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Data Transmission Using Visible Light

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Abstract:

Light is indispensible part of the life. In the present days, LEDs are becoming the main source of light of lighting in many areas. Mostly, White LEDs so, can we use them to transmit data? The answer is yes! We use Radio waves as the main sources of transmission these days, but the Radio Frequency (RF) spectrum is limited and they cannot be used in certain places like Hospitals, Underwater, Petrochemical plants or Planes. This technology solves the problem. It is safe to use anywhere, where light is available.

Keywords: *Wireless, Visible communication, VLC, Visible spectrum, OFDM.*

1.Introduction

In the 21st century, high speed data transmission plays a prominent role in our Day-to-day life. Wireless communication constitutes a major element to achieve these goals. However, we have a certain limit in radio waves frequency band. For this reason, alternate wireless communication means have to be explored. Then, come's the idea of Visible Light Communication (VLC). VLC can be achieved using White LEDS, which offer a great potential for such alternative. The main reasons are as follows:

White LEDs are presently used in many areas of everyday life. They are replacing high energy consuming light bulbs, like fluorescent lamps, bulbs, in private and business homes and even in street lamps. Moreover, the can be used in front and back lights of a cars, planes and for object illuminations in museums, etc. Bandwidth is not limited like RF spectrum. Transmitters and receiver devices are cheap, and there is no further need for expensive RF units. As light waves cannot be penetrated through opaque objects, they can't be eavesdropped. It is very difficult for an intruder to pick the signal from outside the room. Unlike RF waves, Visible light is free on any health concerns. So, these can be used in hospitals, private homes etc.

The wavelengths of Infrared and Visible light sources are so close to each other and therefore exhibit similar propagation behavior. In addition, there are no health regulations to restrict the transmit power. Therefore, a unique feature of white Les is that they can be simultaneously used as lighting sources and high speed wireless data transmission devices. This data transmission can be viewed as a complementary to radio medium but not as a replacement. For instant, if a Wireless Local Area Network (WLAN) is required to cover a large area then the radio transmission is the best option to transmit data. If a WLAN is required to cover a relatively small area, but a high transmission rates are required, then visible light transmission with unlimited bandwidth can be preferable.

2.LED Characteristics

White LEDs are classified into two types. Some are fabricated using a blue LED chip and a phosphor. These types of LEDs have a phosphor layer on top of an InGaN- bases blue LED chip. The other types of white LEDs are fabricated by mixing light from LEDs of the three primary colors, such as red, green, and blue. All the three colors are emitted simultaneously. The optical source used in the prototype is a single chip (the first type as described above) 5mm white LED with a luminous intensity of 11000mcd. This type is

chosen as it can be considered standard and inexpensive. The circuit employs a *P* (positive) on *N* (negative) silicon planar photodiode designed to deliver a maximum response through the visible part of the spectrum. The 9.8mm2 planar photodiode has a built in infrared rejection filter and provides a high shunt resistance of 0.07GOhm maximum, and low dark current of 2000pA maximum. The generated photocurrent is proportional to the incident light power and it is converted to voltage using a transimpedance configuration. The photodiode can be operated with an applied reverse bias, photoconductive mode, or unbiased, photovoltaic mode. The photodiode was chosen with the previously mentioned characteristics to achieve very low offset when the photodiode is operated in the photovoltaic mode, and when it is used in a high gain transimpedance operational amplifier circuit. For our application in the low frequency range, photovoltaic mode provides reasonable linearity and low noise.

3.Process

There are currently 1.4 million of these masts dotted around the globe, many of them diesel-powered. And there are more than 5 billion cellular phones currently in existence worldwide. Generally, the data from a transmitter is sent in single streams after modulation is performed. But, here this technology doesn't send data in single streams but in several thousand streams parallel to each other. That kind of method is called Orthogonal Frequency Division Multiplexing (OFDM). In an OFDM system, a high data rate serial data stream is split up into a set of low rate sub-streams. This type of parallel data stream offers possibilities for alleviating many of the problems encountered with serial transmission systems such as Inter Symbol Interference (ISI) and the need for complex equalizers. Each low rate sub-stream is modulated thereby, on a separate. Sub-channel. This is achieved by selecting a special equidistant set of discrete carrier frequencies. This operation can be performed by the IFFT. At the receiver, the FFT is used to de multiplex the parallel data streams.

The possibility to combine it with multiple access scheme such TDMA (Time division multiple access), FDMA and CDMA (Code division multiple access) and the possibility to combine OFDM with any higher order modulation scheme makes it an excellent choice for visible light communication. This technology allows the LEDs to modulate at a rate so fast that a human eye could not be able to follow these variations and hence, the lighting will not be affected. And the signals can be received by receivers such as smart phone cameras, etc. As a consequence, simple off the shelf LEDs can be used to develop

cheap transmitters. The data can be transmitted at a speed of 100Mbits per second without any losses.

Each piece of information through OFDM signals is transmitted through the medium by varying the hase and amplitude of each subcarrier to adjust to the variation in data.

Serial to parallel converter partitions the incoming data for separation into n-subcarriers. In the Inverse Fast Fourier Transform the information is multiplied by the corresponding carrier g(t) and sum of such modulated sinusoidal form the transmit signals. The sum of all modulated signals (Having a frequency separation of 1/T) will produce the resulting s(t), a signal in the time domain. This summation of the signals is a multiple stream time domain signal which is fed into a parallel to serial converter. This block multiplexes the modulated data for transmission over the channel. Fast Fourier Transform: It does the exact opposite functioning of the IFFT unit. The FFT unit changes the time domain signal back into the frequency domain by using Integration.

4.Conclusion

VLC appears to be an important potential component in expanding useable bandwidth, protecting sensitive electrical equipment and data, creating more biologically friendly communications technology.

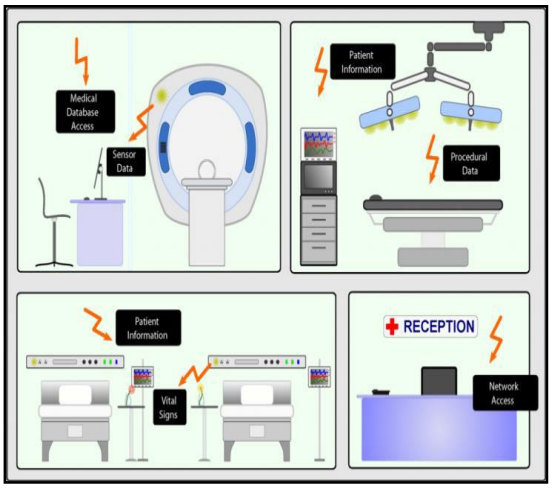

Figure 1

The new transmission technology is suitable for hospitals, for example, because radio transmissions are not allowed there. Despite this fact, high data rates must be transmitted without losses and unzipped, according to the experts. If part of the communication

occurs via the light in the surgical room, this would make it possible to control wireless surgical robots or transmit x-ray images.

Figure 2: Application of this technology in airplanes

In airplanes, each passenger could view his own entertainment program on display, saving aircraft manufacturers miles of cables. Another possible venue for the application of this technology is production facilities like petrochemical plants, where radio transmissions very often interfere with the process. In addition, transmissions can be atopped simply by blocking the light, and thus can be stopped by walls, so there is less risk of data leaking out of house or office.

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