ISSN: 2414-1895 DOI: 10.6919/ICJE.202110_7(10).0030

An Intelligent Image Processing System for UAV Applications

Xinlei Zou, Yun Wang

School of Information and Communication Engineering, University of Electronic Science and Technology of China, Chengdu, China.

Abstract

As the popularity and application of unmanned aerial vehicle (UAV) in various fields, whether civil or military, there are increasing technical demands on the image information collected by UAVs. For instance, for the detection and identification of individual targets within the transmitted images, the defogging and splicing of images. This paper presents the design and implementation of a program that automatically detects targets such as vehicles and houses in UAV video. Furthermore, it is possible to stitch together multiple transmission videos on demand to achieve intelligent image analysis for drone surveillance.

Keywords

UAV; Target Detection; Machine Learning; Artificial Intelligence; Image Stitching.

1. Introduction

As technology develops, UAVs are becoming increasingly popular in our daily lives and work, whether for military or civilian use. For example, border control, forest fire prevention, traffic control, geographic mapping and news gathering. Ultimately, all of these applications involve the analysis of the captured images and the collection of information. If a thorough view were to be carried out by the human eye, each surveillance video would require an inordinate amount of manpower and time. If the information contained in the images could be intelligently analysed by computers through machine learning methods, this tedious work would be saved. Hence, it is important to study intelligent image processing in the field of UAVs.

2. General system design scheme

The general framework of the system is shown in Figure 1, and the general framework flow of the whole system is divided into three major parts.

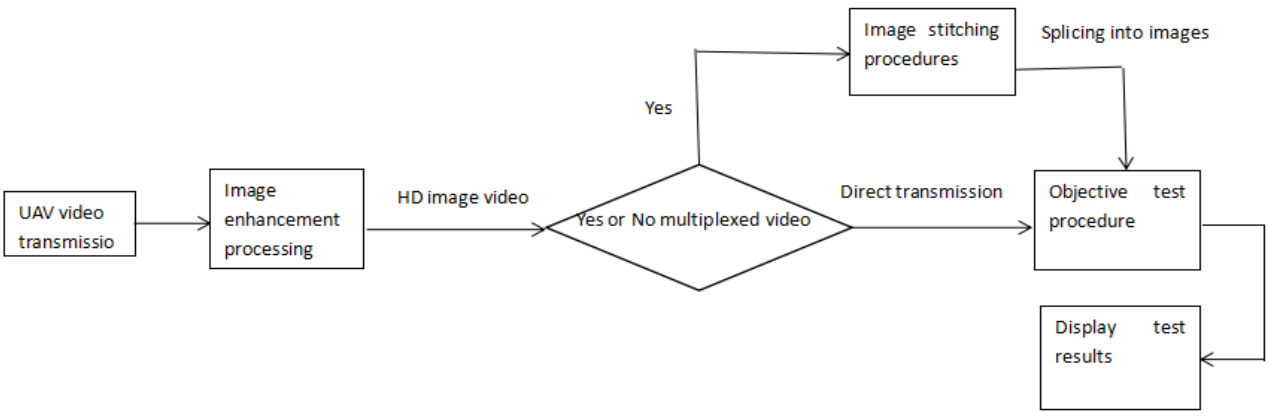

Fig. 1 System framework

ISSN: 2414-1895 DOI: 10.6919/ICJE.202110_7(10).0030

2.1 Image enhancement processing module:

The module primarily makes the images transmitted from the UAV clearer. Due to the fact that the images are transmitted from high altitude and the weather is unknown, this module mainly does brightness enhancement and defogging operations.

2.2 Image stitching module:

The module primarily processes images transmitted by parallel UAVs and enables a series of spatially overlapping images to be aligned to form a seamless, high definition image so that the newly formed image has a higher resolution and a larger field of view.

2.3 Target detection module:

The module features the intelligent analysis of the transmitted images, based on the training of a large number of data sets, so that the program can automatically identify the targets and their locations that appear in the video.

3. Introduction to system algorithm technology

3.1 Image Enhancement Algorithm: Multi-Scale Retinex (MSR)

MSR is a Retinex algorithm that has been developed from SSR. In contrast to the SSR algorithm, MSR has the advantage of maintaining high image fidelity with compression of the dynamic range of the image, while enabling colour enhancement, colour constancy, local dynamic range compression, global dynamic range compression, and can also be used for X-ray image enhancement.

MSR is formulated as follows:

$$r(x,y) = \sum_{k}^{K} \omega_k \{\log S(x,y) - \log[F_k(x,y) \cdot S(x,y)]\}$$

Where K is the number of Gaussian central surround functions. When K = 1, MSR degenerates to SSR.

Figure 2 is a demonstration diagram of the defogging effect.

Fig. 2 MSR image defogging effect

3.2 Image stitching algorithm: SIFT algorithm

The SIFT (Scale Invariant Feature Transform) refers to the scale invariant feature transform. It describes the detected feature points in an image as a 128-dimensional feature vector, so an image can be represented as a 128-dimensional feature vector set after the SIFT algorithm, which has features invariant to image scaling, translation and rotation, and invariant to illumination, affine and projection transformations, thus being an excellent local feature description algorithm.

The image stitching system starts with feature point extraction by using the SIFT algorithm, followed by coarse matching of feature points using the Fast Nearest Neighbour algorithm and initial screening using threshold setting and two-way cross-checking methods. Subsequently, the RANSAC algorithm

ISSN: 2414-1895 DOI: 10.6919/ICJE.202110_7(10).0030

is applied for fine matching, which is followed by an image transformation to map different images to the same coordinate system to complete image fusion.

3.3 Target detection algorithm: YOLOV4

YOLO (You Only Look Once) series is a regression method based on deep learning. At its core, the idea is to use the whole picture as input to the network, simply going through a neural network to obtain the position of the bounding box and the category to which it belongs.

The advantage of this algorithm is its fast detection speed, which can be achieved in real time by running on a GPU. It has a low background false detection rate and is highly versatile.

YOLOV4 proposes an efficient and powerful target detection model compared to previous generations, allowing users to train fast and accurate target detectors using 1080 Ti or 2080 Ti GPUs. It has been tested and works superbly in situations where the UAV is flying at high altitude and has an extremely large number of targets.

4. UAV field test applications

A number of field tests were carried out with this system on board at the UAV base. Under sufficient light as well as foggy days, evening and other situations where the image is not clear enough, the target unit can be detected accurately and in real time, and the field test detection results are shown in Figure 3.

Fig. 3 Target detection in urban areas

5. Conclusion

This paper provides an intelligent image processing system for UAVs based on machine learning, target recognition, image stitching and other techniques. It designs an accurate and low latency real-time intelligent target detection program, which is successfully implemented on PC and hardware such as development boards. It has a large market and application value in the field of UAVs.

References

[1] Hou Tao, Jiang Yu. Application study of improved YOLOv4 in remote sensing aircraft target detection [J/OL]. Computer Engineering and Applications: 1-10 [2021-04-16]. http://kns.cnki.net/kcms/detail/11.2127.TP.20210409.1559.014.html.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202110_7(10).0030

[2] Yan Yu, Wang Yongzhong, Yang Laibang. UAV-based real-time map transmission system [J]. Intelligent Computers and Applications, 2019, 9(04):65-70.

[3] Yang Jun, Yang Wanyu. Remote sensing image alignment with improved scale-invariant feature transform [J/OL]. Survey and Mapping Science: 1-15 [2021-04-16]. http://kns.cnki.net/kcms/detail/11.4415.P.20210415.1741.006.html.

[4] Wang Mengmeng, Peng Dunlu. Retinex-ADNet: a low-light image enhancement system [J/OL]. Mini - Microcomputer Systems:1-8 [2021-04-16]. http://kns.cnki.net/kcms/detail/21.1106.TP.20210330.1550.042.html.