Abnormal crop warning system based on OpenMV

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Abstract. In order to realize the early warning of abnormal crops, the photographing technology and image recognition technology of openMV and openCV are comprehensively applied to study the early warning of abnormal crops. The design take photos using openMV hardware platform and connects to the cloud through 5G module. Then it conducts in-depth processing such as gray processing, image denoising and boundary detection on the photos through the network server to obtain the location and size of abnormal areas, so as to help spray pesticides later and improve production efficiency.

Keywords: OpenMV; OpenCV; 5G; Image Processing.

1. Introduction

Modern crops need to be planted in large areas, such as corn, wheat, soybeans, etc. are planted in the size of thousands of acres. If there are pests and diseases not found in time will lead to serious consequences. For most of the manual methods to check whether there are abnormal conditions, the severity of pests and diseases, as well as the scope of impact, most of the human eyes can be observed. This method is too inefficient, can not guarantee the final quality to cause serious economic losses, and will consume serious manpower and material resources.

Therefore, an abnormal crop early warning system based on OpenMV is designed so that it can be adapted to fixed pole frame or UAV and other hardware facilities. The whole crop field is scanned and relevant conclusions are drawn by conducting crop inspection in a certain time, reflecting the problem area and estimating the affected area. Close-up photographs were then taken to determine the type and severity of the pests.[1]

2. Hardware composition

The abnormal crop warning system based on OpenMV mainly includes power supply module, signal transceiver module, camera module, storage module, positioning module, height module and processing module.

The camera module in the early warning system is OV5640 sensor with the default configuration of OpenMV4 H7 Plus, which can take farmland photos and collect images of the detected objects. The processing module uses STM32H743II ARM Cortex M7 processor. The signal transceiver module uses 5G signal transceiver to send the picture to the cloud, and OpenCV is used on the server to conduct in-depth processing of the pre-processed image, such as grayscale, noise reduction and boundary detection. Divide the problem areas and calculate the area that needs to be cleaned. The storage module is a high-speed μSD card delivered with OpenMV, which can store photos temporarily. The power supply module uses lithium batteries. The positioning module selects 5G communication, GPS ATGM332D module GNSS global positioning extension module, which can be connected with GPS satellite to locate the position of the UAV in real time, so as to determine the boundary point. The altitude module selects the altitude measurement function in the ATGM332D module to determine the height of the UAV, so as to facilitate the calculation of the area size.

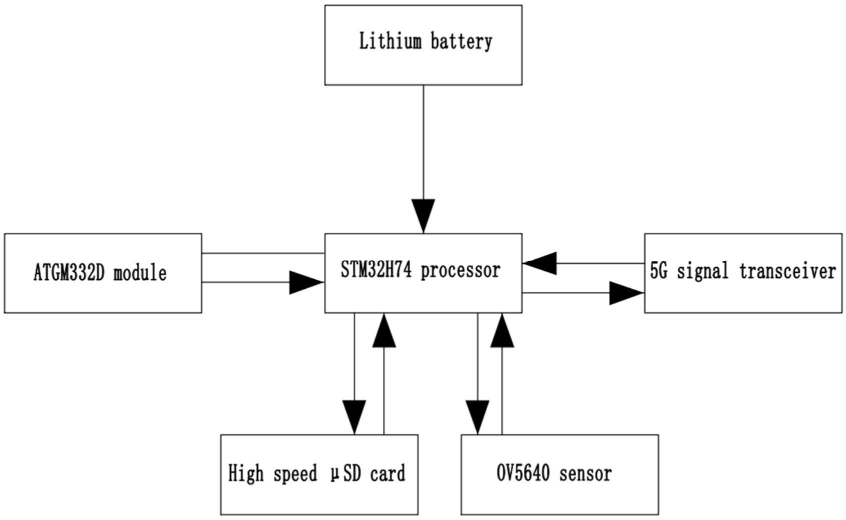

Fig. 1 Block diagram of hardware components

3. Software platform selection

When HD cameras are used to collect images, OpenMV is selected. MicroPython language is used to program the platform, and 5G technology is adopted to directly send the captured color images to the cloud remote server.

On the server side, OpenCV and Python are used to further process the image, such as gray-scale, noise reduction and boundary detection, so as to obtain the boundary and area of abnormal crops. After that, the irregular area to be treated is separated by several rectangles through image segmentation and image discretization technology, which is convenient for subsequent pesticide spraying route planning.

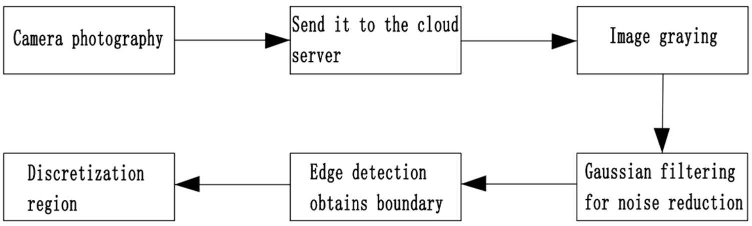

Fig. 2 Software flow

4. Key technology

4.1 Image acquisition

4.1.1 GPS position & Altitude measurement

When determining the boundary of abnormal crop range, it is necessary to obtain accurate coordinate points to plan a more reasonable spraying path range. Therefore, the Beidou satellite system used in China can maintain an error within 2 meters, which is very accurate. [2] At the same time, to calculate the area, we also need to know the altitude of the aircraft at the time of shooting and then apply the formula to calculate the corresponding proportion. To measure the altitude during flight, use the ATGM332D module to measure the altitude. [3] Then the local ground altitude is obtained through big data, and the altitude above the ground of the UAV is obtained by making difference.

4.1.2 Image shooting & transmission

The OV5640 sensor of OpenMV is used to shoot high-definition color images on the UAV, and the images are sent to the cloud server through 5G. Then, OpenCV and Python are used to further identify the images on the server.[4]

Fig. 3 High definition farmland photo

4.2 Image processing

4.2.1 graying

To convert the original image into GRAY color image, firstly, the image is converted from BGR color space to RGB color space using cv2.cvtColor_BGR2RGB. RGB color space is converted to GRAY color space standard formula (1), so cv2.cvtColor is used next

_RGB2GRAY Changes the image to grayscale.[5]

$$Gray=0.299*R+0.587*G+0.114*B \quad (1)$$

Fig. 4 Grayscale picture

4.2.2 Gaussian filter denoising

The convolution kernel is defined as 5*5, and the Gaussian filtering is realized by automatically calculating the weight.Using OpenCV provided in DST = cv2. GassianBlur (SRC, ksize sigmaX, sigmaY, borderType) function to implement, including sigmaX and sigmaY respectively convolution kernels weight value on the horizontal and vertical direction, It can be obtained by calculating formula (2).Therefore,

gauss=cv.GaussianBlur(image,(5,5),0,0) can be used to obtain the image after Gaussian filter denoising.

$$\begin{aligned} sigmaX&=0.3*[(ksize.width-1)*0.5-1]+0.8 \\ sigmaY&=0.3*[(ksize.height-1)*0.5-1]+0.8 \end{aligned} \quad (2)$$

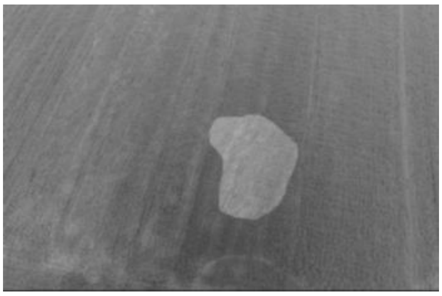

Fig. 5 Gaussian filter denoising

4.2.3 Edge detection

Use of OpenCV cv2. Canny () function to achieve the image edge detection, the general format for edg = cv2. Canny (SRC, threshould1 threshould2 [, apertureSize [, L2gradient]]).Canny algorithm uses Sobe operator to calculate the amplitude of image edge. Image matrix I convolved with the convolution kernels dx and dy in horizontal and vertical directions respectively to get dx and dy, and then took the square root of (3) to get the edge intensity, and then calculated the gradient direction angle (4),

$$\text{magnitude}=\sqrt{dx^2+dy^2} \tag{3}$$

$$\text{Angle}=\arctan2(dy,dx) \tag{4}$$

Fig. 6 Boundary detection

So edg=cv.Canny(image,100,130) was used to mark the edges.[6]

4.3 Determine boundary & distance calculation & area calculation

Fig. 7 Discretization area

The boundary is determined by discretization method, that is, the irregular area is separated by ten parallel rectangles, which is convenient for later path planning and calculation of spraying area. Since the height h of the UAV can be measured, and the shooting Angle θ of the camera is fixed, the coordinates (x,y,h) of the UAV when shooting are also known, the trigonometric function formula (5) and coordinates can be used to calculate the coordinates of the photo boundary, and then through a similar method to calculate the coordinates of each boundary point, and finally calculate the distance size. After calculating the distance, multiply the length and width together to get the area Si of each piece. Add together to get S total (6).

$$l=h*\tan\theta \tag{5}$$

$$S_{total}=\sum_{i=1}^{10} S_i \tag{6}$$

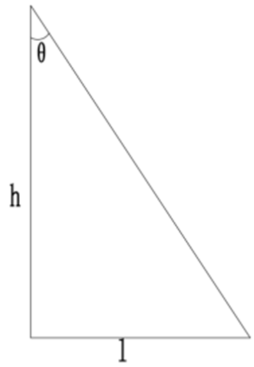

Fig. 8 Width measurement method

5. Summary

This paper discusses a design for the early warning of abnormal crops, in which: the system uses the cloud server to achieve the effect of quick image analysis, which greatly improves the efficiency of inspection; In the whole process of inspection does not need manual intervention, greatly save the manpower and material resources required; The abnormal areas to be dealt with are divided in the way of discrete rectangle, which is convenient for the planning of pesticide spraying route and improve efficiency.

References

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