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The Design of Wild Animals Monitoring System Based on 3G and Internet of Things

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Abstract

As the rapid growth of economy and population, the wild animals' habitat is badly damaged by the development and utilization of wild animals living environment by people. To carry out the research on wildlife monitoring technology is of great significance. Along with the advent of the era of 3G, 3G transmission technology is more and more advanced, and the Android operating system is currently the most popular operating system. The advantages and disadvantages of the existing monitoring technology are summed up, then wireless multimedia sensor network monitoring technology solutions which is a collection of 3G technology, Android platform and Zigbee short-range wireless communication technology is put forward in this paper.

Keywords: *wild animals monitoring, android, java*

1. Introduction

Environmental and economic development is the two subjects never changed today. Wild animals as a good portion of the ecological environment should be protected by human beings when developing economy [9]. Wireless multimedia sensor network (WMSN) is a new generation of sensor network, and is one of the hottest technology researches at home and abroad, and is considered to be the second largest after the Internet network. Wild animals' monitoring system based on WMSN is designed in this article [2].

2. Existing Monitoring Methods

Wildlife monitoring method can be divided into two aspects at home and abroad: artificial and intelligence.

Cut line method, designated notation, meet rate method and questionnaire are belonging to the former. While automatic camera, intelligent WSNS technology,remotesensing, and 3S (Remote sensing, Geography informationsystems, Global positioning systems) technique pertains to the latter [4].

The workload of traditional artificial monitoring is big, and the data is inaccurate and lack of real-time. Automatic camera techniques havefew studies at home. Wireless network sensing technology (WSN) can only monitorenvironmental factors such as temperature humidity, so the effect is not directly [5]. The cost of remote sensing technique, 3S technology is higher and environmental impact is big. They can only monitor generally [1].

Thus, traditional wildlife monitoring methods are far cannot meet the needs of the current. The current WMSN in general is the use of short distance wireless communication technology called Zigbee to transmit the image, but the maximum transmission rate of Zigbee is only 250 KB/s, so the MAC protocol, routing protocol, image compression technology, node hardware system processing power has strict requirements to transmit a high clear picture. Each node must be equipped with a DSP processor, and the cost is quite high. A kind of low cost, multiple technology fusion of WMSN is designed and realized in this article.

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3. Function Parts of Monitoring System

WMSN node is arranged in the land of wild animals, when animals pass by, they can trigger automatically and pictures is taken which can be uploaded automatically to the monitoring points, monitoring points can also be active for habitat information. Therefore, wildlife monitoring system based on WMSN function module is designed as shown in Figure 1 [10].

The top part is Zigbee node. Using infrared sensors as a detection module, and the detected signal is sent to the Zigbee coordinator node. Zigbee is a kind of short distance wireless communication technologies and commonly used short distance wireless communication technologies are RF technology, Wi-Fi, Ultra-wideband technology, Wi-Fi, infrared, Bluetooth and Zigbee.

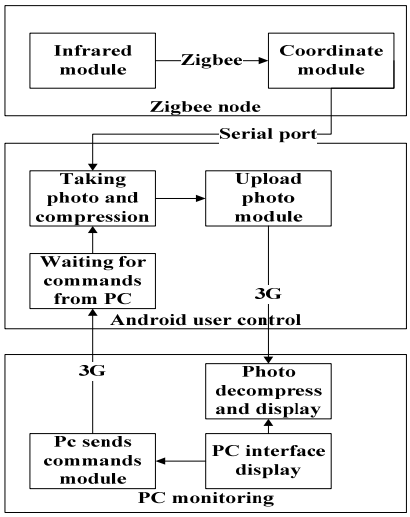

Figure 1. Function Block for Monitoring System

The development of general radio frequency technology is relatively simple and easy, work frequency is band; UWB ultra-wideband technology has a fast transmission rate which can be up to a few hundred Mb/s, and the anti-jamming is strong, but the system bandwidth is high, which is easy to influence other communication bandwidth, what's more, the technology is not mature yet; Wi-Fi is wireless local area network (LAN) standards, it's only for a small scale network, but the volume of hardware implementation is bigger, not easy to concealment; Infrared technology is based on infrared light from the object, is a point-to-point communication, is not conducive to network communication; Bluetooth transmission rate is high but the short transmission distance is about 10 meters.

While Zigbee technology is mature, has a set of specialized structure, the transmission rate is low, but power consumption is low, and can automatically networking. Thus the features low power consumption, high capacity, ad-hoc network make Zigbee more suitable than others.

The middle part is Android. The main function is compressing and upload pictures taken, and waiting for PC control commands. Currently, DSP or FPGA hardware encoding functions is commonly used in picture compression, but the hardware cost is high, study is complex. Now, Android and IOS are two giant operating system. The development process of Android is convenient because of numerous resources, and the portability is strong, so the application can be easily embedded network, running in parallel. Now a Smartphone with the Android operating system is cheap, and experimental platform like this is numerous.

Therefore, Android platform is selected for slave computer in this monitoring system. 3G technology is developing rapidly after 2010. Compared with wired broadband technology, the features fast transmission, low prices, wide coverage is of great goodness. So 3G module is used in the platform.

Below part is PC monitor. Interface development can use VC++, VB, but the entry for VC++ is more complicated, VB development is relatively easy while its portability is very low. Here Java image interface module based on the eclipse platform is chosen to develop the monitoring interface and communicate implementation. So slave and host computer can complete the communication with the socket.

a. Communication Reality between Infrared Node and Coordinate Node

The flow chart shown in figure 2 is the infrared node sending data to coordinator. When the infrared child node and the coordinator node networking successfully, the infrared node will pass specific command data to the coordinator then inform the Android application as a trigger signal arrival. For child node, it set trigger information after joining the network.

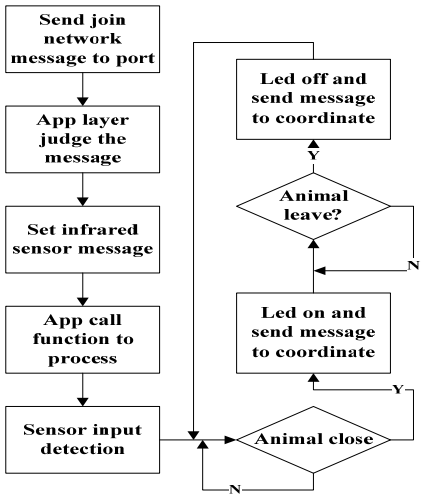

Figure 2. Flow Chat for Sending Data of Infrared Node

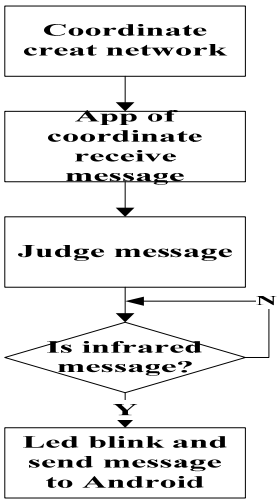

Figure 3. Flow Chat for Receiving Data of Coordinate Node

SAPI layer sets status ofled upon receipt of this message, and then calls the function to send data to the specified address. This is a complete detection process of animals close and leave again. Sensor node sends two data to the coordinator.

Coordinator receives the message and processing and process is as follows andthe flow chart is shown in Figure 3.

Application layer of the coordinator will invoke SAPI_ProcessEvent to process when it receives the message from infrared sensor nodes, judging the kind of message, and if the message is infrared sensor data report, turn off the led and flashing, and then pick up the message data sending to the Android application.

b. Image Processing

Developing rapidly in recent years, wavelet transform is a widely used transform coding method and is applied in the standard of JPEG2000 compression. The image signals can be decomposed into a low frequency subband and 3 high frequency subbands after ranks transform of wavelet. The low frequency signal contains most of the image information, and the high frequency part of the basic is zero. So after wavelet transform signal becomes concentrated, giving a good foundation for the following quantitative coding. Developing up to now, embedded zero tree coding called EZW and multi-level tree collections division method called SPIHT are two mainly coding methods [8].

Figure 4 is window interface written based on the Eclipse.

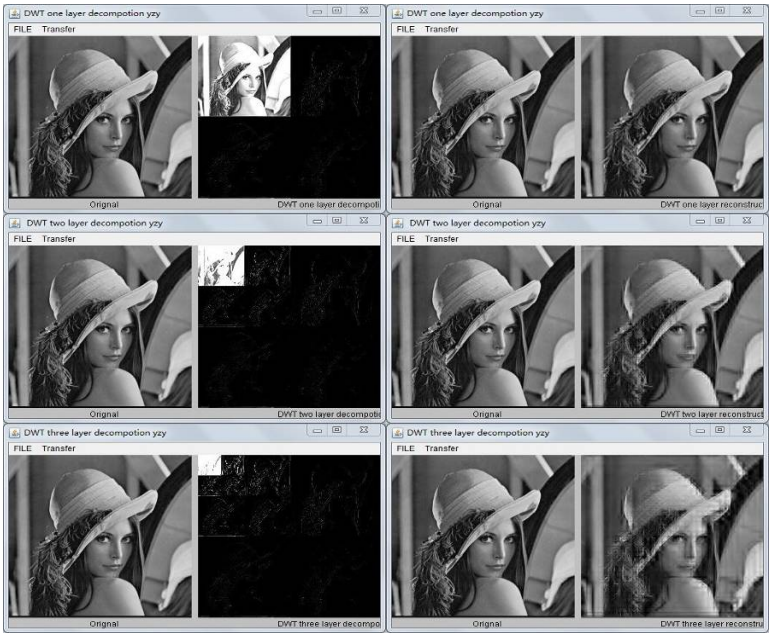

Figure 4. Wavelet Transform and Reconstruction

This compression algorithm is running in Android environment, so it should be written in the Java language. Unlike VC++ and Matlab including many packed functions, functions all should be written by yourself. Using the existing algorithms can improve the compression ratio, but more consumption of memory when runs in java threads.

Therefore the quantization coding used in this paper is as follows: first, get integer part of the double type data after wavelet transform; Second, there are a lot of data close to zero in high-frequency subband, threshold in this pape r(Lena photo is tested) is 6; Third, the high frequency part has a lot of continuous zero value after the second, so using run length encoding is s better choice; Last, Encoded image is stored in the disk, and then decoding, inverse quantization, wavelet inverse transform.

It is the views for the same image carrying on the one layer, two layers, three layers wavelet transformation and refactoring. Obviously, the more wavelet decomposition levels, the more indistinct of the photo on the left and in the three layers of decomposition, the reconstructed photo on the right is more different from the left. While the reconstructed photos decomposed of two layers and one layer are almost the same as the original. The original image size is 64K, after one layer is more than 20K, two layers are about 11K, and three layers are less than 4K. So two layers decomposition can be chosen, the image has both good compression ratio and better visual effect.

c. User Login Interface and Main Display Function

User login interface is designed in this paper for integrity of program and the right allocation to use. After landing on the main interface, program waits for the "Start monitor" button pressed. There is a text field with the scroll bar using for displaying image upload process, five buttons, "Clear message", "Get photo," Photo remote", "Start monitor", "Stop listening" at the bottom container. North of main frame is a picture and middle of the main frame is used to display the image after clicking on "Get photo" button. "Start listening" button allows the client and the PC to communicate with sockets. "Stop listening" is pressed to disconnect. "Clear message" is to clear the contents of the text field.

Sub thread operating of host computer flow chart is shown in Figure 5.

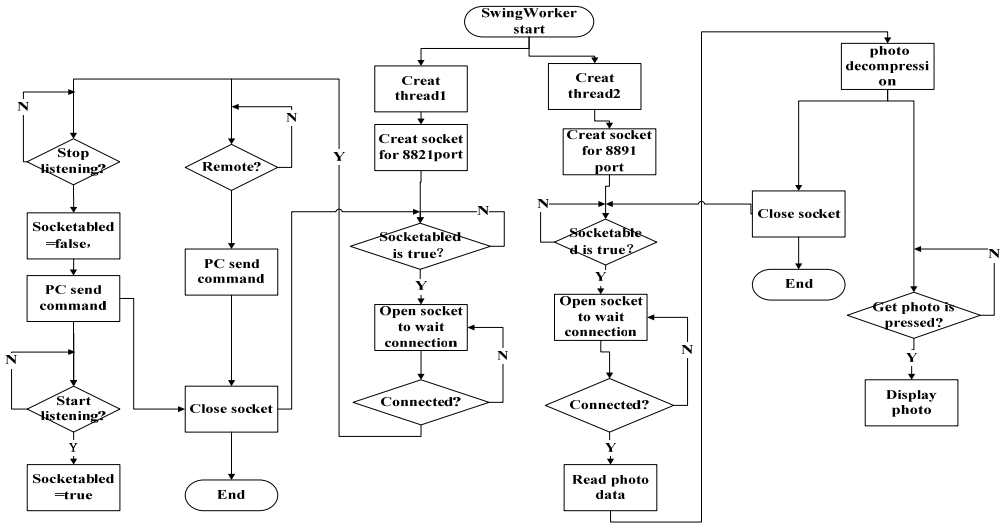

Figure 5. Flow Chat for Sub Thread Operating of Host Computer

After the main frame is established, the main program will create a new SwingWorker object, and two child threads will be created to realize the communication between the PC and client computer.

The left part is the thread1 that is used to listen on port 8821, namely the PC sends a command to the client. The program running in PC will connect socket of client computer to communicate when "Start listening" button is pressed. If "Remote" is pressed, then send the taking photo command to the client. If the "Stopping listening" is pressed, send stop command to the client and alsomake the button gray in addition to "Start listening", then close the socket communication to wait for the socket again allowed to connect.

Right side part is thread2 used to listen on port 8891, namely the client sending photos to PC. The socket connection is the same as thread1. When connected, photo is read and stored in disk to decompression, then close the socket communication back to waiting to be allowed to connect. If "Get photo" button is pressed, the decoded image will be displayed in the middle of main frame.

4. FunctionTest

a. Android Program Communication with Zigbee Infrared Node

Figure 6 is a mobile phone receive text message.

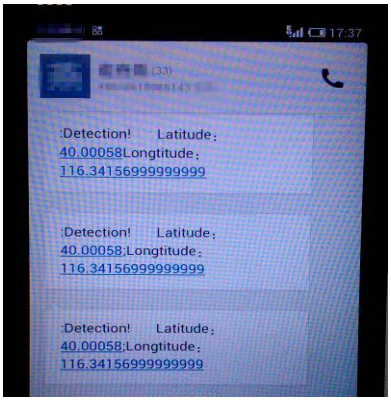

Figure 6. Alarm Message Interface Assigned Telephone Number

When the underlying Zigbee node detects animal, Zigbee child node will transmit this piece of data to the coordinator node sending data to Android platform through the underlying socket communication. If it is an effective close and leave, program in client computer invokes the camera taking photos, stores in the SD card and sends a warning message to designated mobile phone

b. PC Program Communication Function

User login interface will be displayed when Program in PC start running. If the user name and password is correct, it can enter into the monitoring system interface.When "Start listening" there are two situations:The first is detecting animal invasion and sending pictures; the second case is the PC requiring taking photos. As long as the socket is connected, "Remote" button is used to let the Android platform call the camera to take photo and upload the compressed photo. After "Get photo" is pressed, working process will be display in the text area as shown in Figure 7.

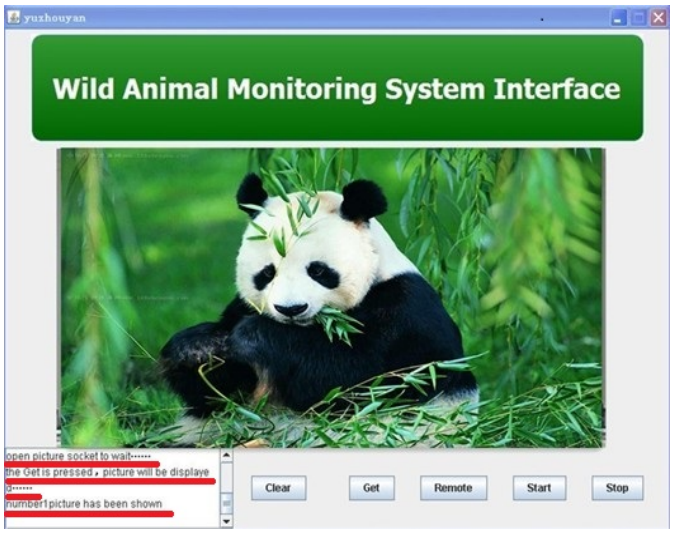

Figure 7. Picture for Host Computer Taking Pictures Initiatively

As shown in Figure 8 which is printed out when the slave computer is working, a compressed photo of 32K uploading from the client computer to the PC only costs 33ms.Uploading a larger photo to PC with public IP through 3G is also very quickly, and the flux cost is also greatly reduced after image compression. "Stopping listening" button can be pressed to stop photo uploaded, which completely meets the requirement of project.

Figure 8. The Words Printed Out when Slave Compute Process in

5. Conclusion

Infrared Zigbee node sends triggered message to the client computer if animal is detected, when the client receives this message, first it calls camera to take photo and stores photo in the SD card; second compresses automatically; third upload the photo through the 3G to PC; forth, sends warning and location message to the specified phone number. PC can display the photo, can request remote take photo, can stop listening, and can see working process in real time from PC interface.

The project can be to improved from the following several aspects in the future: first, because of the constraints, in the trial analog camera is used, which is not conducive to take high quality pictures, thus, hardware can be changed to adapt to hd cameras, or even wireless cameras making it more conducive to field monitoring; Second, image compression ratio in this paper is not high enough, although basic functions are realized here, and it does not satisfy the requirements for high definition in the future, thus further study of compression algorithm is needed, combining with the characteristics of existing technology to developed a suitable wildlife compression algorithm of image processing for this topic; Third, this project designed is elastic, and more than one Zigbee sensor nodes can be expanded to monitor environmental factors for comprehensive monitoring.

Acknowledgement

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