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LED Traffic Light as a Communications Device: A Review

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ABSTRACT: ***An LED (light emitting diode) traffic light's visible light may be manipulated and encoded with data. As a result, it may be used to transmit audio messages or any kind of track or road information. All LED track lights may, in theory, be utilized as communication devices. This article describes an audio information system consisting of high-brightness visible light emitting diodes (LEDs) with one or more LEDs modulated and encoded with audio messages. High-intensity light emitting diodes (HILEDs) for traffic signals have just been available on the market. For instance, a new bluish-green LED has been developed to satisfy the color and brightness criteria of green traffic lights based on US standards and other international specifications. For many years, high-brightness red and yellow LEDs have been available on the market. A receiver with a speaker is also included in the system, which is placed at a distance from the LED traffic signal. The receiver's job is to demodulate the audio information sent through optical transmission and broadcast the messages via the speaker. Intensity modulation with direct detection is used in the optical connection. The open space, wireless transmission of audio messages may be provided by an audio information system based on an LED traffic light.***

KEYWORDS: ***Communication, Connections, LED, Signals, Traffic Light.***

1. INTRODUCTION

High-intensity light emitting diodes (HILEDs) for traffic signals have just been available on the market. For instance, a new bluish-green LED has been developed to satisfy the color and brightness criteria of green traffic lights based on US standards and other international specifications. For many years, high-brightness red and yellow LEDs have been available on the market. As a result, traffic signal makers have access to all three hues of high-intensity, high-efficiency LEDs. There are many benefits to using LEDs. The incandescent lights in a standard 8-inch diameter traffic signal may require between 116 and 150 watts of electricity. The new LED light only uses 10 to 18 watts of power. With a greater tolerance to humidity, the life expectancy is also increased. The failure of an LED bulb is usually gradual, and the red, yellow, or green indication does not go black abruptly. For motorists, this adds another layer of protection [1], [2].

The following is the core concept of this study. An LED traffic light may be utilized as a communications device for the transmission and dissemination of information in addition to its usual duty as an indicator and lighting device. As a result, it is integrated into a wireless optical communication system. This article proposes an audio information system that uses visible light emitting diodes to transmit audio signals [SI. Many novel and fascinating applications result from the simultaneous use of visible LEDs for signaling and communication. The technology proposed in this article has been implemented in experimental prototypes.

In large cities and cities in which the metropolitan area has a percentage of its infrastructure and economy centered around an airport, a large percentage of the population travels the streets. Traffic jams are frequent and contribute to lower efficiency in people’s work. The objectives

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of airport and surface transportation planning objectives are to ensure maximal access to airports and business sites with minimal time and cost. The time and cost of connectivity supersede space and distance as the primary planning metrics. It is not the speed, but the time required for firms to connect to their suppliers, customers, and enterprise partners that is important.

Synergy between airports and urban development is necessary for sustainable development, such as through improvement of the urban surface transport capacity. To deal with this problem, the most natural solution is to build new roads, but this is generally unfeasible in urban areas due to the presence of existing buildings, which makes the construction of these new roads very expensive or even impossible. Hence, traffic density keeps increasing at an alarming rate in major cities, which calls for the development of intelligent traffic light control to replace the conventional manual and time-based methods. To ease this problem and improve mobility, safety, and traffic efficiency, many countries are improving their existing transportation systems.

Traffic signal control systems can be either static or dynamic. In static systems, the predetermined timing of the signal is optimized using historically measured data. However, such systems are not able to predict or adapt to changes in demand. Moreover, they do not deal well with accidents and other disturbances. When dynamic systems are used, traffic signal timing is adapted to the current conditions, which are measured from sensors. This leads to better traffic control (TC). Large cities usually implement a traffic monitoring system. A large number of sensors are deployed under the pavement. TC central receives all of the information and controls the traffic accordingly. The necessity of a large cabling infrastructure usually limits their use to central areas.

Currently, wireless sensor devices are becoming less and less expensive, which enables the rapid expansion of monitoring system structures. Hence, the sensor market has become larger, which allows the connection of more sophisticated sensors. The usage of radar sensors or digital cameras has been increased in order to allow the measurement of car speeds as well as general variables, such as the quantity of cars on the road to be measured in order to inform drivers directly and avoid congestion. TC systems have evolved to provide better traffic management. Intelligent Transport Systems (ITSs) are applications that provide innovative services for traffic management. ITS provide users with better information to allow smarter, safer, and more coordinated use of ITS infrastructures. In this paper, the authors combine ITSs with wireless communication technology (WCT) systems that are easier to install and more easily expandable to areas outside the city center.

The work presented in this article is distinct from previous studies that have used infrared (IR) radiation as a medium for short-range wireless communications. Infrared connections and local area networks are now available. At a cheap cost, IR transceivers for use as IR data connections are readily available on the market. Provides a comparison of infrared with other media such as radio and microwave. In any case, relatively little research has been done on the use of visible light as a communication channel. The advent of high-brightness LEDs has also increased the viability of visible light. In theory, any device having visible LED components (such as an LED traffic signal head) may be converted into an information beacon. The purpose of this article is to look at how it may be used for audio transmission. Figure 1 shows the LED traffic light as a communications device [3]–[5].

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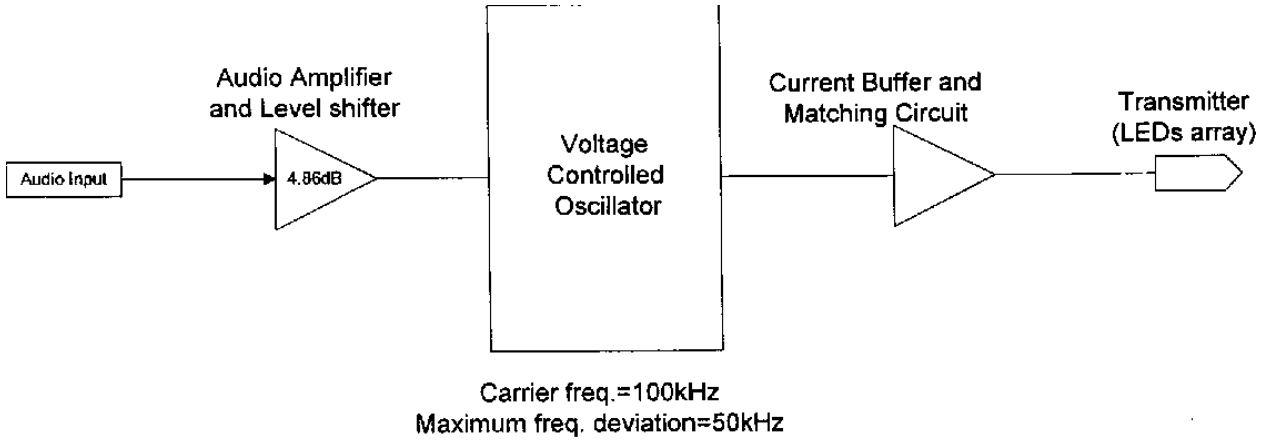

Figure 1: The above figure shows the LED traffic light as a communications device [semanticscholar].

For many years, visible light in fiber optics has been utilized as a communication channel. The use in this study is as a short-range information beacon in open space. Because the receiver needs a line-of-sight to the audio system or transmitter, the application must take use of the directional character of the communication medium. The audio signal broadcasting apparatus and the receiver are largely stationary in the present experimental configuration. The dopplar frequency shift seen by the receiver may be safely ignored since the relative speed between the receiver and the source is considerably less than the speed of light. It's worth noting that the transmitter offers simple targets for the receiver's line-of-sight reception [6].

This is because the LEDs are always on and serve as indications of the transmitter's position. With a viewing angle of almost 180 degrees, the transmitter can broadcast.

1.2 Description of the system:

The audio signal from the cassette tape or CD player has a low amplitude, it must be amplified. The audio amplifier is used to amplify a weak audio signal and change the average voltage level of the audio signal to an acceptable level, allowing the signal to be captured by a voltage-controlled oscillator (VCO). To modulate the incoming audio signal fluctuations from the audio amplifier and produce the FM signal, a VCO chip is required. Because the LEDs have just two states (ON and OFF), a square wave VCO is utilized instead of a sine wave VCO. With a maximum frequency variation of +50 kHz, the carrier frequency is fixed at 100 kHz. The modulated signal is conveyed via the LEDs' switching. The switching frequency is high enough that the perceivable light seems to be lit continuously to the human eye [7], [8].

A photodiode and a resistor make up the photo detector circuit. The current limiting resistor is connected to one end of the photodiode, while the other end is connected to ground. Because the signal from the photo-detector circuit is so weak, the following step requires amplification. Two op-amplifiers, as well as resistors and diodes, make up the limiting pre-amplifier circuit. The diodes are employed to set a limit on the input voltage level (such as between -0.7 V and 0.7 V). This circuit uses a comparator to generate rectangular signal pulses and attempts to amplify the input signal to a specified level [9].

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This circuit employs two pre-amplifiers since a single pre-amplifier would need an extremely high gain amplifier. As a result, two pre-amplifiers, each with a lesser gain, are employed to obtain a high gain while reducing noise.

After that, a data reproducing circuit with an operational amplifier, a resistor, and two NAND Schmitt triggers is employed. The purpose is to generate rectangular pulses from the previously amplified signal. As a comparator, an operational amplifier is employed with virtual ground as a reference. Two NAND Schmitt trigger gates are utilized to improve noise immunity and rectify edges caused by the amplifier's slew rate from low to high voltage levels. To avoid signal inversion, two NAND Schmitt trigger gates are utilized instead of one. The leading edges of the pulse are then detected using a differentiator circuit consisting of a capacitor and a resistor, with the trailing edges blocked by a diode. The circuit of a pulse generator is next. The pulse generator is a Schmitt trigger gate, and the output is the inverted counterpart of the pulses from the differentiator [10].

An LED (light emitting diode) traffic light's visible light may be manipulated and encoded with data. As a result, it may be used to broadcast audio messages as well as traffic and road information. Almost all LED traffic lights may function as communication devices. The article describes an audio information system comprised of high-brightness visible light emitting diodes (LEDs) with one or more LEDs modulated and encoded with audio messages. A receiver with a speaker is also included in the system, which is placed at a distance from the LED traffic signal. The receiver's job is to demodulate the audio information sent through optical transmission and broadcast the messages via the speaker. Intensity modulation with direct detection is used in the optical connection. The open space, wireless transmission of audio messages may be provided by an audio information system installed on an LED traffic light.

The following step has an integrator and an envelope detector. Double integrations are performed using an envelope detector as the integrator. The frequency of integration is greater and the voltage level of the output is higher if the inverted pulses from the pulse generator have a high frequency. However, if the inverted pulses have a low frequency, the integration frequency will be lower, and the output voltage level will be lower. The modulated signal would be rebuilt in this manner. After that, a band-pass filter is used. The preceding stage's output signal, the integrator and envelope detector, has a lot of aberrations in it. All high frequency aberrations are filtered out using a band-pass filter. A capacitor and a resistor determine the higher cut-off frequency. Low frequency noise, such as the 50Hz power line frequency, is also filtered away using a lower cutoff. The band-pass filter's output signal is an audio signal. The receiver circuit's last step is a power amplifier, whose output is linked to the speaker. The goal is for audible messages to be delivered via a speaker or headphone/ear jack 3. Audio system for LED Traffic Lights.

The purpose of this article is to outline the first stages in the development of a smart traffic light control system using powerline communications (PLC) technology. The system is controlled by traffic lights that use LED technology, which offers a variety of benefits over conventional incandescent lighting. The suggested system takes use of transmission means to transmit information about the condition of lighting components between various traffic light groups and a central regulator. The state and functioning of the traffic light group may be monitored and modified from the regulator, depending on traffic circumstances and time. The

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suggested technology may be utilized to remotely manage the functioning of traffic signals and reduces long-term maintenance expenses.

A traffic light group is a collection of traffic lights that are all regulated by the same master or coordinator regulator. The regulator is controlled by an intelligent system that enables it to regulate the state of the lights based on time, traffic circumstances, and other factors.

Several improvements on the basic idea of traffic light regulation have been developed in the past 70 years. These advancements include the implementation of sophisticated procedures such as macro- and micro-regulation, redundancy to increase security, more efficient and cost-effective reflectors, and so on. However, one feature that is consistent across all instances is the employment of incandescent bulbs as a lighting source. In the 1980s, a new lighting technology called Light Emitting Diodes, or LED, was developed. LEDs may be powered by a dc voltage and produce light with a specific wavelength. Displays, panel indicators, remote controls, and television screens all utilize LED technology.

LED technology has advanced significantly in recent years, with reduced manufacturing costs and the ability to produce LEDs with a variety of light colors. LEDs are built in such a way that they can emit a high number of photons. Furthermore, they are contained in a plastic bulb that directs the light in a certain direction. The aforementioned audio system may be used to control LED traffic lights, for example. High-brightness LEDs are increasingly being utilized in traffic signals these days. This is mostly due to the low power consumption and low maintenance requirements of LED-based traffic lights, which may result in significant annual cost savings.

The city of Philadelphia, Pennsylvania, is replacing all of its 28,000 red lights with LEDs, saving an estimated US 1.2 million each year. The three-color LED signals will be used in the next stage of development. The LED traffic light may be utilized as a communications device in addition to its usual role as an indicator and signaling device, thanks to the concept and research presented in this article. Because it can broadcast local traffic information, vehicle position, road and navigation information, and fulfill its usual role of being a traffic signaling device, traffic lights may be used simultaneously. To enable roadside-to-vehicle communications, the LED traffic light transforms into a new kind of short-range beacon. The angle of view is 30 degrees. Outdoors, audio transmission distances may exceed 20 meters.

2. DISCUSSION

The Industrial Automation Laboratory at The University of Hong Kong has developed two prototypes of the acoustic information system proposed in this article. The first is a straightforward LED transmitter made up of HP high-intensity AlInGaP LEDs with a luminous intensity of 1100 mcd and a rated driving current of 20 mA. It's a 15-degree viewing angle LED light with a 5mm diameter. The authors show that using only one of these LEDs and a 50mm focusing lens in front of the receiver photodiode, the transmission distance may reach 390 cm. The transmission distance without the lens may reach 77 cm. Photographs of the implemented transmitter (showing six LEDs). An LED traffic signal head with 441 high-brightness LEDs is the second implementation. At a 20mA driving current, each exhibits a luminous intensity of 2000 mcd.

3. CONCLUSION

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Long working lives, little maintenance, durability, minimum heat production, low power consumption from low current operation, and compatibility with TTL and CMOS circuitry are just a few of the advantages LEDs offer in many industrial goods. The benefits of LED traffic lights are the same, and there is no reason not to convert to them saves for the initial cost of the transition. The concept is based on the rapid switching of LEDs and the modulation of visible light in this paper. The goal is to turn a traffic light into a new type of audio information system using LEDs. This visible LED audio system uses visual light beams to send audio signals to a receiver that is situated far away. The function of open space, wireless broadcasting of audio signal may be provided by a system made up of high brightness visible LEDs. It may be used as a short-range communication information beacon. Only line-of-sight communication is possible with this system. However, the usage of LED traffic signal heads for both signaling and communication will open up a slew of new possibilities.

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