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A Trends Analysis of Image Processing in Unmanned Aerial Vehicle

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***Abstract*—**This paper describes an analysis of domestic and international trends of image processing for data in UAV (unmanned aerial vehicle) and also explains about UAV and Quadcopter. Overseas examples of image processing using UAV include image processing for totaling the total numberof vehicles, edge/target detection, detection and evasion algorithm, image processing using SIFT(scale invariant features transform) matching, and application of median filter and thresholding. In Korea, many studies are underway including visualization of new urban buildings.

***Keywords*—**Image Processing, UAV, Quadcopter, Target detection.

I. Introduction

WITH respect to today's rapidly developing algorithms, the improvement in processor performance has made almost all the equipment fully-automated.

Unmanned Aerial Vehicles(UAVs) have revolutionized outdoor aerial tasks from photography to war-fighting. New developments in UAV technology have extended their use to indoor tasks. UAVs can operate in cluttered indoor environments and can negotiate obstacles, such as stairways, which complicate the operation of wheeled and legged robots. This maneuverability makes them useful for many indoor robotic applications.

Especially, because of its excellent maneuverability, the unmanned aerial vehicle (UAV) is widely applied to the private sector such as exploration, aerial photography, and agricultural and disaster observation as well as to the military sector such as military surveillance, urban combat environment. In the area to which it is difficult for people to access such as disaster areas or much crowed downtowns, the UAV image processing can properly assist people to perform their tasks without actually accessing the areas.

For Korea in particular, 70% of which is mountains, UAV has a very high usability. This paper briefly explains about UAV and Quadcopter, and presents the examples of image processing in UAV obtained from domestic and international researches conducted by Konkuk University, Pusan University, and Chungbuk University and in China, Australia and Singapore as well.typical image processing is target tracking, edge detection, target sensing and avoiding, sift matching, thresholding image, new urban buildings classification.Based on the results of this trends analysis of image processing, it is planned to research into security UAV using a Quadcopter like Japanese SECOM to be developed [1]-[9].

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II. A Trends Analysis of abroad

A. UAV and Quadcopter

Unmanned aerial vehicle (UAV) generally refers to any flying vehicle that autonomously fly based on the pre-entered program or on its own recognition of the surroundings, without a pilot. The history of the UAV started with the research conducted by the USA after the World War I as they recognized the need for unmanned aircrafts for reconnaissance and currently 155 different types of UAVs are being developed in the USA, and France, Germany and other European countries as well as Israel and Korea developed and have put them into actual use. Quadcopter means a flying object that controls the components of Roll, Pitch and Yaw, maintains the balance, and flies back and forth and from side to side, with four props[1]-[4].

B. Image Processing

Thomas proposed a method of totaling the number of vehicles in UAV. In order to reduce errors in vehicle detection, the research was conducted for the limited area of paved zone. He conducted vehicle detection by firstly detecting important point detection, secondly classifying SMs, and lastly summing up vehicle features. The result shows a detection rate higher than 65%. Fig. 1 shows a total number of cars in the image being detected [2].

Fig. 1 Thomas' image processing of car detection

Menna detected and tracked multiple targets using a Quadcopter. The proposed method detected and matched edges based on the image feature extraction and geographic projection, and detected moving targets as density using a spatial clustering algorithm. Fig. 2shows the image in which edges and cars are being detected [3].

Fig. 2 Menna'sedge and target detection

Ryan proposed an algorithm which enables UAVs sense and avoid approaching flying objects or features in their routes. For image stream processing, he took daytime background. As for pre-analysis dataset, he extracted 6.5km distance detection time, which had 35~40% higher detection ratio than the crowded people. Fig. 3 shows the detection of a target with the threshold of 0.030 in a binary output image [4].

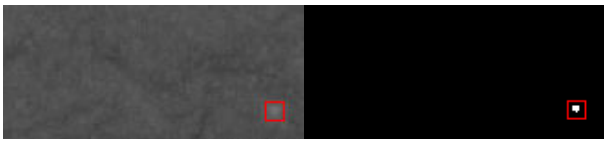

Fig. 3 Dynamic programming output and binary output

XI was able to efficiently improve the target identification, using SIFTmethod. For enhancement, Xi proposed the following: first, spatial hierarchy of images; second, building up of pyramidal shape of images; third, refining of the locations of feature points; fourth, production of SIFT feature points; and lastly SIFT image matching. His image processing technique was capable of extracting features 10% more than the existing SIFT matching and reducing the processing by 20%. Fig. 4shows images of a building processed with the enhanced SIFT matching [5].

Fig. 4 Image processing using siftmatching

Lin proposed a method of tracking a target in real time in helicopter. She applied the median filter and outputted the image at the image module through thresholding. She used this method for the purpose of classification based on pattern recognition and base formula. Fig. 5shows the images generated by the median filter and thresholding [6].

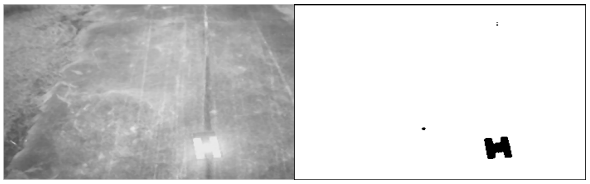

Fig. 5 Image generated by the median filter and thresholding image

Japanese Security Firm's drone takes off as soon as an intruder alarm is triggered to track the intruder. It has a form of mini-helicopter with a small surveillance camera mounted on it, and transmits crime scene photos taken by the camera in real time. When the security system detects any unauthorized access, the drone goes out immediately. The main goal is to capture as quickly as possible what is happening in the field. Fig. 6shows Japanese security company SECOM's drone.

Fig. 6 Japanese security firm's drone

III. A Trends Analysis of Domestic

A. Image Processing

Konkuk University studied about hovering of the gas around the object by tracking the target. Fig. 7shows the images of gas hovering around the target being tracked in the order of time, and + mark in each image indicates the location of the gas on the ground and the square in which the target is located indicates that the image system has detected the features of the target. The closer the distance between these two symbols, the closer the horizontal location between the gas and the target. When these two symbols overlap, it means that the gas is hovering above the target[7].

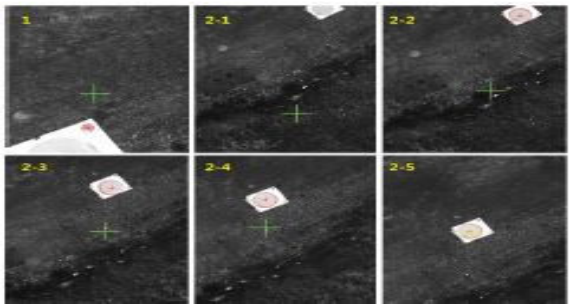

Fig. 7 Target tracking: Aviation electronics and information systems laboratory of Konkuk University

Aerospace Engineering Department of Pusan National University performed target detection using a drone and evaluated the target detection performance through total three flying experiments. They made the drone continuously circle around over the blue target to be detected and tracked, through manual flight, extracted 100 frames from the images taken, detected the target from the input images, and calculated the center point. Then, in order to compare the results of target detection and tracking, they compared the resultant image with the original image in the sized of 320 x 240 pixels, which had been saved on SD memory, on a desktop computer with high-performance CPU. Fig. 8 shows the result of target detection and tracking performed on an on-board image processing system [8].

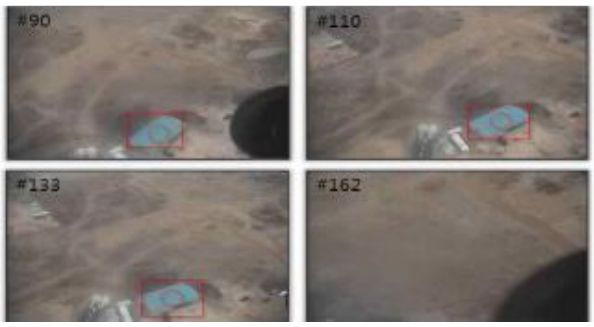

Fig. 8 Target tracking: flight dynamics laboratory of Pusan National University

Chungbuk National University proposed a technique for quickly acquiresthe 3D information about the frequent changes in urban areas. The proposed photogrammetric measurement using UAV can be done using an inexpensive drone and a measurement camera, and the internal orientation parameters were obtained through camera calibration Fig. 9shows an image which is made easier to see the slope of the ground, and Fig. 10shows an image of a limited view of newly constructed building only [9].

Fig. 9 Aerial slope photo

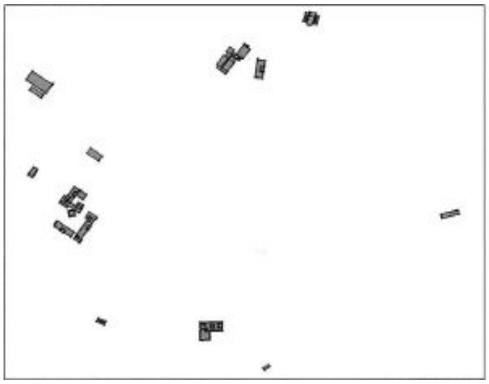

Fig. 10 New urban buildings

The future study aims at enabling the user to recognize an intruder by extracting images taken by the multicopter based on the image processing in UAV, detecting and tracking the intruder through a detection algorithm, and notifying the user of the intruder in real time via a cell phone or an alarm. Whilepatrolling no registrant when he is detected, first the user is known from alarm, the multicopter performs real time target detection and tracking, an obstacle sensing and avoiding. it can easily be found because of GPS function.Fig. 11shows a multicopter to be used for implementing the image processing.

Fig. 11Fy450 multicopter

IV. Conclusion

This study investigated the domestic and international examples of applying images taken by UAVs and quadcopters to various researches about image processing in the actual environment. It has a great applicability to the aerial surveillance rather than to the ground where there is limitation in movement. As UAVs are becoming more compact, it is expected that the image processing in UAV will become more popular in many areas including disaster control, public service, surveillance and reconnaissance.

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