Realization of Infrared Wireless Local Area Network

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ABSTRACT

The technology of Infrared wireless local area network is one branch of the IEEE802.11 protocol's access network technology. As a medium for short-range or indoor communication, infrared radiation offers several significant advantages over radio. Infrared emitters and detector capable of high-speed operation are available at low cost. The Infrared spectral region offers a virtually unlimited bandwidth that is unregulated worldwide.

Keyword: Infrared NIC , IEEE802.11, DFE, PPM, IrDA

1. INTRODUCTION

As the increasing developments of the mobile communication, such as portable computer , PDA. The demands for wireless access technology is increasing rapidly. Today the medium for wireless digital communication include microwave, infrared and radio. As a medium for short-range, indoor communication infrared link offers several significant advantages over others. The infrared spectral region offers an unlimited bandwidth that is unregulated worldwide. And the infrared can not penetrate through walls or other opaque barriers, so that the signal is confined in the room which makes it easy to secure. The infrared has other several advantages as that Infrared emitters and detector capable of high-speed operation are available at low cost.

1.1 PPM(pulse position modulation) technology

In the infrared wireless communication system we employ encode and modulation technology, such as OOK,ASK,QPSK,PPM. The analysis shows that PPM has the best compromise of power and bandwidth efficiency. So the IEEE802.11 recommends the PPM for Infrared wireless communication. PPM is the technology which use the pulse position to modulate data, different position stands for different data. Using the PPM technology, we can reduce the proportion of the high level pulse and decrease code streams duty ratio. And that we can increase the efficiency of transmitter. The PPM modulation decrease the power consumption. And this is important to the Infrared communication systems. PPM is been used like X-PPM, 2-PPM stand one pulse represent 1 bit message. In the 4-PPM one pulse denotes 2 bit message. And 16-PPM is 4 bit message.

1.2 IrDA(Infrared Data Associate Protocol) and IEEE802.11 Standard

IrDA is an International Organization that creates and promotes interoperable, low cost infrared data interconnection

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standards that support a walk-up, point-to-point user model. The standards support a broad range of appliances, computing and communications devices. Today the IrDA is the widely accepted wireless transmission standard. It is a half duplex technology. IrDA Data is recommended for high speed short range, line of sight, point-to-point cordless data transfer - suitable for HPCs, digital cameras, handheld data collection devices, etc. If IrDA is supported, it must be targeted at the 4 Mb/s components. IrDA Data Protocols consist of a mandatory set of protocols and a set of optional protocols. The mandatory protocols are: PHY (Physical Signaling Layer) , IrLAP (Link Access Protocol) , IrLMP (Link Management Protocol and Information Access Service (IAS)). IEEE802.11 standard specifies a single Medium Access Control (MAC) sub layer and three kinds of Physical Layer media. The standard provides 2 Physical layer specifications for radio, operating in the 2 400 - 2 483.5 MHz band (depends on local regulations) and one for infrared. In our system. we will use infrared as the physical medium.

1.3 ANTI-NOISE AND DFE (decision-feedback equalization) technology

There are two configurations for indoor wireless infrared links. The transmitter and receiver may have a narrow field of view or a wide field of view, producing a directed or a non-directed systems. Systems may also be classified into line-of-sight (LOS) or non line-of-sight (non-LOS), depending on whether there is directed path between transmitter and receiver. We will choose non-directed, non-LOS, or diffuse links because they combine ease of use with robustness against shadowing. Infrared links are also impaired by noise due to background illumination. This comes in two forms. Sunlight and incandescent lights sources whose intensity varies slowly with time. It will produce shot noise at the receiver. So it can be modeled as a stationary, Gaussian, white noise with a power spectral density proportional to the total detected optical power. On the other hand, fluorescent lights flicker in a nearly deterministic periodic fashion at the drive frequency. A low-pass filter is employed to limit shot noise and receiver thermal noise. In addition, to reduce the impact of near-dc fluorescent-light interference, we employ a high-pass filter. So when the ambient illumination is sufficiently weak. the signal-to-noise (SNR) of direct-detection links is limited by thermal noise of the receiver front-end preamplifier. In this system there are multi-path effects. It lead to distortion that produces significant inter-symbol interference (ISI) wher the symbol rate is over 1Mbaud. A decision-feedback equalizer (DFE) is introduced to mitigate inter-symbol interference (ISI). The DFE reduces the impact of ISI arising form multi-path distortion. The forward filter consists of four taps that are spaced one-half baud apart, and the reverse filter consists of four taps that are spaced one baud apart. There filters are constructed using analog tapped delay lines and manually controlled tap gains.

2. PRINCIPLE OF INFRARED NETWORK INTERFACE CARD (NIC)

Infrared communication is the technology which employ infrared ray as the signal carrier. It is made up of infrared transmitter, infrared receiver and network interface card. The infrared transceiver accomplish the signal's transfer. In the sending part the digital data is encoded. Through the electric-opto transfer circuit, it will drive the infrared LED and transmit infrared light pulse to the air. In the receiving part the receiver gets the infrared light pulse from the air and converts the light pulse into electric signal. Then the signal gate through equalization, judgement and decoding. The original data signal is be recovered. The infrared network interface card (NIC) accomplish function of connecting with the computer.

2.1 Infrared transmitter

Infrared transmitter is the device that can convert the electric signal into optical signal. It transmits infrared pulse in the form of IrDA style. The key components of the infrared transmitter are infrared LED and corresponding drive circuit. The

wavelength is between 850nm and 910nm.The infrared LED's light power should be high enough. The analysis shows that the system's signal-to-noise(SNR) is proportion to the square of the transmitter's light power. So increasing the power of the transmitter can reduce the bit-error rate(BER), and increase the communication quality. But the large power infrared LED will is relatively expensive and the high infrared light is harmful to our eyes. So the IrDA has specified the light power of infrared data communication in a limited field.

2.2 Infrared receiver

Infrared receiver receives the infrared pulse from the space and convert the optical signal into electric signal. Then handle the signal in the following ways: demodulation, threshold judgement and decoding. In the infrared communication system the transmitter light power is low and the signal is transmitted through air. So it is easily affected by the environment. And the signal received is very weak. So the key part of the receiver is low noise preamplifier and self-adapting code element judgement. We choose the large input resistance transconductance amplifier as the preamplifier which has large dynamic range and wide bandwidth. Self adapting code element judgement can automatically trace the input signal electric level and judge the threshold electric level according to the signal and change the signal into digital level. Because the inter-symbol interference(ISI) is the obvious when the data transfer rate is high, we will employ a block decision-feedback equalization(DFE) strategies to mitigate the effect of multipath-induced ISI. We use the time domain equalizer because it is easily to realize.

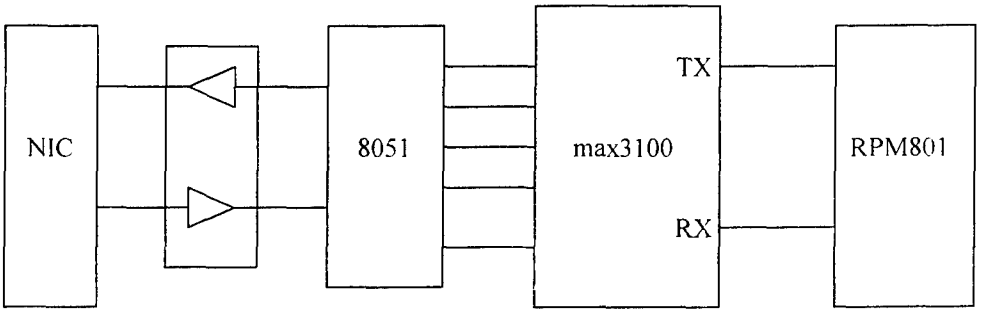
2.3 Infrared network interface card

Infrared NIC include two parts. One part is the computer communication module. The other part is infrared transceiver part. The IEEE has defined the IEEE802.11 as the standard of infrared links. The IEEE802.11 has specified that base-band range is 0~10Mbit/s and recommended the pulse position modulation (PPM) technology. The* IEEE802.11 employed the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) collision detection system. In our system, our infrared network interface card (NIC) is based on ethernet card. By adding a infrared transceiver and properly to the ethernet NIC, we can realize the infrared links. Using this kind of NIC we can utilize current network resource. The signal of the ethernet NIC port rj45 is the difference TTL level. And the code element rate is 10Mbit/s. The infrared transceiver get this signal and change it to single-level signal. We employed is the same communication agreement as current ethernet, such as TCP/IP, IEEE802.11. The infrared NIC can not work automatically with the computer, so we use some tool software, such as vtool for windows to drive the hardware to work compatibly with computer.

3.DEVICE CONFIGUTION

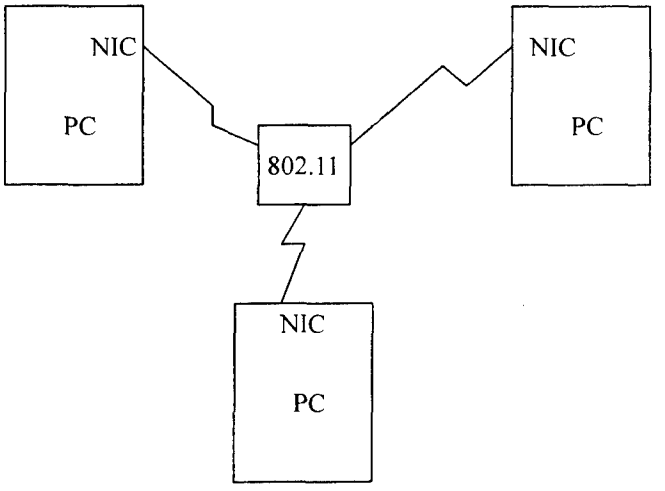
3.1 Infrared network interface card (NIC)

The infrared transceiver is one important part of the device. It is made up of universal asynchronous receiver transmitter(UART), microcomputer and integrated IrDA element. In our device, we use MAX3100 as the UART. The MAX3100's IrDA mode can be used to communicate with other IrDA SIR-compatible devices. In IrDA mode, a bit period is shortened to 3/16 of a baud period (1.6μs at 115,200 baud). A data zero is transmitted as a pulse of light (TX pin = logic low, RX pin = logic high). The integrated IrDA element we use the Rohm Electronics RPM-801CB. This module include a infrared LED, PIN opto-electronic diode and wave form shaping IC. It supports IrDA 1.0 SIR standard. In the following I will draw the simplified schematic:



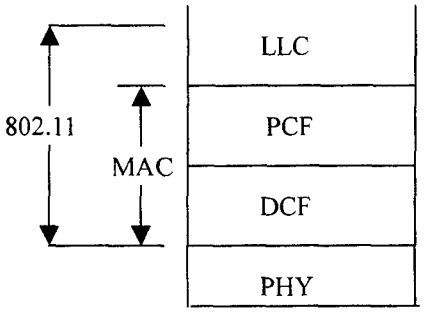
Infrared network interface card schematic

3.2 Infrared wireless local area network



Infrared local area network configuration

The infrared wireless local area network (WLAN) is consists of three sets of PC and NIC. The WLAN is built according to IEEE802.11. Its hierarchy structure is described as follow.



The infrared transceiver accomplish the physical layer function. We use 850nm infrared light to transfer data in the room. And the access rate is 4Mbit/s. The Medium Access Control(MAC) includes Distributed Coordination Function(DCF) sub-layer and Point Coordination Function(PCF) sub-layer. These two sub-layers function is realized with software routine. Many software such as C, Visual C and visual Basic can do this work. In our system we use turbo c. Sub-layer DCF use CSMA/CA to let every PC complete the chance of sending. Sub-layer PCF provide a service of non-completion. It is suitable to time-sensitive service, such as packed voice service should choose PCF. The 802.11 has three kinds of inter-frame space (IFS). They are SIFS(short IFS), PIFS(PCF IFS) and DIFS(DCF IFS). The SIFS is the shortest and has the highest priority. Using these IFS, we can easily avoid collision. The layer LLC ensures accurate link. Using software we can programmed the user communication interface. Such as chat, ftp, http universal program. So it is easily to realize the resource sharing and form a local wireless infrared area network.

4. CONCLUSION

In our system we realize three PCs' communication and resource sharing. Its operation mode is diffuse links. The communication distance is 5 m in a room and code element rate is 10Mbit/s. This paper gives the details about infrared wireless communication and the configurations of the infrared wireless local area network. The protocols of IrDA and their components have been introduced. A Infrared network interface card (NIC) has been designed which can realize the wireless connection. The wireless local area network is made up of three sets of PC and Infrared network interface card. PC is used to form the local area network and control data communication. The Infrared network interface card is responsible for establishing the infrared link, detecting transmission errors, compensating for speed changes and obtaining the required quality of service. The design of the Infrared link must take into account a number of factors to obtain the best compromise for the indoor environment. As for the average-power efficiency and bandwidth efficiency, we employ the pulse-position modulation(PPM) ,using block decision-feedback equalization(DFE) strategies to mitigate the effect of multi-path induced inter-symbol interference(ISI).The key technology in developing this system consists of designing a high performance Infrared network interface card which can work compatibly with the computer and an Infrared link channel with high anti-interference characters.

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