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Wireless Audio Communication Device Design Based on Infrared Light

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Abstract*:* Infrared communication is a kind of communication method that uses infrared ray to transmit information and can transmit language, text, data, images and other information. In this design, the infrared audio communication device is a kind of communication device which uses the near-infrared band of 950nm to transmit sound information. The system is composed of infrared emitting device and infrared receiving device, and the relay transmitting device to make the signal be transmitted farther from distance. The infrared communication has the characteristics of large capacity, strong confidentiality, good immunity, simple equipment structure, small size, and is widely used in sound, toys and security.

Keywords: Infrared light, Audio, Wireless audio communication, Relay transmitting device

I. INTRODUCTION

Optical wireless communications have been around since their introduction in 1979 by Gfeller and Bapst. Their pioneering work explored the usage of the infrared (IR) spectrum to establish a communication link trough the free space optical medium. Initially, research efforts were focused on indoor applications. Nevertheless, it became apparent that infrared wireless communication could also be useful for other scenarios[1-4].

The migration to VLC systems appeared as a natural extension of the well know wireless infrared systems. The ramping up of LED technology brought new opportunities for energy savings and reduced maintenance cost in illumination systems. The replacement of traditional illumination devices by LED devices is an accelerating trend. At the same time, the exploitation of LEDs as information broadcasting devices has become an active research topic. Both incandescent and fluorescent light bulbs are not able to convey information due to their thermal inertia[5,6]. On the contrary, LEDs are solid state devices able to switch between on and off states at moderate frequencies. This characteristic can be explored to modulate information using visible light waves. The first works advancing this possibility were published by Pang and Nakagawa, reporting the usage of LEDs to communicate in both indoor and outdoor environments. In particular, the works reported in explored for the first time the usage of LEDs to broadcast traffic information in modern intelligent transportation systems (ITS), between traffic lights and vehicles. More recently, projects like OMEGA [9] or D-Lightextended this research area into other venues. Project OMEGA was an FP7 project, investigating the usage of wireless optical communications for Gbps data delivery in home access networks. D-Light was a proof of concept project, funded by the EPSRC (Engineering and Physical Sciences Research Council), aiming at the demonstration of VLC for short range, high data rate links.

This breakthrough arrived at end of nearly a decade of re- search on quantum electron devices and engineered structures grown by molecular beam epitaxy (MBE), primarily in the Al- GaAs–GaAs and AlInAs–InGaAs material systems, carried out at Bell Labs, which in turn relied on earlier research on quantum wells and superlattices (SL)[7-10].

The speech signal, which the transmission distance is at least 2m, and the frequency range is from 300Hz to 3400Hz, is transmitted by directional transmission through the infrared emitting diode and the infrared receiving module as the transceiver. Increase the relay forwarding node for the infrared communications to change the communication direction of 90°and extend the communication distance of 2 m. The received sound should be no obvious distortion. The system design requirements as shown in Figure 1.

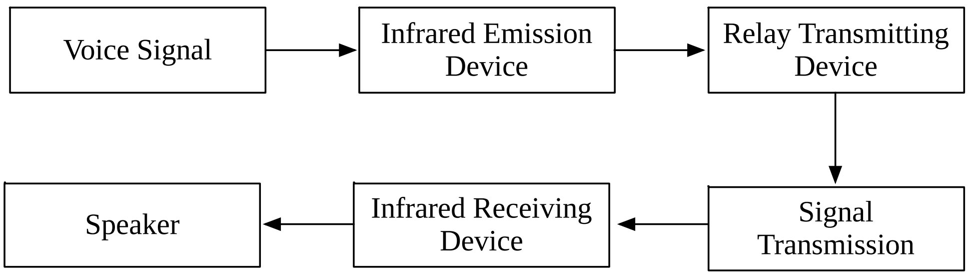

Fig. 1 The design requirements of proposed device

II. SYSTEM PLAN

A. Overall system design

A block diagram representation of the schematic diagram of the transmitter design is shown in Figure 1. The audio signal from the cassette tape or CD player has small amplitude and hence amplification of this audio signal is necessary. The audio amplifier is used to amplify the weak audio signal and to shift the average voltage level of the audio signal to an appropriate level so that the signal is within the capture range of VCO[11-12]. A VCO chip is used to modulate the incoming audio signal variations from the audio amplifier and generate the FM signal. A square wave VCO is used instead of sine wave because there are only two states (ON and OFF) for the LEDs. The carrier frequency is set at 100 kHz with a maximum frequency deviation of +50 kHz. The modulated signal is transmitted by the switching of the LEDs. The frequency of switching is high enough such that the perceivable light appears to be constantly illuminated to the human eye.

The infrared communication can be divided into the digital communication and the analog communication, and this system uses the analog signal. The analog signal input from the headphones will be transmitted through the stopping capacitor, the audio power amplifier. The receiving end converts the optical signal which received by the infrared receiving tube into the electrical signal, and the signal is transmitted to the speaker trough the band pass filter and the audio power amplifier[13].

B. Design of transmitter system

Novel devices that utilize size quantization for their operation were demonstrated. Among the latter, one should cite quantum-well lasers, integrated quantum-quantum-good electroabsorption modulators and lasers, and high electron mobility transistors, all of which have made a major commercial impact, enabling high- bandwidth lightwave and wireless communications.

The circuit diagram of the transmitter system is shown in Figure 2. The electrical signal, which is received by the earphone plug, is entered into the audio power amplifier through the stopping capacitor. Use the chip LM386 as the audio power amplifier. And this chip is a kind of audio integrated power amplifier, which has the advantages of low power consumption, adjustable internal chain gain, wide supply voltage range, and less outward element. The input signal is very weak, thus we can get the gain of 50-200, increase the transmission energy and enlarge the receiving distance using the audio power amplifier LM386 before launching device[14,15]. The amplified analog signal is emitted through an infrared emitting tube. In addition, the infrared tube of the emission can be used in the spotlight to increase the transmission distance.

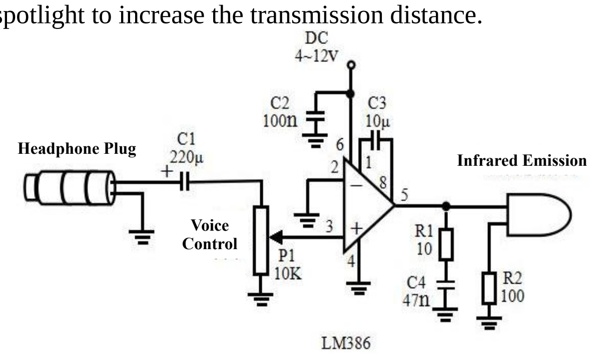

Fig. 2 Circuit diagram of the transmitter system

C. Design of receiving system

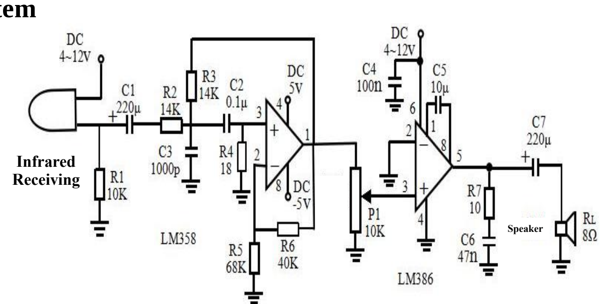

Fig. 3 Circuit diagram of the receiver system

The circuit diagram of the receiver system is shown in Figure 3. The optical signal, which received by the infrared receiving tube, is converted into the electrical signal through the band pass filter. The band pass filter LM358 is a dual operational amplifier, including two independent dual operational amplifier, which has the advantages of high gain, internal frequency compensation. It can be used in a single power supply that the supply voltage range is very wide and a dual power supply. Its use scope is including transducer amplifier, dc gain amplifier module and all the other available the occasion of the use of single power supply operational amplifier. Therefore, the LM358 can be used as the band pass filter in the circuit, while adjusting the size of the capacitor resistor so that the frequency is set to 300-3400Hz, filtering out other frequency signals and noise such as Gauss white noise. The filtered signal is still weak and insufficient to drive the load horn to work. Therefore, the audio power amplifier LM386 is needed to amplify the filtered signal and then drive the horn to work normally. In addition, the infrared tube of the transmitter can be used in the spotlight to increase the transmission distance.

D. Design of relay system

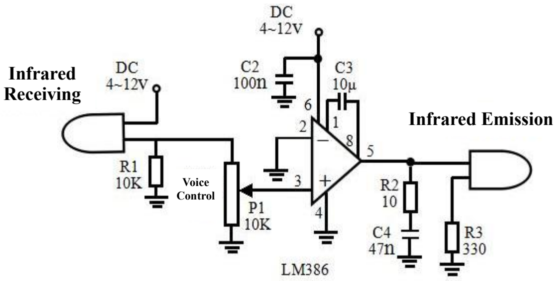

Fig. 4 Circuit diagram of intermediate forwarding system

The circuit diagram of the intermediate forwarding system is shown in Figure 4. Increasing the relay can extend the distance of the infrared communication, and the system design only needs two infrared-emitting tube, two infrared-receiving tube and the audio power amplifier LM386. The infrared signal received by the infrared-receiving tube is amplified and transmitted through the infrared-emitting tube, so the relay system can play a role in enhancing the intensity of the infrared signal. Adjusting the size of the R3 can change the power of the relay. After testing, the size of R3 can be about 330Ω and the power consumption of relay is low.

Other applications can be found indoors in a museum or exhibition hall environment. The information on individual exhibit can be broadcast via a plurality of LEDs, which is also used for the purpose of illumination. With the guest pointing the receiver to the relevant LEDs on a transmitter, with the head phone or ear jack attached to the portable receiver, he can listen to the audio message about the specific exhibit item he is interested. Thus, the indoor environment can remain quiet while the guests stroll in the museum. A major advantage over conventional broadcasting system is that an individual with a receiver has the freedom of choice in receiving specific messages without hearing any unwanted announcement, music or commercials.

III. TEST RESULTS OF THE DESIGN SCHEME

The situation is radically different in QC lasers, because in these devices the relaxation of the carrier density to equilibrium is dominated by phonon scattering. Since this is an ultrafast mechanism, transient oscillations of the population inversion, and hence of the photon density, are overdamped, and no resonance will, therefore, appear in the frequency response. The modulation dynamics of QC lasers is to a large extent simply limited by their picosecond carrier lifetime, so that intrinsic bandwidths in excess of 100 GHz can be obtained.

When the speech signal from the transmitter input is the tone signal which frequency is 800Hz, and the load resistance is 8Ω, the effective value of the receiving output voltage is 0.442V. The state of the circuit is not changed, and the input signal at the transmitter is reduced to 0V. Measure the noise voltage at the output of the receiving device is 0.24V with the low frequency milli-voltmeter.

When the speech signal is inputted at the transmitter, the design of the circuit is achieved the basic requirements according to the parameters and the waveform of the speech signal from the test. The received sound has no obvious distortion, and the infrared transmission distance can be reached 8~10m, which is consistent with the basic requirements of the subject. The signal can be changed the direction of communication after 90 degrees, the transmission distance can be reached 10m and the system can be reached the requirements of the design through the relay system.

High brightness LEDs are getting more popular and are opening up a number of new applications, especially with improved efficiency and new colors. In this paper, the novel idea based on the fast switching of LEDs and the modulation of the visible light is developed into a new kind of information system. A visible LED audio system makes use of visual light rays to transmit audio messages to a remotely located receiver is described. Such a system made up of high brightness visible LEDs can provide the function of open space, wireless broadcasting of audio signal. It can be used as an information beacon for short distance communication.

The development of single-mode QC lasers has been essential for spectroscopic applications such as chemical sensing and trace gas analysis. Single-mode operation is achieved using a suitably designed grating satisfying the Bragg reflection condition for a wavelength within the gain spectrum. These distributed feedback (DFB) QC lasers, reviewed in the companion paper of Gmachl et al. of this issue, have allowed the detection of gases at levels of a few parts per billion in volume. For a re- view of the sensor and spectroscopy applications of QC lasers, see the paper by Kosterev and Tittel in this issue.

IV. CONCLUSION

The infrared-emitting tube and the infrared-receiving module are used as the transmitting-receiving device for the directional transmission of the analog speech signal in the communication device based on the infrared light. The analog speech signal, which the frequency range is 300~3400Hz and the transmission distance can be reached 10m, is transmitted by audio jack line input or a low frequency signal source.

In order to make the sound more clear，it is necessary to reduce the noises generated by the heat of the each component in the circuit and other interference signal (such as the infrared signal emitted by the objects, the electromagnetic radiation of other electrical appliances in the room, etc.), and to regulate the magnification of the triode and the power amplifier, thus ensuring the minimum distortion of the sound signal. For longer transmission distance of signals, on the one hand the signal magnification of the receiver can be improved as far as possible in the case of the smallest degree of distortion, on the other hand the transmitting power of the transmitter can be regulated.

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