



VISIBLE LIGHT COMMUNICATION BASED VEHICULAR COMMUNICATION

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ABSTRACT

Visible Light Communications (VLC) is turning into a mature communication technology, significantly for indoor usage. The appliance in outside environments is especially interesting within the scope of vehicular VLC (V-VLC), however, there are some crucial challenges remaining. In general, VLC may be a sensible complement to oftenness (RF)-based communication. For automotive use cases, V-VLC is cashing in on the large accessible spectrum and also the pronto accessible light Emitting Diode (LED)- primarily based lighting systems of recent cars. Its Line Of Sight (LOS) characteristics, the radial asymmetry of the sunshine, and also the smaller collision domain considerably reduces interference. During this survey paper, we have a tendency to study the state of the art of V-VLC and establish open problems and challenges. We have a tendency to study the V-VLC communication system as an entire and conjointly perforate the characteristics of the VLC channel. For the beginner within the field, this review acts as a guide to the foremost relevant literature to quickly catch up with current trends and achievements. For the knowledgeable, we have a tendency to establish open analysis queries and conjointly introduce the V-VLC analysis community as an entire. conveyance communications area unit predicted to play a key role to extend road safety and notice autonomous driving. Additionally to the oftenness (RF)-based dedicated short vary communication (DSRC) and long-term evolution (LTE) communication technologies, vehicular visible light communication (V2LC) is projected as a complementary answer, utilizing pronto deployed vehicle light-weight emitting diode (LED) lights as transmitter with image sensors like photodetector (PD) and camera because the receivers. This project proposes a study and implementation of an inexpensive Vehicle-to-vehicle Communication (V2V) mistreatment the conception of VLC. By modulating the vehicle's tail lights, it's doable to transmit event-based messages with this standing of the automotive. To realize this, a miniature model was created mistreatment high bright LEDs and controlled environmental conditions to avoid external interferences.

Keywords: *Vehicular visible light communications, V2V, Vehicle Safety, Signal Processing.*

1. INTRODUCTION

The adoption of light-emitting diode lamps is increasing throughout the last years in many applications, together with the automotive. This technology will offer additional edges than the energy economy, as a result of the sunshine emitting diode properties will add new functions to the lamp. The crystal rectifier quick response to electrical impulses permits the high frequency change, making the chance to transmit information victimisation the visible radiation. This paper can show a model of Vehicle-to-vehicle communication victimisation the tail lights. Next-generation quality trends like autonomous driving and ride sharing necessitate varied transport property schemes. On the opposite hand, intelligent transportation systems (ITS) in harmony with transport communications aim to cut back tie up, accidents, pollution, energy, and time wastage. Upto date, transport communications area unit expected to produce timely and economical information dissemination relating to accidents, traffic jams, and road conditions on the far side the drivers' information security vulnerabilities of RF-based communications, optical wireless communication is professional exhibit as a complementary technology for transport property. Utilizing redundant communication schemes for transport communications is anticipated to extend road safety whereas supporting safer machine-driven driving applications. LEDs change versatile vehicle headlight/taillight style, whereas providing higher illumination, low energy consumption, and longer sturdiness. Hence, crystal rectifier lights area unit began to be wide deployed with new production vehicles. Moreover, vehicle crystal rectifier lights change creation of varied illumination patterns to stop glare from different road users and illuminate the blind areas higher [1]. crystal rectifier light-weights illumination necessities and style pointers are enclosed within the automotive light laws [2], that paves the means for additional makers to utilize crystal rectifier in their vehicles. Dimming capability of crystal rectifier lights is another favorable feature for automotive trade, providing energy economical transport lighting. Fashionable vehicles are equipped with image sensors like PDs and cameras. PDs area unit used to notice close light-weight levels and rain to mechanically activate headlights or wiper blades, whereas the cameras area unit used for driver help systems like lane keeping assistant, traffic sign recognition, pedestrian detection, and forward collision warning. Hence, usage of the prevailing vehicle crystal rectifier lights and image sensors is expected to permit low vehicular visible light communication (V2LC) system implementation prices. visible light communication (VLC) systems with intensity modulation and direct detection (IM/DD) utilize signal intensity rather than signal section data. As section data is liable to distortions for quality situations, sole dependence on signal intensity of

IM/DD theme additionally makes VLC a promising technology for transport communications. Currently, V2V aims to transmit vehicle position and state data to boost the road awareness of near vehicles. However, with the future autonomous driving options, high-definition real time road maps, vehicle measuring instrument information, high-resolution image, and video information from on-board cameras area unit expected to be changed between near vehicles. These events driven giant size information is needed to be sent with minimum latency. what is more, high quality needs higher message update rates ensuing with dense message generation. so as to produce high information rates with minimum latency, hybrid schemes, utilizing varied communication technologies at the same time, area unit provisioned to be favorable. it's already been incontestible that, communication degradation sourced by packet collisions and contention with the usage of single theme like DSRC will be avoided with a hybrid theme using DSRC and V2LC [3]. Transportation systems of nowadays area unit nearer than ever guaranteed to expertise a serious technological transformation. Vehicles on roads have return a protracted means from the clean metal-on wheels they accustomed be, to the sensing and computation capable machines they're nowadays. High-end models of last generation vehicles today area unit equipped with many embedded computers and sensors which permit them to understand their surroundings, and act with it in semi-autonomous, and eventually, fully-autonomous fashion. though at a slower pace, the road infrastructure has evolved also, as reconciling traffic lights and communication capable pay tolls area unit being deployed on roads. associate degree anticipated next step within the evolution course of trans portation systems is to adopt the construct of communication and change data exchange between vehicles and with infrastructure. this can unleash the complete potential of next generation transportation systems whereas shifting the paradigm from autonomous driving to cooperative driving. The new noninheritable capabilities of vehicles and infrastructure pave the means for a group of latest applications. As a result, various agencies and regulative bodies worldwide have step forward with standards and techniques to deploy such applications, often brought up as Intelligent Transportation Systems (ITS) [1], [2]. In essence, the most goal of ITS is to enhance road safety, traffic potency, and luxury of driving by taking advantage of Vehicle-to-Everything (V2X) communications [3], [4].

2. RELATED WORK

Visible light communication (VLC) systems with intensity modulation and direct detection (IM/DD) utilize signal intensity rather than signal section data. As section data is liable to distortions for quality situations, sole dependence on signal intensity of IM/DD theme additionally makes VLC a promising technology for transport communications. Currently, V2V aims to transmit vehicle position and state data to reinforce the road awareness of near vehicles. However, with the future autonomous driving options, high-definition real time road maps, vehicle measuring system knowledge, high-resolution image, and video knowledge from on-board cameras square measure expected to be changed between near vehicles. These events driven giant size knowledge is needed to be sent with minimum latency. what is more, high quality needs higher message update rates ensuing with dense message generation. so as to produce high knowledge rates with minimum latency, hybrid schemes, utilizing varied communication technologies at the same time, square measure provisioned to be favorable. it's already been incontestible that, communication degradation sourced by packet collisions and contention with the usage of single theme like DSRC will be avoided with a hybrid theme using DSRC and V2LC [3]. Upto date, VLC is rumored to realize multi-Gbit/s knowledge rates for some meter distances. Compared to DSRC most rate support with twenty seven Mbps upto one thousand m distances [4], Gbit/s rates build VLC enticing for prime knowledge rate transport communications. additionally to higher rate blessings, with its immunity to malicious jam with LoS characteristics, VLC is additionally predicted to off-load RF networks whereas providing secure communications for safety important applications. within the literature, varied studies investigated V2LC applications. In Ref. [5], LEDs square measure used as vehicle close lights and dome lights square measure predicted to act as VLC transmitters. Authors in official. [6] enforced IEEE 802.15.7 customary to convey data mistreatment vehicle light-emitting diode lights. In Ref. [7], V2LC system that's supported image detector and high-speed camera receivers is incontestible.

3. THE PROTOCOL

The communication protocol was developed to be as lightweight and as easy as potential. The frame contains a total size of eight bytes, that the primary computer memory unit corresponds to the event ID, generating up to 256 completely different events. The seven staying bytes square measure event-specific information. which means these bytes square measure crammed in an exceedingly completely different manner looking on the event. as an example, in associate degree 'Emergency Braking' event, it's necessary to grasp the instant vehicle speed, its braking system health or alternative parameters which will influence the receiver vehicle's response reaction. the complete message is generated by a Java application so transferred to Arduino via a standard serial association, World Health Organization works as a physical layer committal to writing the information into Manchester so transmittal it by a digital pin. in an exceedingly similar manner, the receiver contains a photodiode connected to a digital pin of receiver Arduino UNO is accountable to decrypt received information to positional notation characters so send them to the receiver Java application by a serial interface moreover. Below there's associate degree example of a frame sent to Arduino employing a serial interface. Note that during this case, the positional notation characters square measure delineate mistreatment American Standard Code for Information Interchange format.

4. SECURING VEHICULAR VISIBLE LIGHT COMMUNICATION

In system level attack, vehicle hardware/software or security certificate is targeted by either malicious business executive in producing level or by an outsider. Via fixing essential vehicle elements like sensors, a dead system is meant. although the transport communication channel is secure, vehicle generates faulty info that features a ruinous impact on safety. what is more, application and network layer attacks targeting transport communication might have substantial effects on transport communications security. Application layer attacks may be summarized as; spoofing, wherever AN human imitates another vehicle among the transmission vary and injects wrong info into the network; replay attack, wherever the disseminated packet is hold on by human and replayed at a later time to ruin transport security, and eavesdropping, wherever human in secret collects the transmitted packet among its transmission vary and processes the packet info. Compared to application layer, network layer attacks aim multiuser applications wherever in distributed-of-service (DoS) and distributed DoS communication

medium is full via redundant transmissions. In RF radio electronic jamming, explicit geographical locations area unit attacked via DoS and vehicles within the space area unit disturbed.

5. PROPOSED METHODOLOGY

VLC could be a medium range optical wireless communication technology that uses the 380–780 nm wavelengths of the spectrum [3]. In vehicles, VLC is enabled by LED-based headlamps and taillamps as transmitters and PDs or camera image sensors as receivers. Figure one depicts a typical traffic situation wherever V-VLC may be deployed. As illustrated, vehicles will understand Vehicle-to-Vehicle (V2V) communication with the vehicles in their direct neighborhood, therefore, establishing head to tail and tail to move links once driving, or head to move links once facing one another, as an example, at intersections. Tail to tail links are potential, but not common in typical driving eventualities. Figure one additionally illustrates Vehicle to-Infrastructure (V2I) communication, wherever LED-based infrastructure parts, like traffic lights, road-side aggregation, and street lighting, will convey visual data to the motive force and digital data to the VLC-enabled vehicles [5], [6]. Originally, V2I applications were the earliest style of V-VLC applications, thought-about for traffic data systems in late Nineteen Nineties. For V-VLC, to support these completely different communication eventualities (and corresponding applications) careful style choices have to be compelled to be created on the system level. This raises a large number of analysis queries, above all relating to Physical Layer (PHY) aspects of the system. for example, spectrally economical Modulation and secret writing Schemes (MCSs), like Orthogonal Frequency Division Multiplexing (OFDM), area unit favorable and are enforced for V-VLC [1]–[2]. However, hardware limitations of the V-VLC transmitters and receivers (e.g., nonlinearity of the electronics), as well as the difficult outside conditions and restrictive safety laws, vastly impact the possible performance. nonlinear transfer functions, restricted dynamic vary, and also the restricted information measure of the LEDs used for exterior automotive lighting area unit a number of the foremost challenges on the transmittal aspect. On the receiving aspect, it's the “square law” property of the Direct Detection (DD) receivers and also the hardware evoked noise that have an effect on the communication.

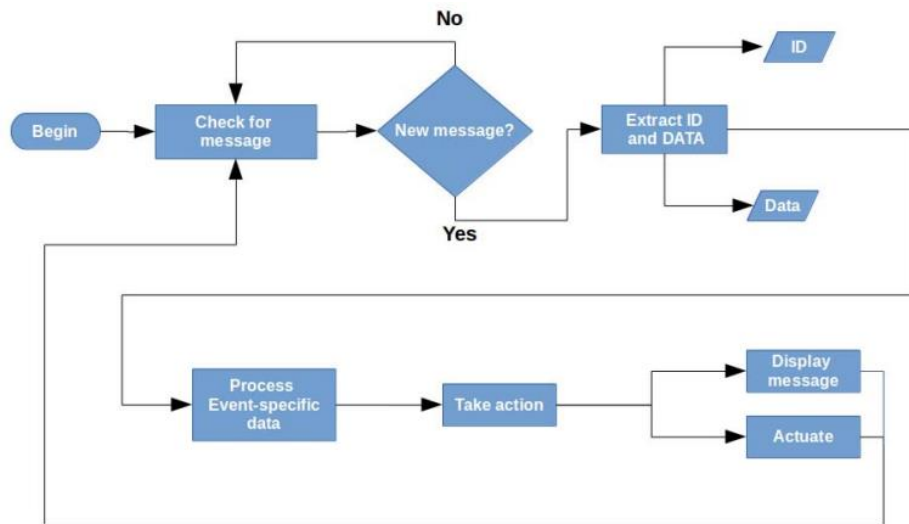


FIG.1. FLOW DIAGRAM

6. DIRECT DETECTION

LEDs are incoherent lightweight sources that emit optical waves with random section relationship. As such, within the absence of an identical carrier section [7], it's impractical to use (angle-based) modulation techniques like section or modulation. Therefore, completely different from standard RF communications, wherever the signal will be modulated in section, frequency, and amplitude, VLC systems place confidence in modulating the intensity of the optical wave [8, 1]. In optical wireless communications, this can be referred to as Intensity Modulation (IM). Once the signal is intensity modulated, it's transduced via the LEDs from the electrical domain to the optical domain, and it passes through the optical channel. Since the intensity can't be negative, IM imposes that the modulating signal has got to be non-negative unipolar and real valued, as hostile the bipolar complicated valued RF signal [4], [1]. when the signal is adjusted befittingly, several MCSs originally designed for RF communications will be used for VLC too. standard selections within the literature embody, On-Off Keying (OOK), OFDM, and Direct Sequence unfold Spectrum (DSSS) [7], [9]. Color-based MCSs, like Color Shift Keying (CSK) or Wavelength Division Multiplexing (WDM), may also be used for V-VLC, provided that the lighting module deploys multi-color LEDs [1]. an important purpose to contemplate once planning and deploying MCSs for V-VLC is that, they ought to be spectrally economical to accommodate application's necessities (e.g., throughput, delay, robustness) among the restricted information measure of LEDs utilized in exterior automotive lighting . an in depth discussion relating to MCSs for VLC will be found in [7]–[9].

7. EXPERIMENTAL SETUP

To validate the proposal, an on-scale model used 1:24 automobile models was created. LED lamps were accustomed represent the vehicle tail lights and one photodiode within the front to browse the messages transmitted by the front automobile. The cars in place and output signals were measured employing a electronic equipment. The check surroundings was back-lighted by fluorescent lights (1250 lx of illuminance) and windows were coated with curtains to dam daylight. the space between cars was twenty centimeters. The best transfer rate make up my mind by testing different information measure rates while not dynamic the surroundings conditions. The check started with a three hundred rate baud and was doubled till a 9600 rate. Considering a progressive Roman deitytortion, it's attainable to investigate the standard of the received signal supported the bottom, the second lowest and also the high Eastern Standard Time baud. The LED output channel, depicted by the orange wave shape, is that the reference because the transmitted signal whereas the photodiode response, depicted by the blue wave shape, is that the received signal. In different words, an ideal transmission is outlined as equal orange and blue waveforms. it's attainable to infer that the received signal distorts because the baud will increase. throughout the check with the transfer rate at three hundred rate, the received wave shape are often seen as al most artless. once acting the check with the certain rate at 9600 rate, the distortion effects increase significantly so the voltage to represent logic level low is approximately set at four.1 Volts and also the logic level high at 4.5 volts. The distinction between these voltage levels area unit insignificant and is take into account inadequate for this project. additionally, the photodiode response isn't quick enough to vary from logic level zero to logic level high because the amount decrease. different workaround techniques to scale back these effects are going to be shown on the subsequent things. Considering the results from the waveforms and also the quantity of information that the protocol uses, a 600 rate rate was utilized in the project.



FIG.1.V2LC experimental setup.

8. CONCLUSION

The proposed model worked evidently among the noted limitations and controlled surroundings. using 600 bits per second all transferred knowledge was properly received and put down preted by the applying in receiver mode. As mentioned, the communication is point-to-point simplex and is propa gated by new event generation on every vehicle. These trials solely lined a two-vehicle communication however the model may be ascendible while not losing performance. The project met its goal however some limitations were sweet-faced throughout implementation of the network. a number of them were enforced and lined on this paper however, due schedule and resource limitations, a number of had to be self-addressed as future implementations. Most of the workarounds have direct impact on the laborious ware used. The photodiode used isn't the foremost suited the applying, since it's its best performance on infrared vary (800 nanometers) whereas the red lightweight used has wavelength around 700 nanometers. This quality makes the sun lightweight interference substantial. thus it's suggested to use a bandpass filter to permit solely the red lightweight wavelength. Another noticed issue is relating to the rising and falling time of the photodiode used. The signal deterioration by increasing information measure should be less intense if a high speed photodiode is employed.

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