking» of the aerial photograph fragments,
- «Frame» software.

According to the analysis above modern GIS have no tools to compensate these factors. Some tasks of filtering and special image processing are solved in MATLAB. From the very beginning it has been intended for media files processing. Now it has no tools to solve the special tasks of aerial photograph processing [3,4]. Using Photoshop Extended you may see and process MATLAB image. It is possible to use MATLAB commands combined with the Photoshop technology of image processing. As soon as MATLAB is connected with Photoshop and some commands are entered in the command line of MATLAB all these control actions are carried out in Photoshop.

The main component functions of the «frame» software are:

1) Software of block 1 is designed for the following applications:

- Supporting of the input images and navigation data of memory card recorder,

- Supporting of the registered image and navigational data recording.

2) Software of " imagery archive SVR " designed for archiving images recorded in the memory cards of manned aircraft.

3) Software of «Archive electronic card » is designed for archival storage of electronic card (EC) and digital elevation model (DEM).

4) Software of user interface is designed to support the operator.

5) The control program is intended:

- to provide access to GIS for Customer;

- to protect the data produced by using workstation «Shot» from unauthorized access;

6) PA «system log» is designed for access control and operator actions. The program provides authorized access and registration of the Workstation operator and authorized users. Actions staff during routine maintenance are also registered.

Software Structure. The software package has block structure. It includes some independent modules that may interact each other only by the defined interfaces. Correct structure allow to simplify the modification and focus only on the concrete modules. Also it increases the system stability.

This software product can be considered as a combination of the following logic blocks.

Brief Description of the Modules. Interaction with the user by window interface. The system provides the convenient interface for controlling image processing. It is made using the standard Delphi.

System of Image Information Processing. Provides access to the elements of the image. Provides the ability to read and write images in various formats. The system includes standard and specially designed tools. The few words about defocusing and blurring the image [3]. To solve the inverse problem to determine the kernel of the Fredholm and compensation blurring and defocusing has also developed a program that implements the method of Tikhonov regularization. Below are the description of the program and the results of experiments.

Formulation of the inverse problem:

It is known that for modeling defocused and blurred images used Fredholm equation of the second kind:

$$f(x, y) = \iint_{-\infty}^{\infty} f'(x - x', y - y') K\{(x - x'), (y - y')\} dx dy, \quad (1)$$

where $K\{*\}$ - the kernel of the integral equation, the impulse response of the system, $f(x, y)$ and $f'(x, y)$ - model of the ideal and distorted images.

Direct Fourier transform:

$$\tilde{F}(v_x, v_y) = \iint_{-\infty}^{\infty} f(x, y) \exp\{-2\pi j(v_x x + v_y y)\} dx dy, \quad (2)$$

where v_x, v_y - spatial frequencies.

Solving Fredholm equations by blind deconvolution:

$$f(x, y) = F^{-1} \left\{ \frac{\tilde{F}(v_x, v_y)}{\tilde{K}(v_x, v_y) + \alpha(v_x, v_y)} \right\}, \quad (3)$$

where $F^{-1}\{*\}$ - operator inverse Fourier transform:

$$f(x, y) = \iint_{-\infty}^{\infty} \tilde{F}(v_x, v_y) \exp\{2\pi j(v_x x + v_y y)\} dx dy. \quad (4)$$

2. The results of the numerical experiment

The user is given the opportunity to test the reconstruction and modeling of defocused images. The original window is as follows:

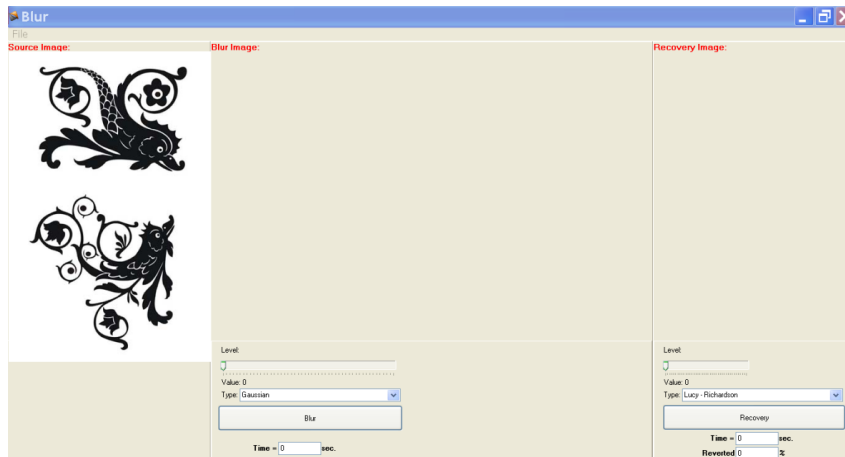


Fig. 1. Original window with the image

Functional area is divided into three parts. The first part is used to display the original image. To do this, select the file in the study drop-down menu «Open».

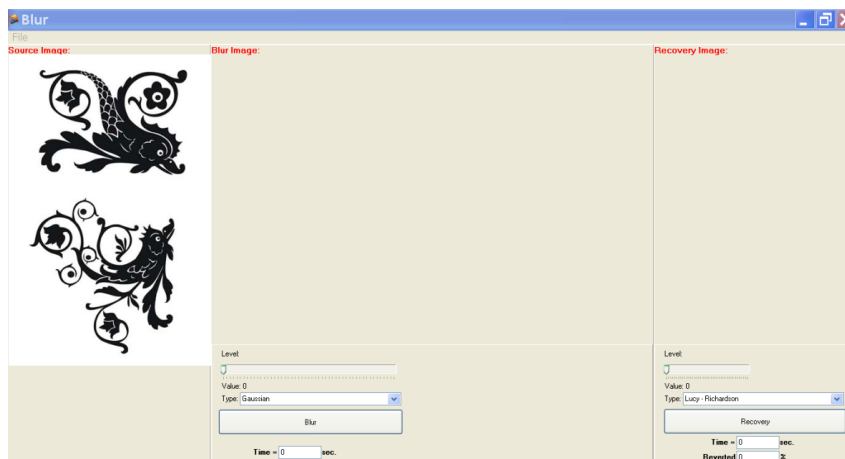


Fig. 2.

The second functional area is used to display the results of modeling of defocusing. Distortion parameters and the method of determining the blur kernel are installed by the user. The following parameter setting window is fixed processing times. Starting the simulation is carried out by pressing the «Blur».

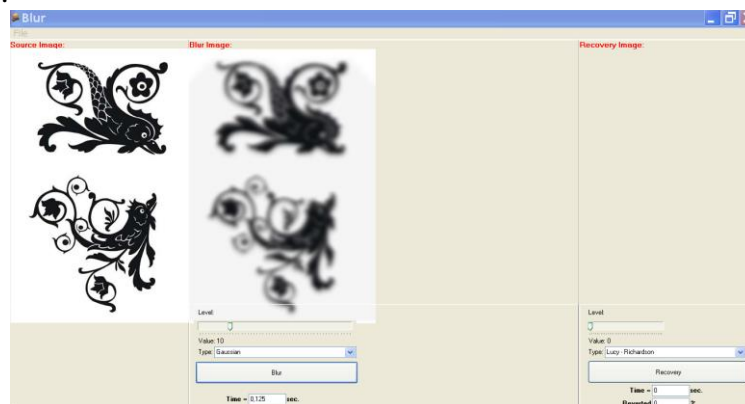


Fig. 3.

The third functional area is designed to recover defocused image. There are two methods of recovery: blind deconvolution algorithm and Lucy-Richardson. When the user selects and clicks the "restore", starts the recovery process. In the lower part of the window has to display the time and quality recovery. However, it should be noted that the rate of recovery of quality should be used

only to restore the model variant defocus when you know the reference version of the image. Thus, it becomes possible to compare the two images. Result recovery blind deconvolution method:

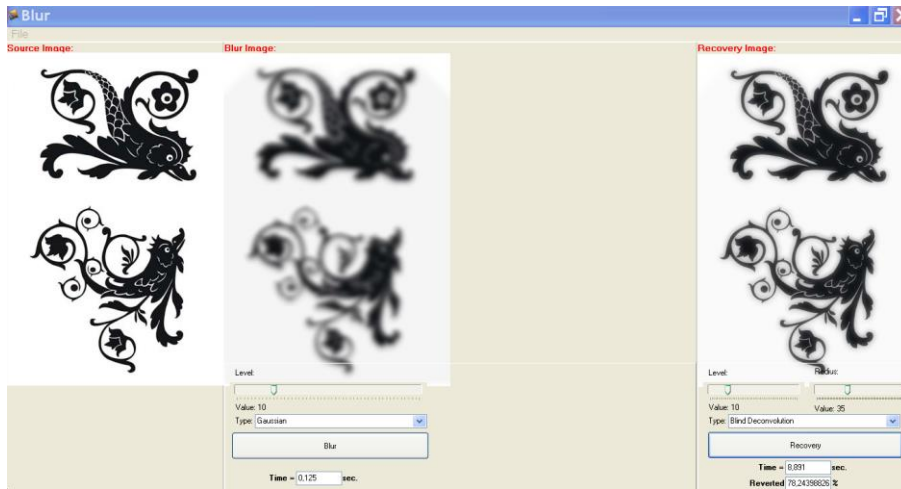


Fig. 6. Result recovery blind deconvolution method. right picture.

Last functional area is used to display the results of recovery. The parameters are also set by the user. There are fields to display the time and quality of recovery. As in the case of defocusing, should evaluate the quality recovery when the model only embodiment, when the known reference version of the image.

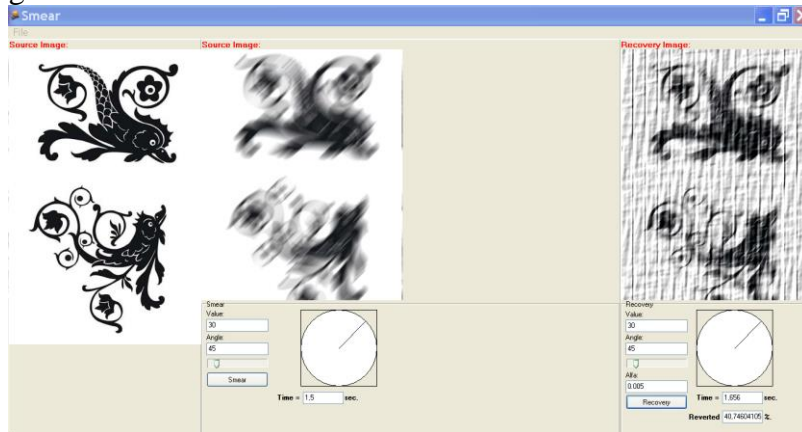


Fig. 7. Unsuccessful recovery. The result of instability of the solution.

Experimental part. For the experiment, images were made using various aerial cameras. Snapshots are the black and white image world (test objects used to determine the resolution of the optical system). The first image obtained by aerial camera (AFA) - AFA 54/100. Second (test object) - through AFA e-magazine. Images were made using various aerial cameras. Snapshots are the black and white image world (test objects used to determine the resolution of the optical system).

Original Images

Photos without filter (focussed)	Photos filter (defocus)
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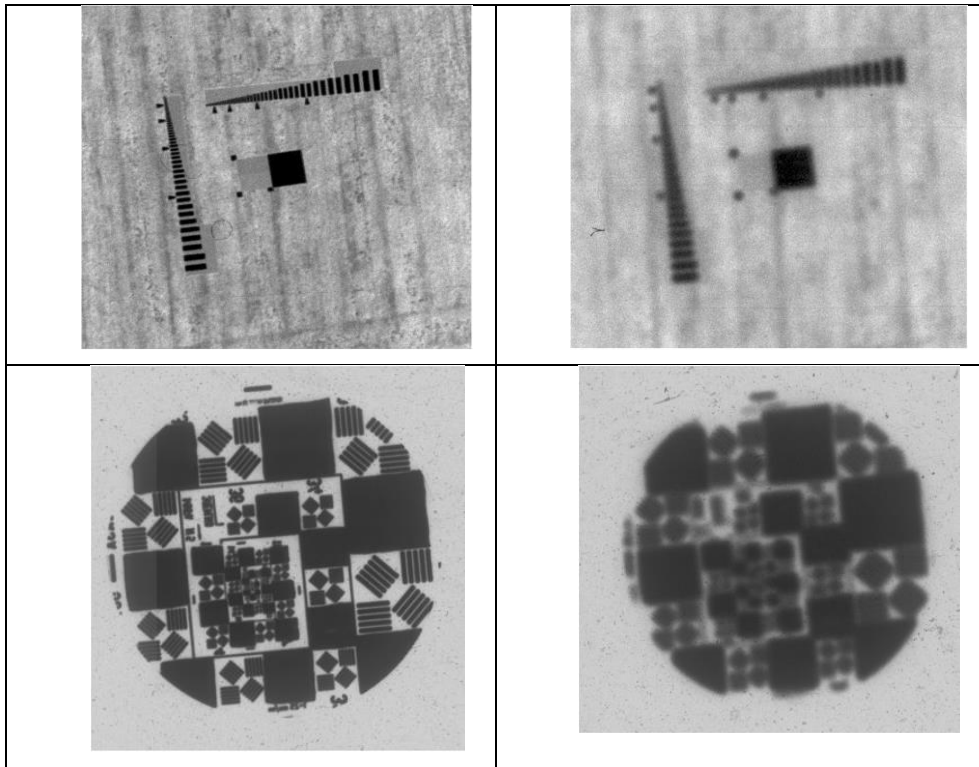


Fig. 8. Photos without filter (focussed) and Photos filter (defocus)

Submitted images taken with AFA , using a filter , have a number of features. The problems solved by the software. With software system can solve both direct and inverse problems of defocusing and blurring. That is a clear image blur with the specified parameters and defocus blurring restore blurred image by adjusting the parameters.

Defocusing. Experience 1. The basis - the image of the test object number 1.

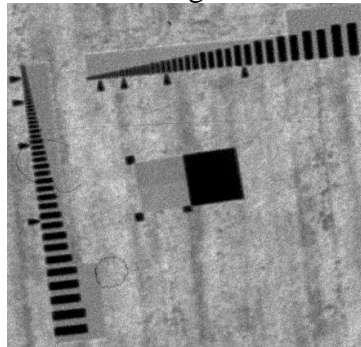


Fig. 9. Image of the test object

Model the defocus with the use of two different kernels on methods of Gauss and Tikhonov [3]. Conduct a series of attempts to restore to the variation of parameters and methods of recovery.

Photo filter (defocus)	Result recovery, comment
Blur gaussioide with parameter 10	Lucy-Richardson method with parameter 10

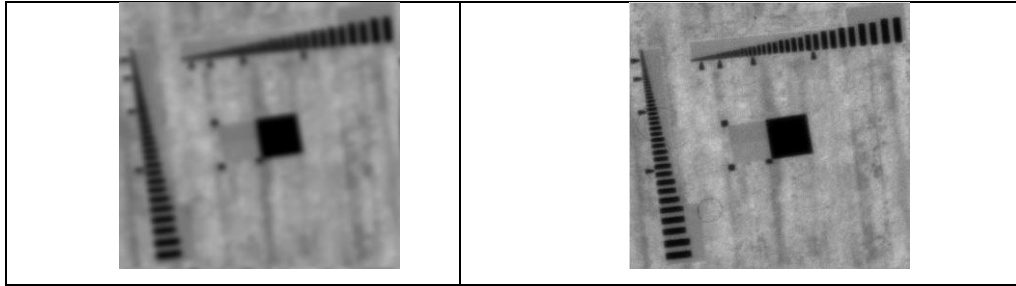


Fig. 10

As can be seen from the experience, recovery occurs at a high enough level, however, the change of parameters does not change the result. As shown by the experiment the shorter method of calculation algorithm Lucy -Richardson wins consistently over time in blind deconvolution method. And the relative gain is permanent. According to calculations, it is 2.33 times . This trend does not depend on the color of the reconstructed image. In this case, the original recovery methods do not underlie one another. Measurement processing time can be of practical use to improve evaluation algorithm for optimization. In this case, the processing speed reflects the efficiency of the algorithm.

The specificity of the photos are of a normal camera is the large amount of noise that adversely affect the quality of pictures and complicate the recovery process.

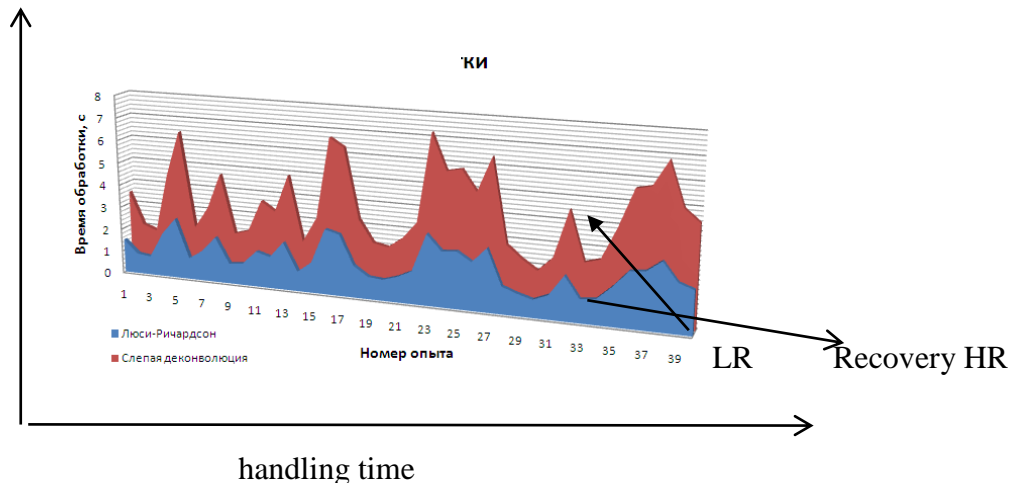


Fig. 11. Dependence on the number of processing time experience

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Analysis of the quality of recovery. Based on experiments with model defocused images evaluate the quality of image restoration the two selected methods. In the experiment again using 40 images. Lucy -Richardson algorithm shows the result by 2 % than blind deconvolution.

Summary

Designed by the Contractor as the software allows to reconstruct and simulate defocus and grease images. However, when the program with real images containing distortions of various kinds, that recovery is much worse than in the recovery of artificially blurred images. It is caused by a lack of information about the core of defocusing , as well as a filter. Knowledge of the scattering function can greatly simplify the task. If not known, the selection method becomes very difficult and time consuming. In our case, the kernel statically adopted Gauss filter. And though it is considered the core one of the most versatile, it is not the only one. The task of finding the kernel is

very complex and is part of the problem under consideration. By the quality of the filter means its linearity or non-linearity. That is, the transformation of the image points on the same law, or arbitrarily.

Also in the real world, there are other third-party effects, such as grease, noise, etc. These additional distortions may hinder recovery and change the picture. Their influence should also be taken into account.

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