Research on Key Technologies of 60GHz Optical - borne Wireless Communication System

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Abstract: This paper describes the development background of optical - borne wireless communication technology. This paper analyzes the microwave photonics technology applied to the front end of the antenna from three aspects: optical control beam forming network, beam forming module of true delay and Bragg fiber Bragg grating structure. Based on this, the key technologies of 60GHz optical carrier wireless communication system are discussed.

1. Introduction

In the context of the comprehensive development of communication technology in China, people's demand for multimedia communication such as language and video is gradually increasing. In this case, it is necessary to apply a larger broadband to achieve information transmission and better meet people's communication requirements. With the rapid development of the time, optical wireless communication systems appear. Optical carrier wireless technology uses optical fiber to realize radio frequency signal transmission, and under the action of optical fiber broadband, effectively improve the efficiency and level of wireless communication application. As for the array antenna, its generation puts forward a test for the development of traditional electronic system. Under the action of the front end of the array antenna, the application of photon technology can realize the rapid development of wireless communication technology. According to the array antenna in the optical technology, the broadband performance can be effectively improved, which will lay a good foundation for the subsequent signal processing. In the following, this paper will focus on the analysis and exploration of key technologies of 60GHz optical carrier wireless communication system.

2. Development background of optical carrier wireless communication technology

Optical carrier wireless communication technology includes two advantages of wireless communication convenience and large transmission capacity of optical communication, which has become a widely used communication technology. The 60GHz millimeter-wave signal consumes a lot of energy in atmospheric transmission, which is used to improve the frequency application efficiency of cellular mobile communication channel. From the perspective of microwave transmission medium itself, the number of resources consumed will increase with the increase of transmission distance. In this case, optical fiber system is adopted to guide the transmission of microwave signals [1].

Under the function of ROF technology, the central bureau antenna can be connected with each microcomputer station to realize information transmission. It has the advantage of being able to transfer the cumbersome microwave processing unit to the central bureau antenna, and the cooperation of the base station structure, the transmission efficiency and level can be improved.

3. Microwave photonics applied to the antenna front end

3.1 Optical beam forming network

Beam forming networks usually control beam pointing by selecting radiating signals from

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different types of components. Phase control is an important factor to control beam pointing. At first, BFN technology controls the beam direction by applying a phase shifter in the array element. However, with the emergence of advanced requirements, radar needs to achieve high-precision and multi-target, as well as detection, tracking and other functions. In this process, higher frequency and broadband are required. As a phased array antenna, it is usually composed of two parts: signal power distribution network and antenna array element. In order to achieve beam control, it needs to be carried out under the action of a phase shifter. The principle of its application lies in the transformation of the phase relationship between the received signals of each antenna array element.

3.2 True - delay beam forming module

As for optical phased array antenna, it cannot only deal with beam tilting phenomenon, but also realize information transmission under the action of the RF signal and effectively ensure the stability of line transmission [2]. Due to the application of optoelectronic devices, to achieve signal transmission, the device itself small size, lightweight, signal transmission consumption of resources, thus has been widely used in the field of communication. For the optical truth delay module, RF signals are transmitted through microwave sources and transmitted to light waves under the action of electro-optical modulator, and then converted into optical carriers with RF signals. After the signal is transformed, the optical signal is transmitted to the optical power divider to realize information transmission. After the optical path delay in the true optical delay module, the photo-detector carries out signal decomposition and transmission. After amplification, the phase of the RF signal formed in the amplification process changes to some extent, so that the RF signal can be transmitted in the array antenna and the beam control can be realized. The basic structure of optical truth module is shown in figure 1:

Figure 1. The basic structure of an optical module

3.3 Bragg grating structure

Fiber grating is usually due to the influence of the photosensitive characteristics of the fiber core material, so that the fiber core material in the axial refractive index has periodic changes, so that the fiber core material is exposed to the ultraviolet light source, and has periodic changes. Bragg grating axial fiber core refractive index modulation distribution formula is:

$$\delta n_{eff}(Z)\frac{}{\delta n_{eff}(Z)}\left\{1+v\cos\left[\frac{2\pi}{\Lambda}z+\phi(z)\right]\right\}$$

In there, $\overline{\delta n_{eff}}^{(Z)}$ represents the refractive index; V represents the refractive index range; Λ represents the grating period; $\phi(z)$ represents the periodic change of the grating along the axis [3].

4. Key technology of 60GHz optical carrier wireless communication system

4.1 Direction tracing antenna theory

In the late 1950s, L.C.VanAtta first proposed the electromagnetic reflector, namely VanAtta

reflection array. The reflector array consists of several elements related to the geometric center of the antenna. Under the guidance of isometric lines, the antenna elements are connected. Signals are generally transmitted in pairs of antennas. However, in the reflection array, it needs to be realized under the action of planar incident wave and transmitted to the maximum scattering field. With the continuous improvement and popularization of the theory of directional backtracking antenna, the design direction of directional backtracking antenna can be more simplified and practical. Because this new antenna array has the characteristics of fast and automatic tracking, it is widely used in radio frequency identification and multi-target tracking. From the point of view of direction tracing theory, that is, after the electromagnetic wave enters the incident metal plane, it will reflect the original direction θ with the reflection law. The characteristic of directional backtracking antenna is that it can reflect the incoming wave direction from any direction, and it can respond and receive the incoming wave signal from an unknown direction.

4.2 Optical phase conjugation realization. Semiconductor optical amplifier theory

For SOA optical amplification principle, it is mainly in the case of stimulated semiconductor radiation, and the theory of semiconductor energy level and photon transition in the radiation is its main theoretical basis. In general, SOA mainly adopts strain quantum to form structure PN junction devices. With the increase of SOA research, its performance such as output power and small signal gain is improved comprehensively. SOA plays an important role in optical signal processing. In general, SOA itself has features of low energy consumption, high gain, compact structure and easy integration with other optoelectronic devices.

1) Classification of semiconductor optical amplifiers

In general, there are two types of SOA modules: TW-SOA and f FP-SOA. Because FP-SOA has an obvious effect on the end reflection, the incident signal light can achieve multiple reflections in the FP cavity. The TW-SOA reduces the reflection coefficient by adding a permeable film at both ends, allowing the gain curve jitter characteristics to be addressed. It can be seen that no matter which method is adopted, reflection should be ignored and signal transmission should be carried out after an amplification [6].

2) Nonlinear effects of SOA

Applying SOA to nonlinear effects, it works in a state of relative saturation. The principle of nonlinear effect is that when the high-intensity optical signal is input, the carrier concentration in the SOA will change, so as to change the new energy of optical signal transmission. By analyzing and exploring the nonlinear phenomena in semiconductor optical amplifiers, the generation mechanism of four-wave mixing is deduced.

3) Optical phase conjugation

In terms of optical phase conjugation, conjugate light wave generally refers to the conjugate light wave whose waveform is unified with that of light wave when it enters a specific medium or environment. Considering the light wave propagating along the z direction, the electric field can be expressed as: $Es(r) = A(r)\exp\left[-i\phi(r)\right]$

If the complex amplitude of the light wave field is $Es(r) = A(r)\exp[-i\varphi(r)]$, then the complex amplitude of its phase conjugate wave is $E_p(r) = A(r)\exp\left[-i\phi(r)\right]$. The electric field of the phase conjugate wave corresponding to the light wave can be expressed as. $E_p(r,t) - \mathrm{Re}\{E_p(r)\exp[-i(\omega_s t \pm k_s z)]\}$

Where $A(r)$ and $\phi\ (r0)$ represent real numbers. If the incident light wave is expressed as ES (r,t), its phase total frequency wave is $E_p(r,t) = E_s(r_s - t)$. So the phase of a light wave is equivalent to the complex conjugate operation of complex space amplitude.

5. Conclusion

In a word, this paper introduces the development background of the optical wireless communication technology, and realizes the application significance of the optical wireless

communication technology in China's communication industry. Through the current microwave photon technology, it is clear that there is two widely used microwave photon technology. One is the front-end antenna microwave photon technology and the other is the true time-delay optical beam forming network technology. Through analysis of the directional backtracking antenna array, the existing problems in the application of optical carrier wireless communication technology is found out. Through the application of microwave photon technology, the design idea of the antenna array based on optical four-wave mixing technology is put forward. This fundamental technology can be applied in high frequency communication and other places, which is worth in-depth analysis and exploration by relevant departments.

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