The Monkeys Are Coming – Design of Agricultural Damage Warning System by IoT-based Objects Detection and Tracking

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***Abstract*-- Agricultural production is an essential element in the development of human civilization. As the number of Taiwan Macaques increases, the original habitats cannot provide enough space and food for these macaques. So, there are many monkeys break in farm fields to obtain food and make significant agricultural damages. To prevent the crop losses, some protection and warning systems need to be deployed to detect and drive away these monkeys. In this paper, we proposed a coming monkeys warning system to reduce the agricultural damage from monkeys in the farm field. We deploy IP cameras and design a monkey detection system in the field to monitor the farmland. In order to identify the monkey accurately in the field, we used hybrid recognition mechanisms. The system can notify farmers when the monkey is near in the farmland, and then can make noise sounds to drive the monkey out. The experiments show the overall recognition accuracy can be approximated to 91%.**

I. INTRODUCTION

Taiwan macaques are widely distributed at all altitudes of mountain in Taiwan; the number of them is about 200,000 to 300,000 [1]. In recent years, conflicts between humans and monkeys often occur because the monkeys damage crops frequently. The Taiwan macaques are protected under animal conservation law, so some traditional ways are used to get rid of the monkeys including: sound-driven (including firecrackers and tape recorders), man-driven (mainly in the form of slingshots), dogs, mosquito coils with firecrackers, CDs, power grids, planting of other crops, or actually trapping macaques [2,3]. The most common way of these approaches is man-driven approach; but this method has limited control effect because only some macaques can be driven out, and the macaques will still come back after a while. In Taitung, the power grid and anti-monkey network are used. Although farmers said that there are benefits by using grid in the beginning stage, the macaques have good learning ability and will find loopholes invaded after a period of time. Also, the effect of firecrackers or tape recorders will decrease after using a few times. Some farmers in Nantou, Tainan and Kaohsiung use the trap method to catch the individual monkeys, and most of them are moved to other wild or sent to the zoo or institutions. This approach is also not an effect way.

Based on above conservations, we need an intelligent warning system to assist farmer to drive out these monkeys anytime and anywhere in the field. In this paper, we proposed an IoT architecture equipped IP cameras to detect the coming monkeys, and the system can take some warning actions after detecting them.

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II. PROPOSED APPROACH

A. System Architecture

Fig. 1 shows the system architecture, in which some IP cameras are deployed in the field. These nodes will help us to get the daily farmland image. Then, the proposed design of image recognition algorithm can be used to detect whether a monkey is entering the field. If we find the monkey, the node will make a noise sound to drive out the monkey. The system will also notify the farmer when the monkey is showing up in the field. At the same time, all data will be assembled to the gateway and be delivered to the server for further analysis. All messages are based on IoT MQTT, and the proposed system can be integrated in another proposed intelligent system to achieve intelligent agriculture system [4].

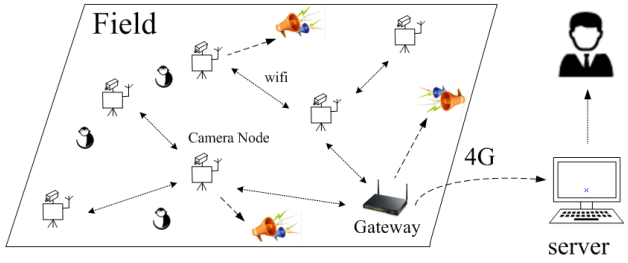

Fig. 1. The warning system of coming monkeys.

B. Image recognition algorithm

Fig. 2 shows the algorithms used in the proposed approach. The approach can be divided into three main modules: preprocessing module, feature mapping module and verification module. We present these modules as follows.

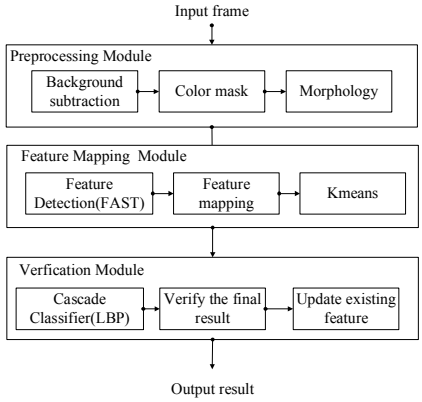

Fig. 2. The flow chart of the proposed system.

1) preprocessing module

In this module, we use background subtraction method to separate the background object and foreground object first. This can help us to get the mask information when a monkey is moving in the frame. Then we need to further filter out non-

monkey movements, like a leaf fluttering, branches swing and so on. First, we took 50 monkey pictures and cut their face to map to the histogram of the HSV color space to decide the color (only the H value). Then, we measure the hue color values for monkey face and non-face area separately. Next, these two color values will be used to get masks of monkey face and non-monkey area. Finally, we can get the union of these two masks to get the full candidate area of a monkey.

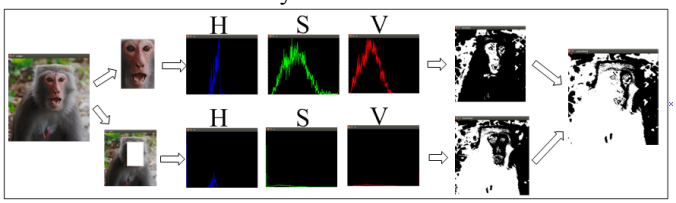

Fig. 3. The process by using the color mask

2) feature mapping module

In the feature mapping module, we want to decide what is a key point we interested. We use FAST algorithm to get features of a monkey. Any point that has a large difference from the surrounding values will be picked out. By FAST, we can get a set of points around the outline of a candidate object. Then we use the k-means algorithm to cluster these points. Fig. 4 shows the process results of the feature mapping. To further verify a possible area which monkey appears, we intersect the results of feature mapping and the results of preprocessing module.

Fig. 4. The process results of the feature mapping

3) verification module

The final module uses the LBP cascade classifier to further verify the result. We collected three datasets for data training including head (positive:9338, negative:16100), face (positive:7350, negative:12100) and full body (positive:5210, negative: 13500). By using these training files, we can get two candidate regions which can be used to check whether the two regions are overlapped to further filter out unreasonable results.

III. Experimental Results

Fig. 5 shows the result of the preprocessing module, in which the results of color masks and background subtraction are intersected to get candidate area.

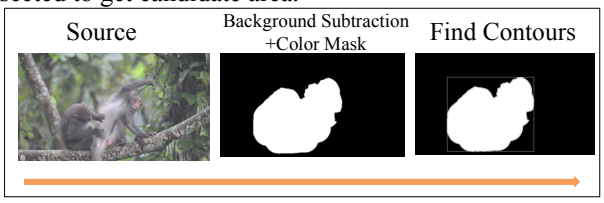

Fig. 5. The results of the preprocessing module

Fig. 6 shows the results of applying k-means clustering for feature points. After using FAST algorithm to get the feature points, we use the KMEANS to get groups of the points. From the figure we can find that some groups are not monkey. In order to further filter out the false positives, we use classifier to verify these groups. Fig. 7 shows the final results of using the proposed approach, and we can find the monkeys can be recognized correctly and no false positives appear.

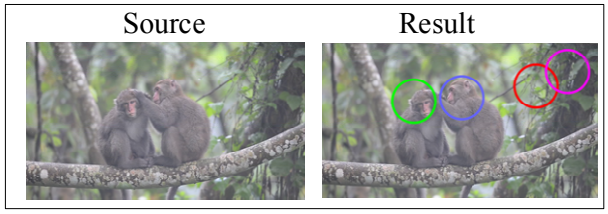

Fig. 6. The results of using feature point

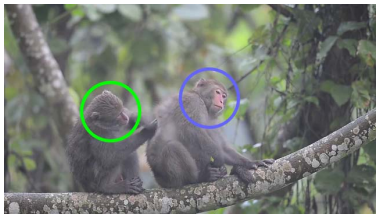

Fig. 7. The final result of the proposed algorithms

We also did experiments for recognition rate shown as Table 1. The total number of testing monkey samples is 134; the TP is 122 and FN is 12. The recognition rate of monkeys is about 91%, the miss rate is about 9%, and the false rate is 15%.

Table 1 Recognition Rates

Standard	TP	FP	FN
Number(total:134)	122	21	12
Rate	91%	15%	9%

IV. Conclusion

This paper presents a IoT-based system to recognize coming monkeys which can be used to warn the farmers and make some noises to drive out the monkeys. Also, the sensing information and images will be sent back to the server for further intelligent analysis. The system is very useful for farmers in Taiwan because the agricultural damages by monkeys become more and more serious. Also, MQTT-based IoT architecture make the system to be extended easily.

Reference

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