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Applying UAV Aviation Image Processing Technology Based on Multi-Integrated Feature Histogram for Scouting, Search and Rescue

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A B S T R A C T

In military operations, the task of scouting vehicles and weapons is very difficult because it is difficult for humans to directly approach, and it is extremely dangerous when detected by the enemy. In addition, the search for wounded soldiers on the battlefield and missing pilots at sea is very prone to incidents, such as the search for the CASA 212 crew. Therefore, modernizing the scouting of military vehicles and the search and rescue of wounded soldiers is an urgent need. Unmanned aerial vehicles (UAVs) for this purpose will expand coverage, increase positioning accuracy, and reduce direct human involvement in the scouting and search process. Stemming from that practical need, the authors researched "Applying UAV aviation image processing technology based on multi-integrated feature histogram (MIFH) for scouting, search and rescue". The MIFH algorithm enables improved discriminant power in image representation, by using a set of simple integration processes. The MIFH method showed higher performance than the BOW, LBP, HOG and MTH methods.

Keywords: Image processing, Computer Vision, Search and rescue, Machine Learning, Unmanned aerial vehicles

1. Introduction

In recent years, image processing has made great progress and achieved. Furthermore, image recognition is one of the fields being actively pursued.The basic idea behind image recognition is to analyze images obtained from image sensors such as cameras, webcams,...[1]. Through image processing systems, humans have reduced the amount of work, as well as increasing the accuracy in making decisions related to image processing in many fields: military and defense, bio-chemical engineering systems, anatomy, Intelligent transportation systems, security systems [2].

The authors set the research tasks as: Building an application to identify military vehicles and search and rescue wounded soldiers. The authors delve into image query techniques [3]. To build an image query system, it is necessary to solve the following three main problems:

- Extract image features (Feature Exaction) [4].
- Determine the measure of similarity between two images (Similarity Measure) [5].
- Image database indexing (Image Indexing) [6].

From there, build the components for the system as shown in Figure 1.

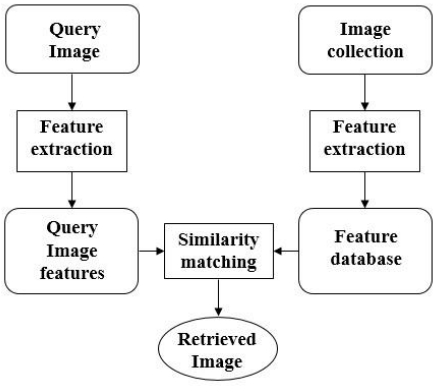

Fig.1. The Image Query Model

The input image (also known as the query image) is feature extracted. Querying an image is querying its features. The images in the database are features extracted in turn. These features are stored in the database. Next, it is necessary to compare the similarity of the features to be queried with each feature stored in the database. The image with the greatest similarity to the image to be searched for will be the resulting image. Usually, an image is called similar, the similarity is greater than 1. The remaining cases are non-similar images.

The idea given by the authors is to build an application that processes images and videos collected from UAVs when performing scouting missions of military vehicles such as tanks, aircraft... and search and rescue veterans [7]. That is, the UAV equipped with a WebCam or camera will take pictures or record videos on the way to a scouting mission, and send them to the processing center. At the processing center, image processing and image recognition applications will be used to detect people, tanks, and aircraft [8].

Feature extraction and representation are the most important issues in CBIR. Edge color and shape are among the components that represent image characteristics. Representing image content through extracting color and edge features of objects is a difficult problem. To solve this problem, the authors propose a multi-integrated feature histogram for image retrieval. Our main contributions are summarized as follows. First, extract the color discriminant properties of the object. Second, proceed to extract all the features of the edge geometry. Third, combine color, edge, and spatial composition into a complete representation. These attributes improve the discriminant power of color, texture, and shape features.

In image processing, color feature extraction and edge detection play an important role [9,10]. In CBIR object recognition applications, color is a powerful piece of information for object extraction and representation [11,12]; even without shape information, it is possible to combine color features with other features, such as textures, edge markings, and spatial properties, to retrieve images [13,14]. Color and edge features are components that represent features of an image or scene. To represent image content by extracting color and edge features based on object integration theory, we propose a multi-feature integration model to represent image content and use it for CBIR. The architecture of the process is shown in Figure 2.

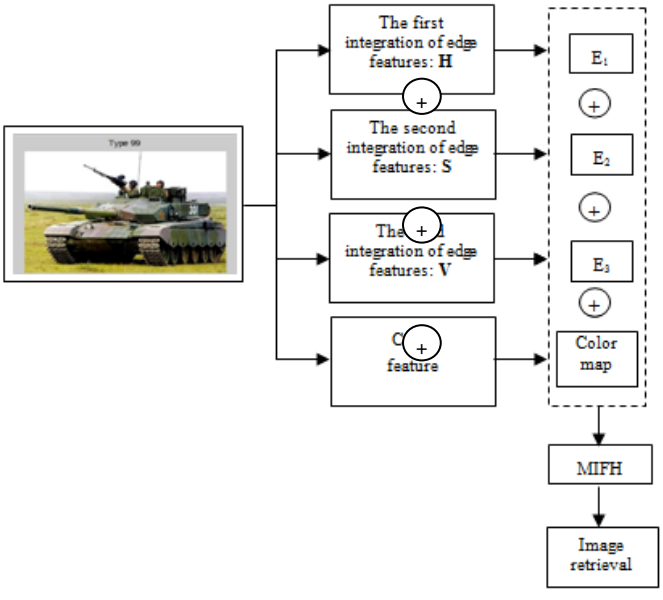

Fig.2. The architecture of the multi-integration features model

Many researchers have adopted the HSV color space for color quantization. It can accurately simulate human color perception. The HSV is defined by the three components of hue (H), saturation (S), and value (V). Where H is the angle around the rod, S is the distance perpendicular to the rod, and V is the central rod. Three integrations of the H, S, and V edge features are used with a set of simple integration processes into E_1, E_2, and E_3 gradient images. The E_1, E_2, and E_3 and color map integrations occur simultaneously in the histogram. The color feature is extracted via color quantization in the proposed MIFH approach.

The authors chose Matlab software as a research tool, because it is an effective support software for reading data from a webcam and converting it into a digital image matrix on a computer, performing methods of comparison with sample images and outputting control commands to the model to conduct identification and send out warning signals when wounded soldiers, aircraft, and tanks are detected.

2. Application program for recognition of military vehicles

2.1. Algorithm of the recognition process

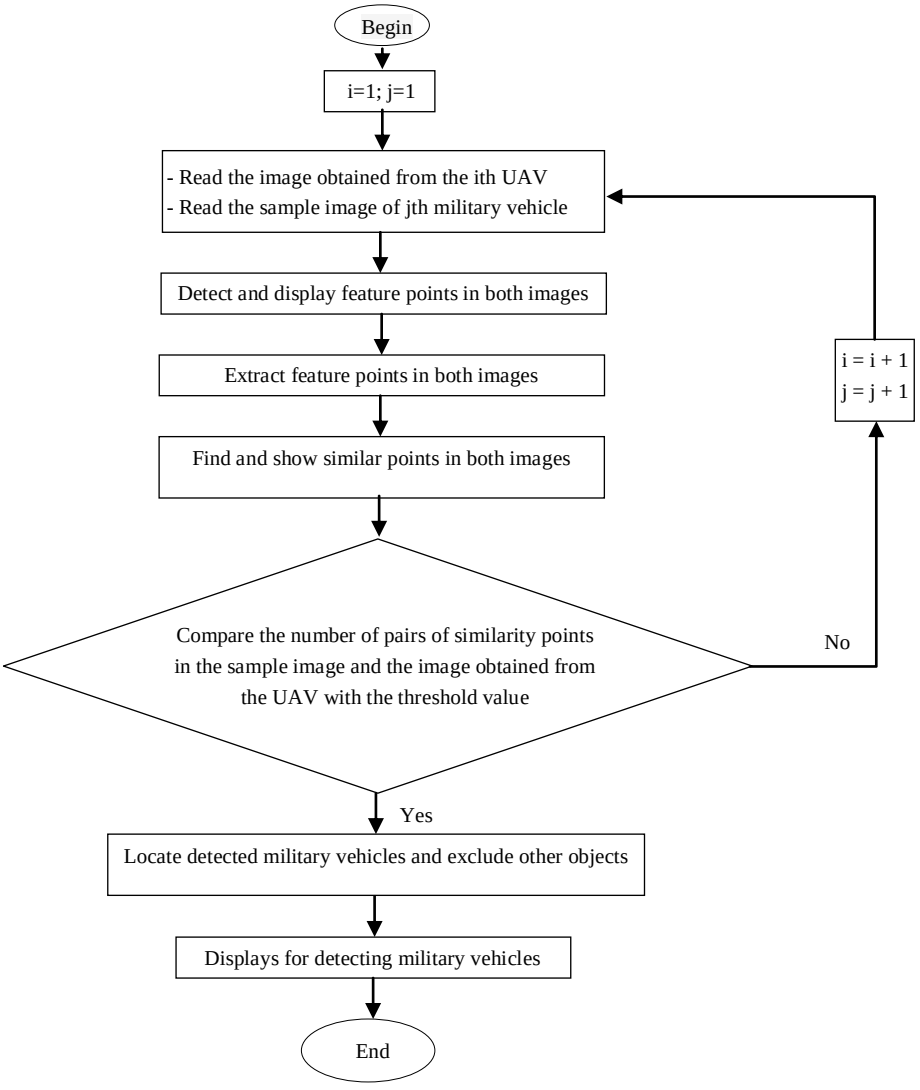

Fig.3. The algorithmic flowchart of the military vehicle image recognition program

Image recognition is the final stage of image processing. Image recognition is based on recognition theory [15].

In the military vehicle image recognition program, the first two approaches are used, including two subroutines:

-Tank and armored vehicle image recognition program.

-The aircraft image recognition program.

These two programs both use the same algorithm to detect a specific object based on finding similarities between military vehicle sample images and images obtained from UAV. The image recognition process is done through the following steps:

Step 1: Read image data.

Step 2: Detect and extract features.
Step 3: Compare and search for pairs of similar features.
Step 4: Evaluation gives results.
The military vehicle image recognition program has an algorithmic flowchart as shown in Figure 3.

2.2. Recognition of tanks - armored vehicles

To conduct recognition of tanks and armored vehicles in images obtained from UAV, objects must go through a preprocessing stage to enhance quality, highlighting details. Sample images and images obtained from UAV are extracted from features and compared to these features. Finally, the stage of recognition and evaluation gives the results.

Step 1: Read image data
Upload data from sample images and images obtained from UAV.

Fig.4. Sample image of type 99 tanks and an image obtained from UAV

Fig.5. Sample image of the ZBL-09 armored vehicle and an image obtained from a UAV

Step 2: Detect and extract features.

The features in the sample image and the UAV image will be detected and extracted, and then compared to find similar features.

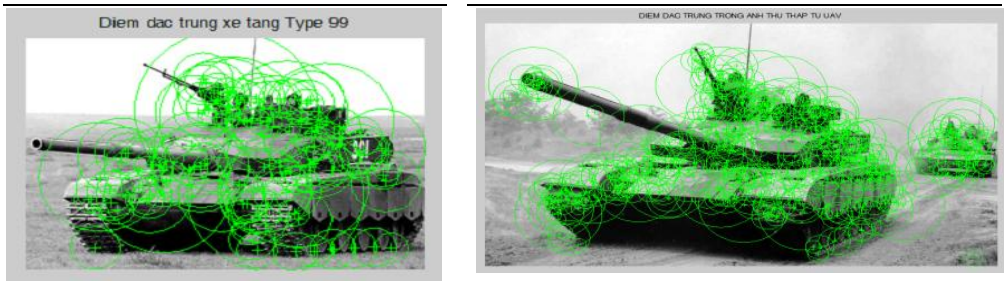

Fig.6. Features in the sample image of the type 99 tank and image obtained from the UAV

Fig.7. Features in the sample image of the ZBL-09 armored vehicle and the image obtained from the UAV

Step 3: Compare and search for pairs of similar features.

The features in the sample image and the image obtained from the UAV will be compared with each other. From there, determine the similarities between the sample image and the image obtained from the UAV.

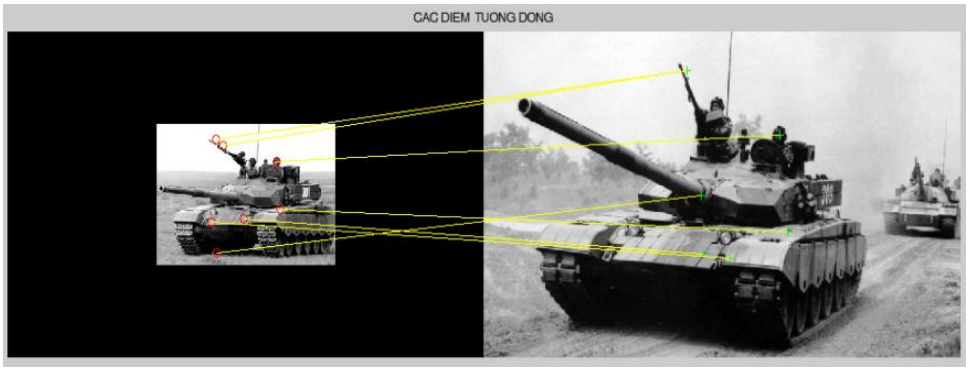

Fig.8. The similarities between the sample image of the type 99 tank and the image obtained from the UAV

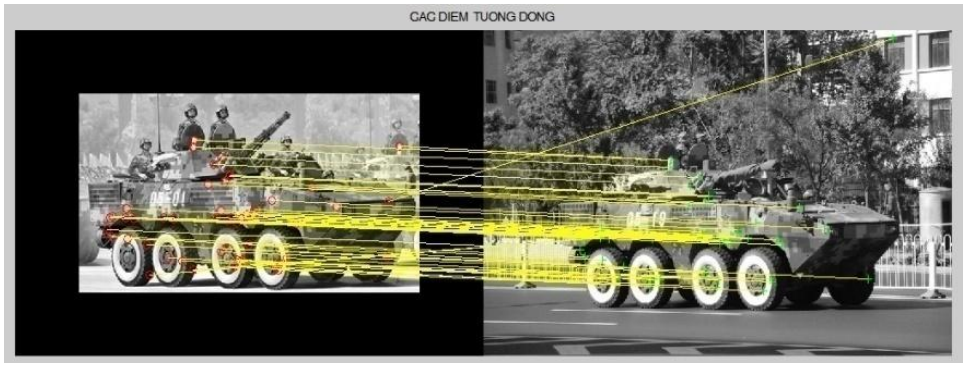

Fig.9. The similarities between the sample image of the ZBL-09 armored vehicle and the image obtained from the UAV.

Step 4: Evaluation gives results.

From the results of comparing the similarities, the recognition results will be given. The recognition object will be framed for easy observation and evaluation.

Fig.10. The Type 99 tank is recognized

Fig.11. The ZBL-09 armored vehicle is recognized

2.3. Aircraft recognized

Step 1: In this test, the program will first call up the sample images of the aircraft and the images obtained from the UAV.

Fig.12. Sample images of aircraft – J15, J7, SU27

Fig.13. The aircraft images obtained from the UAV

Step 2: Detect and extract features**.**

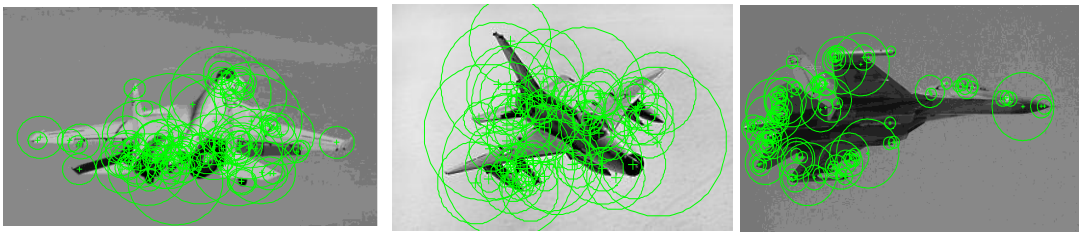

Fig.14. Features in the sample image of aircraft – J15, J7, SU27

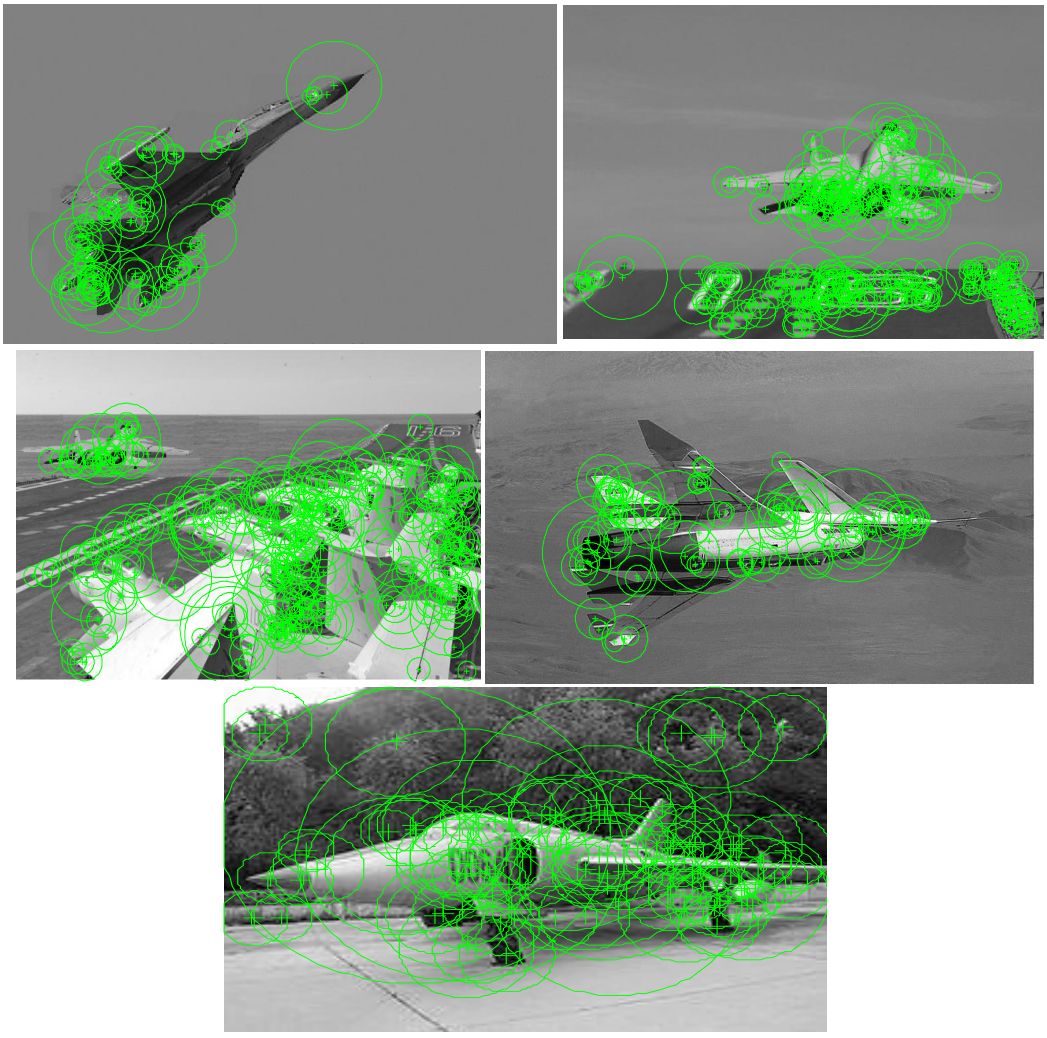

Fig.15. Features in the aircraft images obtained from the UAV

Step 3: Compare and search for pairs of similar features.

With 3 sample images of the aircraft and 5 images obtained from the UAV, a total of 15 pairs of images will be extracted. Here are 1 pair of images extracted:

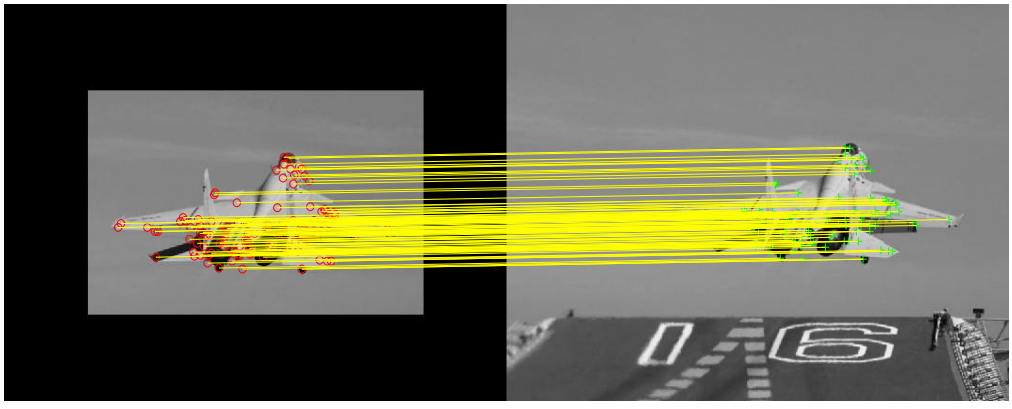

Fig.16. The similarities between the sample image of the aircraft and the image obtained from the UAV

Step 4: Compare the number of pairs of similarity points in the sample image and the image obtained from the UAV with the threshold value

Step 5: Determine the aircraft's position, exclude other objects, show the aircraft detected:

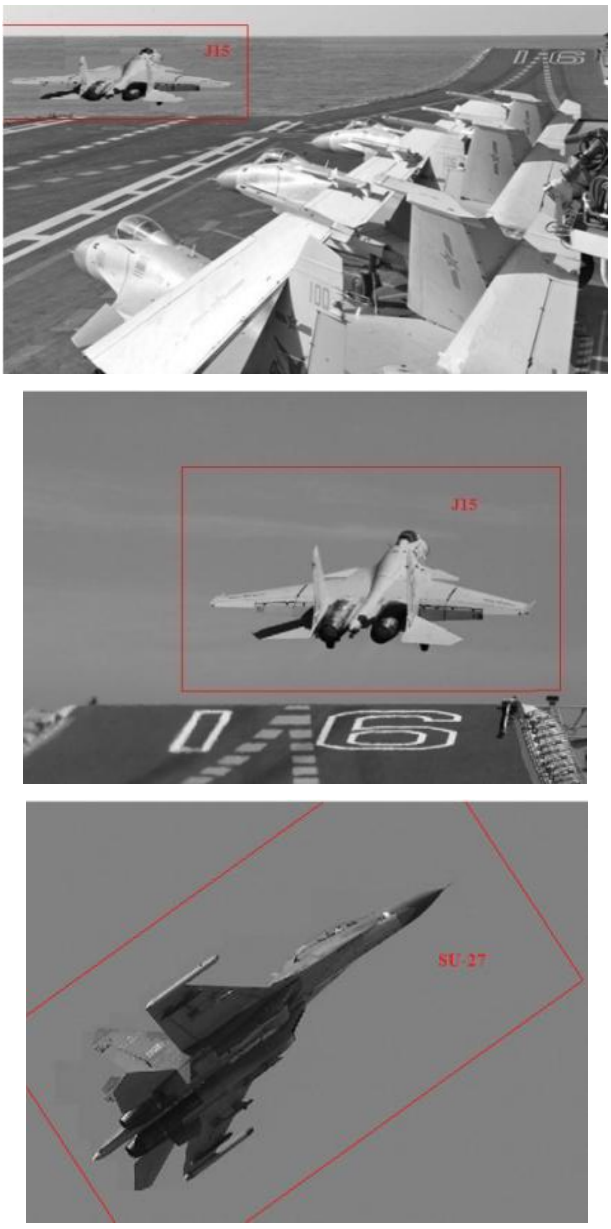

Fig.17. Several aircraft are identified

3. Application program for search and rescue of wounded soldiers

3.1. Human detection algorithm

Human detection is an extremely important job in the search and rescue process. To do that, in the search and rescue program for wounded soldiers, the authors use the human face detection method to detect the presence of people.

Human face detection is a computer technique for determining the positions and sizes of human faces in arbitrary images. This technique recognizes the features of the human face and ignores others, such as buildings, trees, signs, etc. There are many studies on facial features, which can be based on features such as two eyes, two nostrils, a mouth, the connection between the nose and the mouth... or based on the contour of the face.

3.2. Search and detect wounded soldiers

The authors built a program to search, detect and rescue wounded soldiers from images and videos transmitted directly from UAVs.

Search and rescue results for missing soldiers at sea through images received from UAV:

Fig.18. Search and rescue results for missing soldiers at sea through images received from UAV

- Search and rescue results for wounded soldiers through images received from the UAV:

Fig.19. Search and rescue results for wounded soldiers through images received from the UAV

- Search and rescue results for wounded soldiers through video transmitted from a UAV:

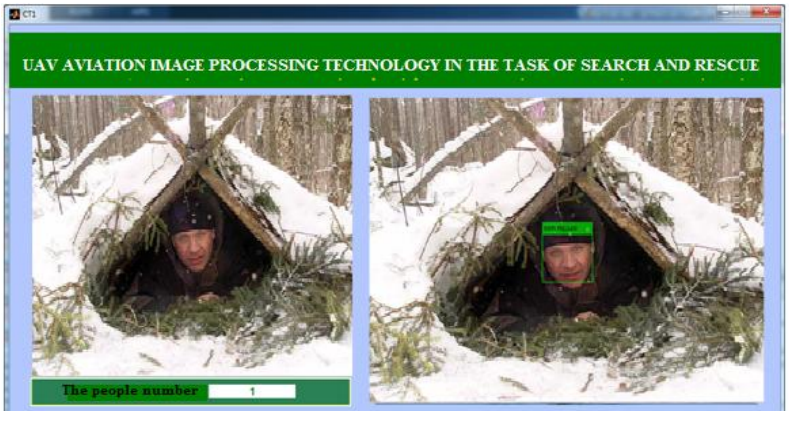

Fig.20. Search and rescue results for wounded soldiers through video transmitted from a UAV

4. Conclusion

Through the study "Applying UAV aviation image processing technology based on multi-integrated feature histogram for scouting, search and rescue", the authors have built an image recognition program to perform the task of scouting for military vehicles and search and rescue of wounded soldiers. The outstanding advantage of this application is to expand the scope of observation, increase positioning accuracy, and minimize direct human involvement in the scouting and search process, significantly reducing the cost, time and effort of scouting, helping the commander have an overview of the enemy's situation, and ensuring the safety of people and property during the search and rescue process, avoiding the dangers of being detected by the enemy, minimizing the loss of life and property when there are incidents during search and rescue.

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