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DIGITAL VIDEO STABILIZATION FOR UNMANNED AERIAL VEHICLE

A video stabilization information technology from unmanned aircraft proposed. It allows compensate the impact of macromotions and micromotions of video camera, ie remove the fluctuations of individual video frames and increase their sharpness. The above methods and means can be used for video processing in real time.

At the beginning of the 21st century more than 60 countries develop and manufacture unmanned aerial vehicles (UAV) of various types. In addition to issues directly related to the design and performance of aircraft, there is a topical question of processing video data from the board of UAV in solving problems of military and civil purposes (including patrolling of long objects, tracking of forest fires, target fixation, and so on). Companies, scientific and production centers and other organizations of different ownership are involved to development of UAV prototypes in Ukraine. They are focusing more on the development and usage of UAV small and medium types. Specific to UAV small and medium types is a speed more than 60 kmph and an insignificant altitude. Through the influence of these factors, to operator rather difficult to analyze video obtained directly from the aircraft. Quickly change of a shooting scene is tiring the operator. The movement of the camera does not allow focus on objects that are of interest to the observer.

The reasons that lead to a reduction in visual quality of the video are macromotions and micromotions of camera. Macromotions may be caused by the movement of an aircraft. Through this type of distortion occurs frame "shake". Micromotions of the camera occur as the result of a work of the engine, and so on. Distortions such as defocus or streaks appear in weakening the top spatial frequencies images.

Outcome following noise can be reduced by mechanical devices (gyrostabilized cameras, etc.). However, apart from high cost of these devices, they can have more weight, consume more energy, which can be critical when limited size and payload volume of an aircraft. Therefore there is a need to use mathematical treatment procedures that allow eliminating the impact of a camera motions.

The need for data in real-time, reliability and versatility are a significant obstacle for constructing high-performance processing systems digital video stream. This is due to the fact that known approaches are typically algorithmically difficult. This leads to extra time and hardware costs. In addition, the algorithms of used methods should allow to perform parallel calculations in the implementation in the software and also video processing system must be integrated into complex ground control station UAV. So actual is the development of information technology (IT), which would allow removing fluctuations of individual video frames and increasing their sharpness in real time and would be part of this complex.

Existing video stabilization tools (for example, Warp Stabilizer [1], VirtualDub Deshaker [2], proDAD Mercalli [3], and so on) allow to process already captured video (only postprocessing). In addition, as already noted, the information technology should be a part of the UAV ground control station. Usage of third-party software does not allow integrate a video processing procedure to the complex.

The information technology video stabilization from the UAV was developed at the Department of Applied Mathematics of NAU. Informational technology allows respond to changes captured by hardware to operators of decision-making systems in real time. It implements two main stages of video processing. The first stage is the macromotion compensation. The procedure of elimination of the negative impact of macromotions can be used in solving of the following tasks: stabilization in planar aerial filming and fixing the object of observation. Next stage is the micromotions compensation. It can be performed parallel to macromotions compensation.

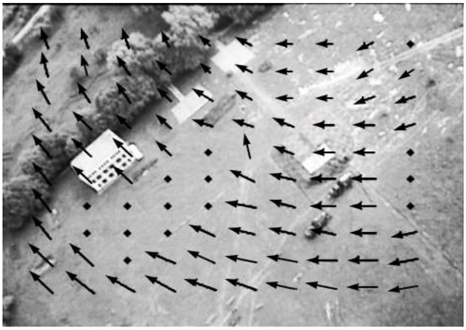

Fig. 1. Determining of offset points relative to the previous frame.

In case of planar filming, the camera is pointed down perpendicular to the earth surface. Shooting scene is constantly changing. To stabilize the video, you must define a regular grid of points that will be detecting. Next to each video frame will be determined offset of these points relative to the previous frame. The figure (Fig. 1) shows an example of the shift points of the frame. Next, calculate homography transform of frame based on landslides series of frames. Shake compensation is through the perspective transformation of the current frame.

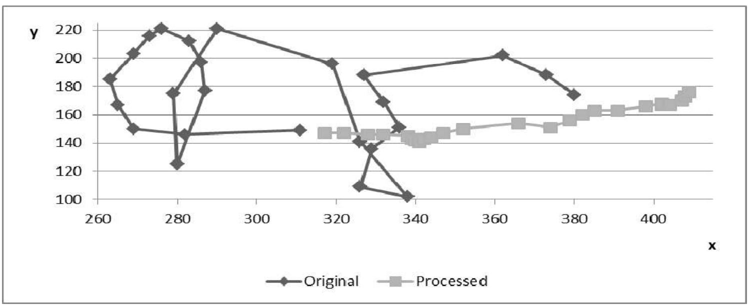

Fig. 2. Coordinates of the position of the control point on the original and processed videos.

In task of fixing object of observation camera pointed in this object. Shooting scene is constant. However, through the movement of an aircraft, objects can approach and depart, viewed from different angles. It is necessary to define feature points [4] for the initial frame of the video to compensate macromotions in solving the problem of fixing the target. Next calculate the offset of these points for each frame. The next step is calculating the average value of the offset feature points relative to the previous frame. On the processed video motion of the control points appears more smoothly. It can be illustrated on the chart (Fig. 2), which shows the relative coordinates X and Y of the control point at 25 frames of original and processed videos. In this example, the length of a curve which is defined by moving the control points, after processing decreased 5.5 times.

When implementing procedures digital stabilization (sharpening of the digital image), which actually spend processing in real time, preference is given to those that reach the target processing functions with a minimum of computing operations. In fact such linear operators obtained in the form of a discrete convolution non-ferrous components and raster mask filters-stabilizers [5]. In paper [6] analyzed such linear operators and experimentally proved their effectiveness in the tasks of increasing the sharpness of a digital images distorted by camera micromotions in the real-time.

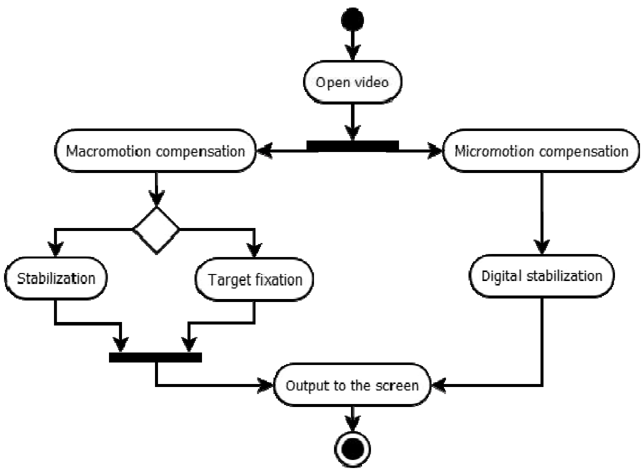

Fig. 3. Activity Diagram

For realization of stated mathematical aspects of information technology that is proposed, developed an automated system intended for stabilization of the video from the UAV. OpenCV computer vision library is used in the implementation of the automated system. Used methods [5, 6, 8, 9] and tools allow you to make calculations in several threads; it allows to carry out processing of video in real time.

In the first step of "Activity Diagram" (Fig. 3), the user can have only one option "Load video" from which we need to start working. This video can be in streaming format, or as a file. After opening the source video, the user can choose one of the parallel actions: compensation of macro- and micromotions. To compensate macromotions select one of two modes: video stabilization or target fixation.

Automated system was tested using data obtained from the board of UAV M-10 "EYE", development of scientific-production center of unmanned aviation "Virage", National Aviation University. Testing conducted on the recorded video with a resolution of 320x240 pixels at 30 fps. Video processing in real time was spent on the Dell Latitude E5530 Intel will be Core i5-3320M CPU @ 2.60 GHz and 8 GB. RAM. Video processing of larger size is possible in not real time or with lesser fps.

Conclusions

The information technology of stabilization of the video from UAV developed. IT allows operators of decision-making systems to respond to changes captured by hardware in real time. Used methods and means allow you to make calculations in several threads, which significantly increases the speed of data processing and allows video processing in real time.

Implementation of information technology can be used to create a workplace of the second external pilot of unmanned aircraft.

Further studies suggest the implementation of a multi-threaded processing by means of the GPU, increase the frame size of the processed video, usage of the additional data transferred from UAV etc.

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