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Automatic Power Adjustment in MROF System

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Abstract. Due to the traditional mobile communication technology cannot meet the development requirement of fiber communication particularly in remote districts, this paper introduces a new kind of multi-channel optical wireless communication system. In order to emphasize the importance of automatic power adjustment, this paper describes the process and the function of automatic power adjustment in detail. At last, the experiments are done to verify the effectiveness of the automatic power adjustment.

1. Introduction

In recent years, with the constantly emerging of high definition television, mobile television, interactive multimedia and wireless Internet and other new business, people have higher requirement of bandwidth then before. But the limited spectrum resources, and the large loss in the transmission process, make the traditional mobile communication technology has not met the new requirement. Especially to part of the customers, in some areas, due to the limitation of environment and policy, there are some difficulties to optical fiber cabling and protection, and optical fiber to household. The digital microwave is combined with WDM (Wavelength Division Multiplexing), and MROF (Multi - channel Radio - Over - Fiber) is adopted to solve this problem.

The microwave frequency in wireless access has wide available bandwidth, and high speed of data transmission. By the tense situation of low frequency spectrum resources nervous, people expect to larger capacity in high frequency data transmission. They drive wireless access up to 60GHz millimeter wave. The traditional digital microwave technology used wireless transmission in outdoor. However, ROF (Radio-Over-Fiber) is realized by using WDM, the high bandwidth of microwave transmission is introduced into the house.

Compared with the traditional point-to-point system, one local device is used in MROF system to control multiple users, but not limited to control one user. And the stability and maintainability of MROF system are improved. In terms of cost, in the same local device, users can be 3 to 6 times more then other's, do not need to add extra maintenance at the same time. The waste of resources can be reduced.

2. MROF System Introduce

MROF system mainly consists of the following parts: Local Device, RAU (Remote Antenna Unit), ODU (Outdoor Data Unit) and BTU (Broadband Traffic Unit).

Local Device consists of ROFCS (ROF Center Station) and WDM. Two conversions are realized in ROFCS: one is between the multiple Ethernet data and multi-carrier RF signal; the other one is between the multi-carrier RF signal and the Optical signal. WDM divide into Local WDM and Remote WDM: Local WDM combine all the multi-carrier RF signal that with different wavelengths together, transport only through an optical fiber, this can save backbone fiber; Remote WDM finish the partial wave processing, divide the combined wave signal from the backbone fiber into multiple single wavelength RF signal, according to the different wavelengths, and output them.

The conversion between light signal and electrical signal, the frequency shift between RF signal and microwave signal are realized, and the signal transmitting, receiving and amplifying are completed in RAU. The conversion between intermediate frequency signal and the microwave signal are realized, and

the signal transmitting, receiving and amplifying are completed in ODU. The conversion between Ethernet data and multi-carrier RF signal are realized in BTU.

The block diagram of MROF system as shown in fig. 2-1.

In the system, 1 MROF module is connected to 1 RAU through WDM module and an optical fiber; 3 ODU are wireless covered by 1 RAU; each ODU is connected to 1 BTU through a coaxial cable.

Each BTU contains 2 voice interface and 4 Ethernet interface. The voice interface connects to user telephone, access voice business. The Ethernet interface access broadband data and video business, also can connect to family gateway device.

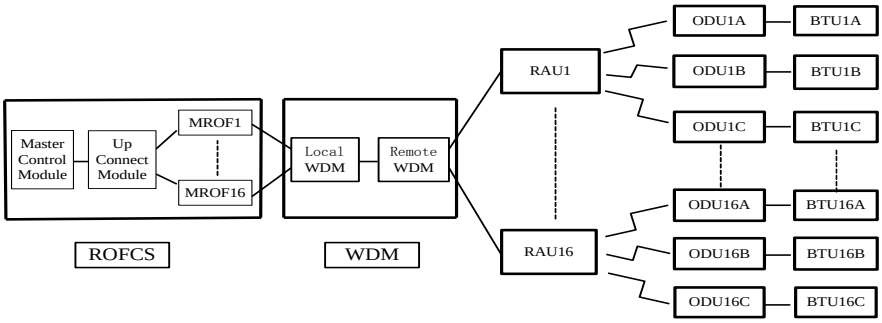

Fig. 2-1 MROF system block diagram

3. Automatic Power Adjustment Implementation

MROF is a point to multi-point system. In this paper, MROF system is 1 point to 3 points. This means 3 ODU are wireless covered by 1 RAU. In this system, No matter whether transmitted power from the ODU are equal or not, as long as the gap of signal intensity that the MROF module receives, launched by different users, is too big, the weak signal won't be demodulated. Then the automatic power adjustment is needed to been achieved.

3.1 Software Implementation

Automatic power adjustment is realized by software, mainly by the Verilog language on FPGA (Field Programmable Gate Array) development platform and the Embedded C language on RAM development platform. The signal power of all ODU are made A/D conversion and sent to RAM platform by FPGA platform. The size of the data sent from FPGA is compared by RAM platform. The transmitted power of ODU is changed, and the process of automatic power adjustment is realized.

ODU compose of intermediate frequency and microwave module. The intermediate frequency signal that inputted from the intermediate frequency cable is amplified by intermediate frequency module, in order to make up for the loss caused by the different length intermediate frequency cable on the signal. And then the RF signal is formed by intermediate frequency signal, through a series of frequency conversion, filter and amplification, input to the microwave module. The RF signal power is amplified by microwave module, and the amplified signal is sent to the antenna by duplex isolation unit.

3.2 Principle

The principle of automatic power adjustment implementation as shown in fig. 3-1:

The signal sent from ODU is received and sent to the MROF module in ROFCS by RAU. The received analog signal is transformed into digital signals by the A/D chip of the MROF modules. The transformational data is sent to RAM by FPGA through the register interface. These data is compared by RAM. According to the result of comparison, the transmitted power of all ODU are adjusted and sent to BTU, through the remote monitor. The adjusted transmitted power is sent to ODU by BTU, through the 485 interface.

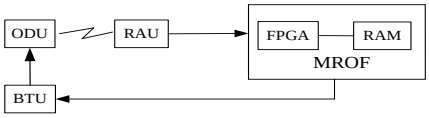

Fig. 3-1 Automatic power adjustment principle

0dB to 15dB are set in this MROF system as the range of ODU transmitted power. So 0dB is set as the low threshold of ODU transmitted power. In the experiments, when the ODU transmitted power is too large, the frequency spectrum is bad. When the frequency spectrum is best, the transmission power value is equal to 7dB. So 9dB is set as the high threshold of ODU transmitted power.

The signal sent from ODU is received and sent to the MROF module in ROFCS by RAU. Due to the influence of the weather and distance and others, although the ODU transmitted power is big, does not mean that the value which FPGA detected on the ODU transmitted power is big too. There may be such a situation, the ODU transmitted power is big, but the value FPGA detected on the ODU transmitted power is small.

The following are defined: in all data sent to RAM from FPGA, the biggest one corresponds to the ODU as maximum ODU; the smallest one corresponds to the ODU as minimum ODU. The transmitted power value of maximum ODU is inquired by CPU of RAM, remember to Txpower1; and the transmitted power value of minimum ODU, and remember to Txpower2. In the process of power adjustment: Txpower1 needs to be adjusted down. Only the value that more than the low threshold of ODU transmitted power can be adjusted downgrade. So Txpower1 is compared with the low transmitted power threshold. Txpower2 needs to be adjusted up. Only the value that less than the high threshold of ODU transmitted power can be adjusted upgrade. So Txpower2 is compared with the high transmitted power threshold.

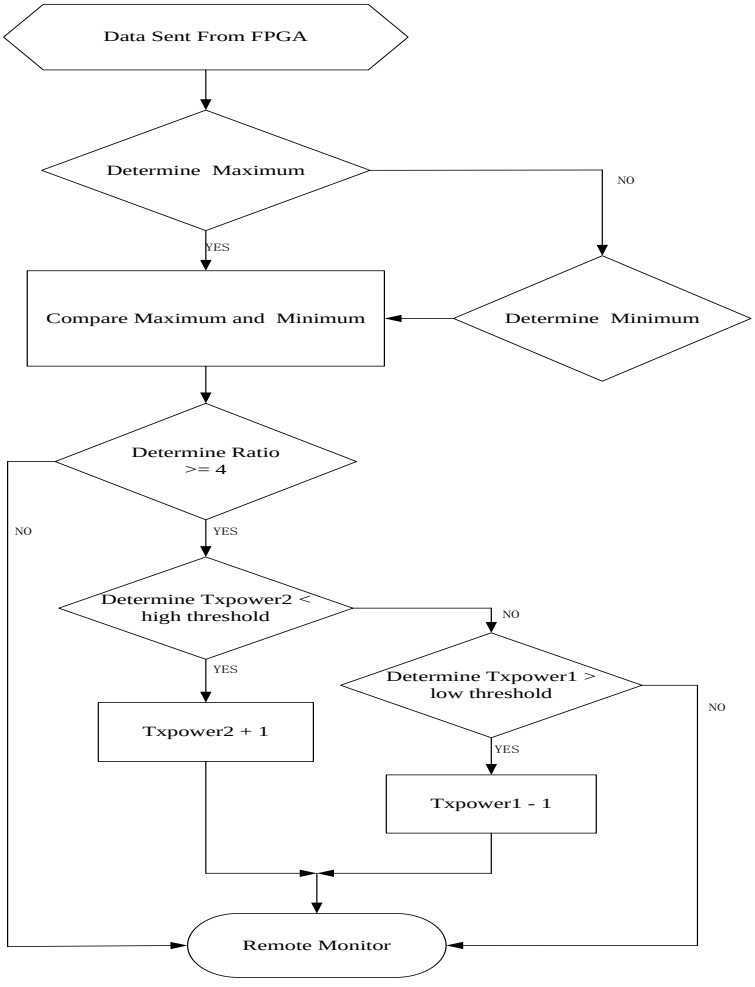

Fig. 3-2 Automatic power adjustment implementation process

3.3 Implementation Process

The implementation process of automatic power adjustment in the CPU as shown in fig. 3-2:

All the data that sent from FPGA is received by CPU of RAM. In CPU, each data is determined in turn, if not the maximum, then whether the minimum. Then the maximum and the minimum are compared, and the ratio of the maximum and minimum value is determined whether is greater than or equal to 4. If the ratio is less than 4, the transmitted power will not be adjusted. If the ratio is greater than or equal to 4, first the size of Txpower2 is determined with the transmitted power high threshold. If Txpower2 is less than the transmitted power high threshold, Txpower2 value plus 1. If Txpower2 is greater than or equal to the transmitted power high threshold, the size of Txpower1 is determined with the transmitted power low threshold. If Txpower1 is greater than the transmitted power low threshold, Txpower1 value minus 1. If Txpower1 is less than or equal to the transmitted power low threshold, the transmitted power will not be adjusted. The value after plus 1 or minus 1 is sent to BTU by RAM through the remote monitor, then set to ODU by BTU, then the transmitted power will be adjusted in ODU. Such a process will be cycled, until the ratio of the maximum and minimum value is less than 4.

4. Automatic Power Adjustment Experiment and Verification

4.1 Simulation Design and Implementation

MATLAB programming is used in Simulation experiment, to verify the automatic power adjustment principle. The input data come from the sampling of I and Q road demodulation data in FPGA. The sampling points are 2500. OFDM is used to realize the modulation and demodulation in FPGA.

4.2 Experimental Results and Analysis

The value of all 3 ODU transmitted power are set to 5 dB, each ODU transmitted power corresponds to one FPGA detection power value (the data sent to RAM by FPGA). But the attenuation size of microwave wireless link between ODU and RAU are not the same, so the FPGA detection power values are greatly different. After automatic power adjustment, the value of 3 ODU transmitted power automatically adjust to 5dB,7dB and 3dB. Through the comparison table 4-1, it can be determined that ODU transmitted power and FPGA detection power value are both influenced by automatic power adjustment. And it can be verified that if the ratio of the maximum and minimum value is greater than or equal to 4 in FPGA, the I and Q road data cannot be demodulated, the ODU transmitted power must be adjusted.

Before and after adding the automatic power adjustment function, the sampling of I and Q road demodulation data is analyzed in FPGA. By making simulation on MATLAB, two spectrum diagrams as shown in fig. 4-1 and 4-2 can be got. By comparing the two figures, it can be found that: before adjustment, spectrum difference is big, spectrum signal can't be demodulated; after adjustment, spectrum is evenly distributed, spectrum signal can be demodulated. So the automatic power adjustment function is effective. In fig. 4-1 and 4-2, the abscissa is sampling points, while the ordinate is power value. 3 sub-carriers are included in this system, each sub-carrier bandwidth is 50M, and the average power is 27 dB.

Table 1. Value Comparison

	ODU Transmitted Power			FPGA Detection Power Value		
	ODU 1 A	ODU 1 B	ODU 1 C	Value A	Value B	Value C
Before Adjustment	5dB	5dB	5dB	86032	32448	142032
After Adjustment	5dB	7dB	3dB	89673	90341	98231

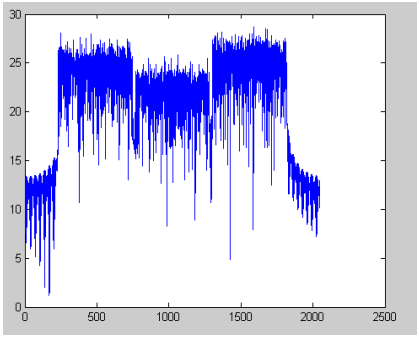

Fig. 4-1 Before adjustment

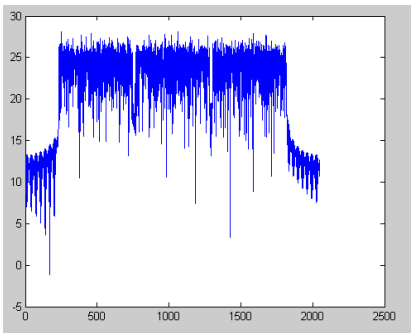

Fig. 4-2 After adjustment

5. Summary

MROF system is extensive used in laboratory and practical. The automatic power adjustment function ensures the stability and reliability of the system. While ROF is point-to-point system, it is used for single carrier modulation and demodulation. So there's no need to take automatic power adjustment function in ROF system. This also lead to the ROF system can't be extensive used. Comparing with MROF system, the same user requires greater costs.

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