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Cloud-based Video Monitoring System Applied in Control of Diseases and Pests in Orchards

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Abstract: As the proposition of the ‘Internet plus’ concept and speedy progress of new media technology, traditional business have been increasingly shared in the development fruits of the informatization and the networking. Proceeding from the real plant protection demands, the construction of a cloud-based video monitoring system that surveillances diseases and pests in apple orchards has been discussed, aiming to solve the lack of timeliness and comprehensiveness in the control of diseases and pests in apple orchards. The system can not only monitor the growth state of all apple trees in orchards, but also detect apple trees’ diseases and pests. The system featured a camera located under tree canopies that could precisely detect diseases and pests on the back of the leaves. On the cloud storage service side, plant protectors can get hold of the situation of apple trees’ diseases and pests by using the software installed in a smartphone or a computer. The system provided pinpoint surveillance data and determining criterions for the control of diseases and pests of fruit trees, which had a great realistic meaning to the development of agricultural and rural informatization.

Key words: video cloud; video monitoring; diseases and pests; apple orchards

1 Introduction

For a long time, traditional method for diseases and pests surveillance in orchards is going to the orchards for checking. This kind of monitoring method exist some drawbacks, such as the surveyed orchard is far from the plant protection station, uncertainly survey schedule and too much manpower input. On the other hand, during apple trees’ growth period, some diseases and pests would occurred on the surface of the trees’ leaves, but others would occurred on the back of the leaves. Orchard surveillance are typically monitored from top to bottom [1], which lack the function of capture the video of the back of leaves. Then, the state and severity of diseases and pests of the back of leaves cannot be detected automatically.

With the introduction of the ‘Internet plus’ concept and rapid development of new media technology, more and more traditional industries have been sharing the development fruits of the informatization and the networking. Liu et al. combined cloud computing and environmental protection industry and discussed the application of cloud computing in the video monitoring of massive pollution sources [2]. In the field of food safety retracing, using the Hadoop file system, Du studied its distributed processing architecture, data storage method and operation procedure of data read and write, which provided a new solution for the application of cloud video information processing in food safety tracing [3]. According to the practical demand of agro-technology extension, Luan et al. discussed the cloud video service applied in visual agro-technology extension, and constructed a platform system of visual video service of agro-technology extension by using the spatial embedding technology of cloud video service [4-5].

Cloud computing is a fresh service that traditional computer technology and networking technology intermingle. A new service pattern would be built by mobilized present information

resources to satisfied different levels of users'needs of information service,which have characteristics of macro scale, virtualization and extendibility.

As an inseparable part of the application of Internet, the development of cloud computing has become more and more extensive. Cloud computing adopt software as a service (SaaS) as its type of service mode. This service mode is a wholly novel software application mode that is gradually formed along with the continuous development of the Internet technology. This is just a kind of extension to the host-client pattern [6]. Emergence of the cloud computing promoted video monitoring to further development, and gradually formed a brand new mode of cloud service--video surveillance as a service [7]. The mode and structure provided users a kind of video surveillance service, on which users just need concern about the demands of video preview and playback they wanted, and they do not care which devices run the service. This kind of fully virtualized method simplified its application steps, and enhanced its convenience. At present, the application of cloud-based video monitoring focus more on video meeting and Internet protocol television, but there is lack of application in the control of orchard's diseases and pests. In time surveillance to detect disease and pest is very important for fruit tree production, even directly influences the year-round fruit yield and quality. Yet, it is hard for traditionally manual operation to surveillance trees' diseases and pests in real time and Omnibearing. Therefore, a convenient monitoring solution is needed to deal with this issue.

The video monitoring of diseases and pests that combined agricultural protection with video technology, networking technology and cloud computing technology is the concrete reflection of 'Internet plus' thinking on agricultural protection surveillance. Proceeding from the needs of the practical plant protection, the construction of cloud-based video monitoring system that surveillance diseases and pests in apple orchards has been discussed. The system can not only monitor the overall growth state of apple trees in orchards, but also detect apple trees' diseases and pests. In particular, the system also can detect the diseases and pests hidden in the back of leaves. Surveillance diseases and pests by means of the spatial convenience of the cloud structure might save much time that plant protectors commuted between orchard in rural area and plant protection station in urban area , and provided more timely monitoring data more accurate distinguishing basis.

2 Overall Frame Structure of the System

The system of video monitoring based on cloud computing is called the "cloud-based video monitoring system" [8-9]. The structure of cloud computing service mode allows cloud video monitoring nodes placed somewhere they want monitored. And then, the monitoring video stream would be accessed to the surveillance service center located on the cloud-side, and stored and managed uniformly [10-11]. Users can access to the cloud-side via the Internet to check the real time monitoring video at any time.

Cloud-based video monitoring system of orchards' diseases and pests divide into four parts: acquisition side, gathering side, cloud storage service side and application side. Acquisition side is the equipment captured video data in orchards. It mainly includes cameras, transmission lines and control devices. Gathering side is the specialized digital video recorder which fuses the functions of Internet transmission, matrix display and encoding. Both of side cooperate with each other and fulfilled the tasks of video acquisition, data encoding and data transfer. Cloud storage service side is an important parts of the system that running data request from the acquisition side and the application side [12]. Besides, it also implements the functions of saving and managing a lot of

monitoring video data of diseases and pests. Application side is belonging to the final client. Users issue a surveillance request to the cloud storage service side used by the desktop computer, notebook computer or smartphone to check the video of diseases and pests at a remote place. Sketch map of the overall system structure is shown in Fig. 1.

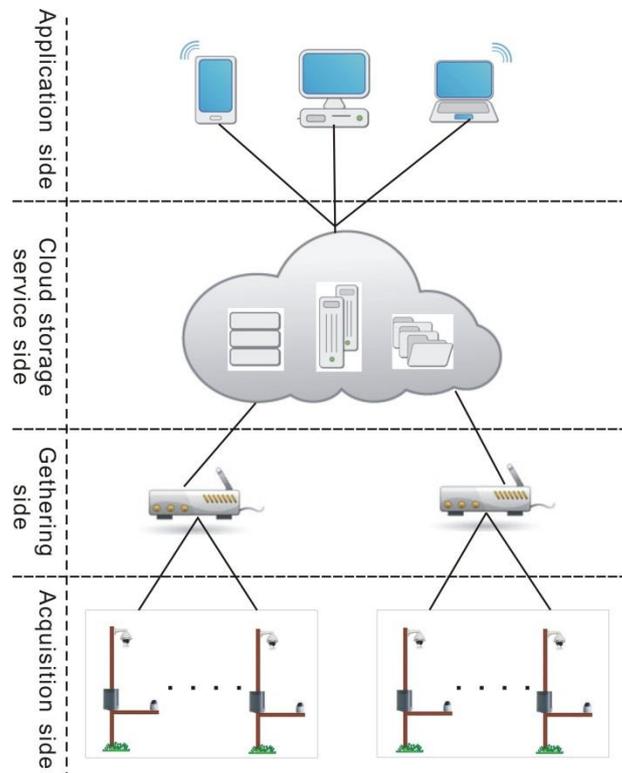


Fig. 1 Overall structure of the system

3 Fundamental Function Modules

3.1 The Module of Acquisition Side

The acquisition side mainly consists of high definition dome camera, hemispheric camera and some auxiliary equipment. According to the requirements of modern management style of fruit trees, in full fruit period, height of fruit trees often remain under about 3m. And the height of surveillance pole need higher than trees' height in order to observe the entire orchard. So the height of surveillance pole designs with about 3.5m. Surveillance pole adopts stainless steel material quality that not only ensured stiffness of bracket, but also prevents rain erosion and field weathering.

Cameras are fitted on the top and the middle of the surveillance pole. In order to observe the diseases and pests of the entire orchard, the top camera use a unibody waterproof dome camera that equipped with a 27-power binocular lens. Lower-middle part of the surveillance pole, under the canopy of the fruit trees, uses a hemispheric camera that equipped with a 10-power binocular lens. Camera stretched into the tree canopy by means of the transverse branch arm to observe the occurrence status of diseases and pests. Similarly, taking rainfall issue into consideration, the sealed rainproof is installed on the external of the hemispheric camera. Physical picture of the surveillance pole is shown in Fig. 2.



Fig. 2 Physical picture of the surveillance pole

Power supply and control of the outdoor facilities use 4 cores copper wire, and divided the copper wire into two sets. One set is used as alternating current power supply. Another set is used as signal line of PTZ control. Given that orchardists would regularly working in the orchard such as blossom and fruit thinning, fertilization and chemical spraying, electric shock are most likely to be occurred if 220V alternating current directly accessed into orchard. Yet the output stability of operating voltage cannot be ensured if transmit electric power with low voltage. Thus, the wire would firstly pass through in 5m high when routing and access to the 5m height relay pole. And then, the wire would access to the surveillance pole after reduced voltage used by an electrical transformer, which can cut down the probability of risk. Video signal of the orchard transferred by coaxial-cable (Syv75-5, theoretical distance is 300m). During the signal transmission, the signal strength would gradually attenuate. So the video signal-amplifier need appended to ensure the quality of the video transmission when the transmission distance is too long. Sketch map of wire arrangement in apple orchard is show in Fig. 3.

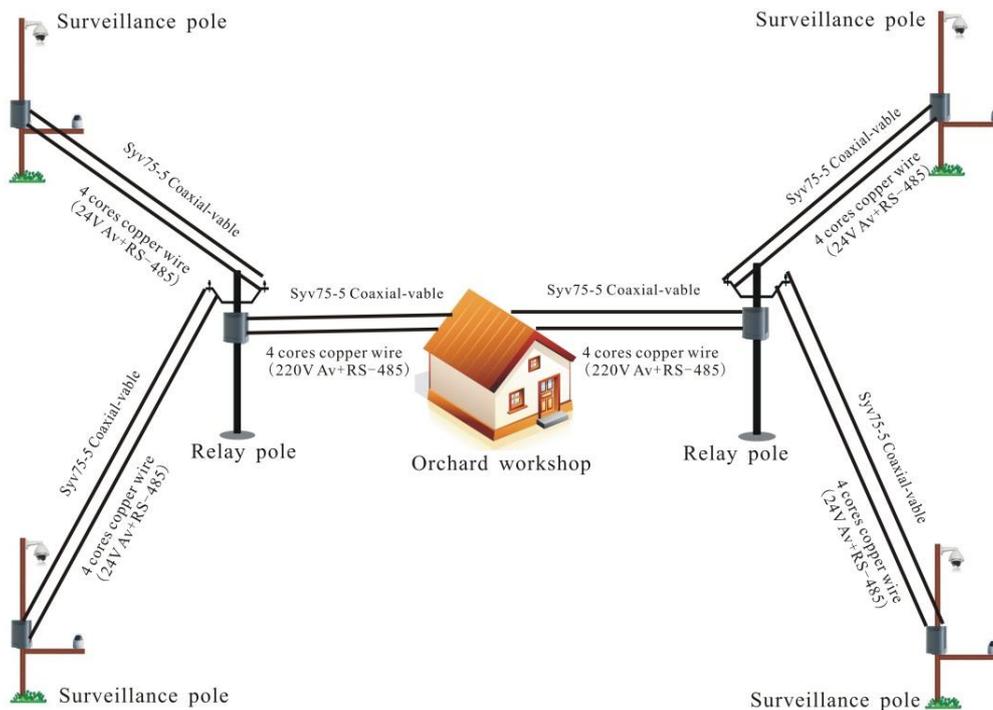


Fig. 3 Sketch map of wire arrangement in apple orchard

3.2 The Module of Gathering Side

The existing patterns of the orchard remote video monitoring most adopt wireless transmission. Although we do not have to consider much about wiring procedure, the steep drop of the video quality caused by the bottleneck of the wireless network bandwidth have limited the application of this technology in remote video monitoring, and it is hard to be practically promoted in remote video monitoring filed.

With the gradually optimizing of the base installation, electric supply and web network have been established in modern orchards. The gathering side of the orchard deployed a digital video recorder with the network transmission function. This side is used to converge the video signal from the surveillance pole, and output and display on the video matrix after converted the signal into image information. Meanwhile, by means of p2p network technology, the digitized video signal would access to the web via ADSL or optical fiber network and transferred to the server farm of the cloud. Users can penetrate the router and firewall through the p2p network technology to visit all of digital video recorder equipment in the cloud and capture the monitoring video of the tree's diseases and pests. In addition, the system would meet the downloading and accessing requirements of p2p pattern by lower the data storage granularity, which rendered sharing and interaction of video monitoring more immediate and simple, and avoided network congestion to some extent. The equipment drawing of the gathering side is show in Fig. 4.



Fig. 4 Equipment picture of the convergence-side

3.3 The Module of CloudStorage Service Side

The cloud storage service side mainly consists of virtual machine, control servers and data storage servers. It can store the video data of diseases and pests from the digital video recorder equipment. The servers on the cloud can distinguish the video origin in the light of the particular ID heading code of the digital video recorder equipment, and saving the digitized video data into the databases of the server farms on the cloud side. Unlike the other platform of video monitoring, the cloud-based monitoring video storage server sides for orchards' diseases and pests not only need to completed the access and manage for the surveillance and browsing nodes by using the control servers, but also need to completed the scheduling and operating tasks from the acquisition side and gathering side. And finally achieved the functions in terms of the data save, manage and visit for the surveillance of diseases and pests. Structure map of the storage service cloud side is show in Fig. 5.

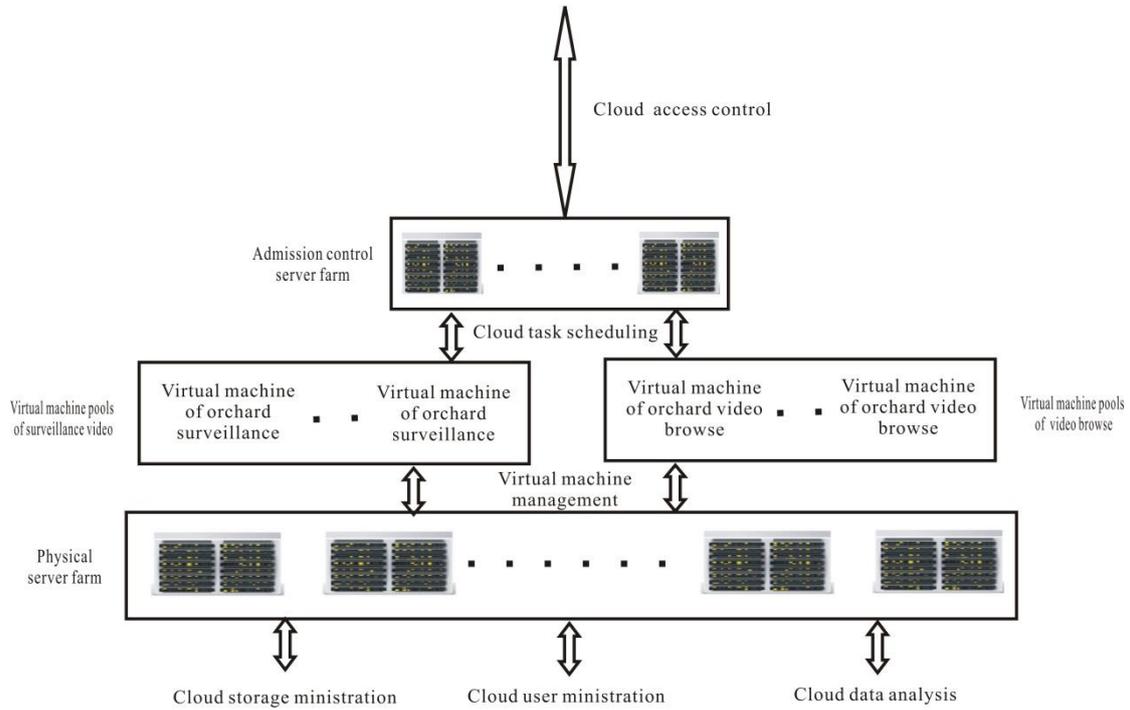


Fig. 5 Structure map of the storage server cloud side

Compute nodes (physical node) is the major carrier of virtual machine. The compute nodes of the storage service cloud side contains a lot of host machines and physical servers that processed the virtual machines of monitoring and browsing of orchard's diseases and pests video. Every virtual machine can execute multiple monitoring or browsing tasks in order to accommodate frequent operations of tasks access and tasks shift out. The storage service cloud that based on virtualization technology can not only unified manages and distributes the video source, but also shield the physical position between storage entities and its particular multi-institutional property. The major duty of the control servers is assign permissions to the user in line with the service they requests, and providing different services for the different users. Meanwhile, it can also complete the functions of network access and user authentication [14]. The underlying data center is the base of distributed storage of monitoring video in cloud structure environment. It consists of servers, disk array and network communication control facilities. In which the storage servers is the most part of the underlying data center, and it responsible for the storage and management of video stream that data volume and growth rate are rather large. The technology of sliced file segmentation storage is adopted on the storage servers. Making the best of the I/O ability of every memory cells and optimizing storage methods, the large video files are distributed stored in the physical storage facilities, which proposed to enhance the data rate of large video files between write and read, and lift the efficiency of storage and access of video data [15].

3.4 The Module of Application Side

Users on the application side can acquire the monitoring video data of the assigned orchard from the cloud server farm by committing video request, which achieve the distributed remote surveillance of orchards' diseases and pests. The software client installed in the users' computers or smartphones, and they can access to the cloud server farm by means of inputting the ID heading

code of the digital video recorder equipment. Through the high definition transmission with low bit-rate video, users on the application side can not only capture the clear real-time video of the orchards' diseases and pests, but also preview and playback the video by means of the web storage function of cloud server farm so that users can get hold of the occurrence status of orchards' diseases and pests. The interface of video monitoring on application side is show in Fig. 6



Fig. 6 The interface of video monitoring on application-side

4 Results and Analysis

Regard to the ordinary video monitoring, the sheer amount of image information is an evident characteristic, so the big enough memory space is required. At present, the domestic video monitoring recorder equipment on the market mostly equip with 1TB hard disk. If store video followed 720p format that is the rudimentary HD format, the hourly data size can reached 4G~8G per route. Even partial video compressing on the premise of remain video quality, the ordinary native video monitoring system required 17000G data size every month. Such a large video data is an insurmountable bottleneck for the native storage equipment's capacity, read/write performance and reliability in the mode of traditional video monitoring.

By use of clustered application, grid technology and distributed file system, the cloud-based video monitoring system of orchard's diseases and pests interconnect and facilitate collaboration between memory service devices, providing the functions of monitoring data storage and visit, which achieved a fully virtualized procedure of video monitoring and decreased the costs of system construction and application. The video monitoring cloud is fully transparent to users. They do not need regard the details of equipment's type, quantity and network structure, and just use an ordinary web connection to access to the cloud side. In general, the mode of cloud-based video monitoring has break through the barriers of performance and storage capacity in traditional video storage. It enable users share the video resources in the monitoring cloud of orchard's diseases and pests, and through the clearly monitoring images, the occurrence of diseases and pests in orchard can be efficiently and conveniently estimate.

5 Conclusion and Prospects

With the continuous development of the video monitoring technology, more and more surveillance system calls for the achievement of long-distance transmission of mass data. Yet the traditional surveillance patterns no longer applicable to current monitoring needs. The cloud-based video surveillance of orchard's diseases and pests is based on clouds, pipes and sides. Clouds refer to video monitoring service clouds. Pipes are the routes of data transmission. Sides are the user clients. In this structure, cloud may not just a complete one. Pipes probably have much more. The

number of sides is countless [16]. The video monitoring data of orchards' diseases and pests can intelligently shuttle and flow among clouds, pipes and sides in vertical and lateral styles.

On the unceasingly development and progress of the cloud technology, the applications of video monitoring technologies in terms of cloud storing, cloud unicasting and cloud searching are bound to become mature. Cloud-based video monitoring pattern has become a trend in future surveillance, and the trend is certain to develop towards high definition, webified, intelligent and stereoscopic, which can provide further professional solution programs of orchards' diseases and pests for the field of agriculture and plant protection.

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