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OCC FUTURE AND OBSTACLES UNDER 5G REQUIREMENTS

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نظرة مستقبليه لنظام اتصالات الكاميرا البصرية وفقا لمتطلبات الجيل الخامس

ملخص

يتم إنشاء مواصفات الاتصالات للجيل الخامس (5G) لتلبية الطلبات المتزايدة للشبكات ذات النطاق الواسع والعالية السرعة (أي بضع عشرات من Gigabits كل ثانية). يستمد معيار 5G بشكل أساسي من تزايد عدد المشتركين والعديد من التطبيقات المختلفة ، والتي يشار إليها عادةً بالأجهزة الذكية ، والتي يتم الاتصال بها كجزء من شبكة إنترنت الأشياء (IoT) للحصول على 5G ، بالأضافه الى ذلك بعض التطورات المحتملة التي أظهرت موجات كبيرةوتكون متعددة المدخلات والمخرجات ، واتصالات الخلايا الصغيرة. في حين أن هذه التقنيات ستفي بمواصفات 5G.في الوقت الحالي يتم الاهتمام بنظام الأتصالات الاسلكية البصرية (OWC)وأن نظام الاتصالات الضوئية (VLC) كجزء من (OWC) تعتبر من بين أكثر الحلول المرغوبة لشبكات الجيل الخامس وما بعدها اتصالات الكاميرا البصرية (OCC). كجزء من المدن الذكية المستقبلية ، ان نظام الأتصالات الضوئية بما يمتلك من طيف ترددي واسع مدمج مع إنترنت الأشياء يفتح مجموعة واسعة من التطبيقات الداخلية والخارجية. يقدم هذا البحث وصفا للتطبيقات البصرية لجميع التقنيات المركزية والتطبيقات المحتملة والقضايا التي تتمحور حول OCC وفقالمتطلبات 5G.

Abstract

Telecommunications specifications of the fifth-generation (5 G) are being established to satisfy the rising demands of high-speed broadband networks (i.e., a few tens of Gigabits every second). The 5 G standard derives primarily from a rising number of subscribers and a multitude of various apps, commonly referred to as smart devices, communicating as part of Internet-of-Things (IoT) network For 5 G, a few possible developments such as millimeter waves, large multiple-input multiple-output, and small cell connectivity have appeared. While such technologies will meet 5 G specifications, attention is being given to a complementary potential wireless optical wireless communication (OWC) system. Clear light contact (VLC) as part of OWC. Among the most desirable solutions for 5 G networks and beyond are optical camera communications (OCCs). As part of future smart cities, VLC with huge frequency spectrum integrated with IoT that opens up a broad range of indoor and outdoor applications. This paper gives a description of the VLC-centric all-optical IoT and Potential implementations and issues centered on OCC under 5 G Requirements.

Keywords— *visible light communications (VLC); light-emitting diodes (LEDs); Optical wireless communications (OWC); optical camera communications (OCC).*

1. INTRODUCTION

The fifth-generation (5 G) cellular network is being established as modern architecture for cell networks, rather than just expanding the current 4 G capability and reliability[1][2]. As such, the emphasis of the 5 G specification is on capability improvement, huge networking, and ultra-high (low latency) reliability [1]. Being part of smart cities, they derive primarily from a growing amount of consumers and mobile apps connected to a wireless network in the realm of Internet-of-Things (IoT). Because of the emergence of IoT, 5 G is well placed as the mainstream architecture for global connectivity systems that enable wide-scale, real-time communications with wireless sensor networks and smartphones. Although 5 G has yet to be decided, several of the candidate technologies have emerged: A) Millimeter-wave (MMW) technology, which aims to significantly improve spectrum performance, especially base stations, by utilizing a carrier frequency in the range of 30-300 GHz [3].

The mm MAGIC project [4] has recently been active in exploring and designing new radio connectivity technologies on the 6-100 GHz MMW frequency ranges, intending to grow efficiency and data speeds. Therefore, a detailed description of MMW's main study fields, channel design, network engineering, usage case, and 5 G issues is illustrated B) Large multi-input multi-output (MIMO) capable of supplying hundreds of uplink and downlink ports using thousands of antennas to maximize efficiency by a factor of 22 or more. C) Small cell base stations providing relay-based signal transmitting capabilities all MMW base stations. And wireless consumers. The specifications in the design of communication networks to help IoT complexity and cost-effectiveness; (ii) availability of resources; (iii) service efficiency and reliability; (iv) transmitting range; (v) protection and (vi) low power consumption. IoT reflects the physical computer network, sensors inside smart environments and their interconnectivity enables artifacts to interact and share data among themselves [5]. When the IoT model opens the doors to technologies that lead to object-to-human experiences it allows smart communities, infrastructures, and utilities to boost the quality of life and greater resource use. As part of the smart home ecosystems, the radio frequency (RF) and Android-based IoT is introduced for home automation systems [6]. In [7], a body detector based on a Raspberry Pi camera utilizing passive infrared sensors and computer vision was proposed for security use. A survey on IoT technologies for outdoor conditions such as traffic monitoring and accident warning system was introduced in [8], which offers a clever way to manage the traffic and address the issues involved an increasing number of multimedia-capable and internet-connected mobile devices have requested extremely efficient and high-speed access for both indoor and outdoor applications during the last decade [1].

Those demands get much bigger. By using sophisticated coding and multilevel modulation schemes as well as spatial variation, modern RF-based communications have so far become the dominant technologies to satisfy these demands. However, with the slowdown in the achievable spectrum performance, the RF spectrum has largely reached its saturation level[5]. Optical wireless connectivity (OWC) is conceived as a possible solution to congested RF-based networking networks as a next-generation communication network that could provide high-speed and secure data transfer in a particular application in both indoor and outdoor environments[9, 10]. This paper intends to provide a summary of the development, processes, issues, and challenges in OWC-based OCC as part of 5G wireless networks, which is termed as optical IoT (IoT). The remainder of the paper is organized as follows. Section 2 introduces OWC, while Section 3 describes the proposed optical IoT. Section 4 describes the OCC applications and challenges and finally, the conclusions are drawn in Section 5.

2. OPTICAL WIRELESS COMMUNICATION

The widespread implementation of mobile devices in urban environments (i.e., households, workplaces, commercial halls, and computer (D2D communications) device to device communication as a consequence of evolving IoT is a significant obstacle for service providers of communication networks to deliver cost-effective and high-quality wireless networking infrastructure [11].

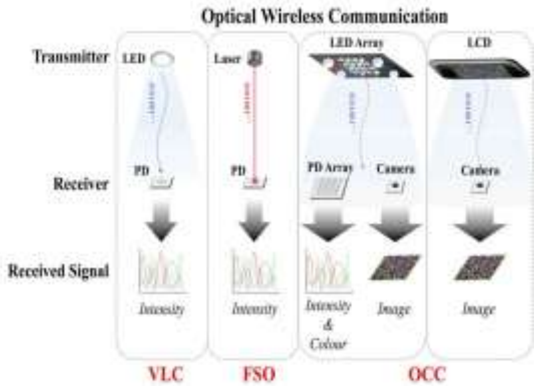

Figure1. Optical wireless communication schemes [10]

VLC is an evolving platform, planned for the 5 G networks. This utilizes light-emitting diode-based lighting fixtures and photodetectors (PDs) to provide data contact and illumination in indoor environments concurrently with potential expansion to outdoor areas as well[12]. Remember that the observable wavelength range of ~370-780 nm has a huge ~400 THz bandwidth. This is 10,000 times that of the Bandwidth [13]. Additionally, the VLC technology provides inherent physical layer (PHY) protection, RF electromagnetic interference immunity, and free licensing [10]. The LEDs deliver many advantages over current lighting infrastructures, such as lower power usage Longer life expectancy, better energy performance, lower maintenance, lower heat production characteristics, and faster-switching speed (higher-order magnitude)[10]. Therefore, it can be told, "VLC technology might reach IoT's dots use smart LEDs." The VLC will allow true IoT as most consumer smart devices come with LEDs and cameras that can be used to communicate data and locate indoors [14].

On the other hand, we have seen smart devices with built-in high-resolution, compatible metal-oxide-semiconductor (CMOS) cameras over the past few years [15]. These CMOS cameras record high-definition videos with a size of at least 1280= 720 pixels and a frame rate of 30 fps [16, 17], and is more than appropriate for low-speed applications. Since of the broad variety and growing quality of cell phones, smartphone

VLC may be appealing because nearly all device users bring it effectively and using camera-based optical receivers daily. Not only smartphones but even the bulk of latest generation mobile devices have built-in CMOS cameras capable of taking images and videos, as well as being used for data connectivity (low-speed), indoor position, and range findings [16, 18].

The mobile or camera-based VLC has been researched within the OWC context and is deemed a contender for the standard IEEE802.15.7rl and is referred to as OCC [19, 20]. OCC represents an extension of VLC with the benefit of no external hardware to create low data rates and indoor positioning of D2D communications [20]. Like traditional VLCs that use PDs as the receiver, OCC uses a CMOS cell phone camera as the receiver [17]. This is, OCC collects two-dimensional data in the form of image series, allowing more details to be conveyed relative to VLCs based on photodetectors. As part of the fourth industrial revolution, i.e., the OCC technology is seeing phenomenal strides in key application., IoT, autonomous cars, and so on[21, 22].

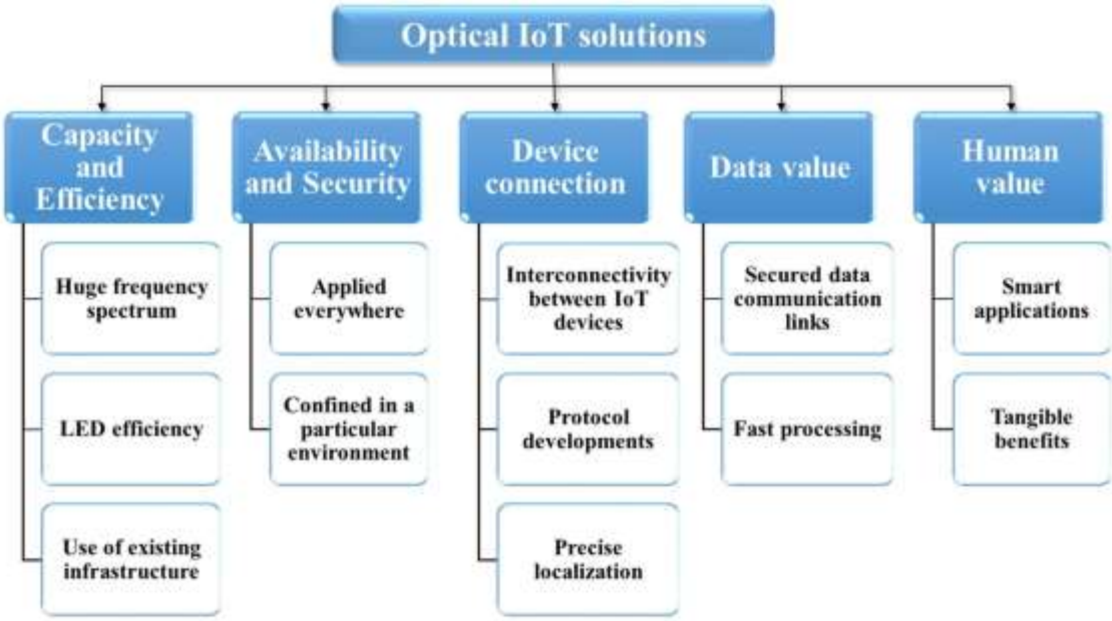

Fig. 2. Optical internet of things solutions [10]

3. OPTICAL INTERNET OF THINGS

VLC with a large, IoT-frequency spectrum will open up a wide variety of applications for both indoor and outdoor environments [23]. Illustration. 2 highlights the main aspects of optical IoT as illustrated below: 1) Efficiency: the RF range (3 kHz–300 GHz) is congested owing to the growing demand for high-speed wireless communications, resulting in latency.

The visible light range (400 THz to 780 THz) gives significantly higher bandwidth orders than the RF, which can be used successfully in IoT networks [24]. Furthermore, lightweight and portable OIoT VLC modules will conveniently be built into the current lighting system. Furthermore, lightweight and portable OIoT VLC modules will conveniently be built into the current lighting system. LEDs are renewable lighting systems that are commonly used worldwide owing to the strong power output of 80 percent relative to conventional lights [25]. The latest U.S. article. Department of Energy notes that energy efficiency will be reached by up to 217 terawatt-hours (TWh) by the year

2025, utilizing LED-based lighting technology [26].

Flexibility and safety: The visible light-based OIoT framework can be built by re-using the ubiquitous lighting network with only a few additional modules (Modulation panel, a digital-to-analog converter, and moving circuit) that may be used in LED lighting systems. Because of the fast development of the LED industry, the cost of the VLC transceivers is projected to be high.

Security is a significant problem in RF communication because RF signal may penetrate walls and other artifacts, thereby jeopardizing the protection of the connection at the physical level Unlike RF, light signals may be contained to a small well-defined range, both indoor and outdoor, rendering eavesdropping virtually impossible unless the receiver is inside the transmitter's field of view. Therefore, the light produced by LEDs is appropriate for the atmosphere if the amount of lighting is below the prescribed minimum.

3) *System connection*: interconnectivity between different optical IoT devices can be established by following the most effective transmission algorithm to ensure smooth contact as mobile devices travel about within a certain transmission range [27]. Relayed related OIoT could be introduced for a longer range. Besides, under IEEE 802.15.7[28], protocol improvements for the PHY, Media Access Control (MAC), and upper-layer architecture to improve link efficiency are analyzed.

On the other side, a mixture of VLC and OCC devices with very good positioning precision can also be leveraged for indoor localization [29]. Using the LED lighting close to the global positioning system, indoor orientation, and localization was done. The findings of the experiment in [30] display a mean positional error of less than 1.7 cm using an indoor VLC dependent positional method dependent on multiplexing exposure to the orthogonal frequency section.

4) *Information value*: Safe connections to data transmission may be established using visible light as the OIoT carrier signal. The fresh, rapid and effective VLC adaptation techniques were examined in [31] to increase the signal-to-noise receiver (SNR) ratio and to reduce the time taken

5) Human value: Developing cost-effective, environmentally friendly, and efficient OIoT within smart environments (i.e., homes, hospitals, industries, cities, etc.) would be possible, which offers higher speed and safer communications. In IEEE 802.15.7[28], the PHY and MAC used to optimize the bond strength of a short-range VLC are issued. To boost versatility in channel distribution, freedom to connect asynchronously, improved anonymity, and expanded network efficiency, a VLC framework utilizing spectral amplitude coding optical code division multiple connect was proposed[43].

Using a camera picture sensor, OCC can identify signals from LED monitors and screens that serve as transmitters in public areas such as airports and rail stations, shopping malls and shops, where details on products and advertisements can be conveyed to consumers using signage [44]. Recently, OCC and VLC dependent motion detection to relay the control signals inside smart home environments and the networks clustered in color [38] were observed. Photo processing is of utmost significance for the demodulation of the obtained data in the form of picture frames collected in OCC. It is therefore important to provide robust and accurate algorithms and schemes for image processing. Neural networks (NN) have drawn tremendous focus in recent years to solve difficult problems linked to visual recognition and pick relevant search results [47]. In addition to image processing, the usage of an artificial neural network (ANN) equalizer in VLC has contributed to improved data levels by the effect of inter-symbol interference caused by multipath [48]. Authors in [49] studied the transmission of an NN related case for an Internet of Multimedia Things (IoMT). NN has been used to process image occurrences to retrieve attributes and to track artifacts to reduce the sophistication of the period. NN in the form of trained neurons often plays a significant role in the identification of motion over established indoor OCC connections, as seen in [50].

Deep learning-focused transceiver architecture for multicolored VLC systems has been suggested in [51]. In the sense of VLC, an optical neuron principle centered on the multilayer perceptron scheme[52] was applied to equalize the incoming signals depending on the samples obtained within the classification process Inside IoT-enabled networks, feasible OCC implementations could be IoT and smart home networks focused on LED lighting, handheld auto-cell, vehicle-to-everything (V2X), smart security systems, etc. Besides, the OCC is fitted with an add-on and fascinating feature of motion detection [16] along with data communication and lighting, called camera movement, which can also be used as a tool of camera movement.

A selective capture (SC) based optical camera vehicle-to-vehicle (V2V) contact was introduced in [21], taking into account different camera capturing techniques. The SC methodology has been developed and applied to resolve one of the most important problems in OCCs with low data speeds notwithstanding numerous advantages and enticing features as

4. ISSUES AND APPLICATIONS OF OPTICAL CAMERA COMMUNICATION SYSTEM

The optical IoT solutions listed in Section 3 will help to deliver various applications both indoor and outdoor. Using sophisticated techniques such as multi-carrier synchronization, multiplexing of the wavelength division, and equalization the data rate can be increased to a few Gbps[24]. Machine to machine (M2 M) MIMO OWC-

well as many factors that render the VLC implementation difficult such as networking when driving, multiuser assistance, dimming, shadowing and confining to a specific geographical region. The problems in OCC are low frame rate, timing, and shot noise, distortions in viewpoint, misalignment, and blurred images.

based communications are demonstrated in [32] as field trials at the BMW robot research site. Whereas effective D2D communications were explored in an indoor setting over a transmission range of 1 m and an extended distance of up to 3.5 m utilizing an optical repeater in[33].

Figure. 3 Shows OCC implementations inside different ecosystems. Initially, high-speed VLC may be used in areas where Wi-Fi access is restricted or low, i.e. hospitals (access

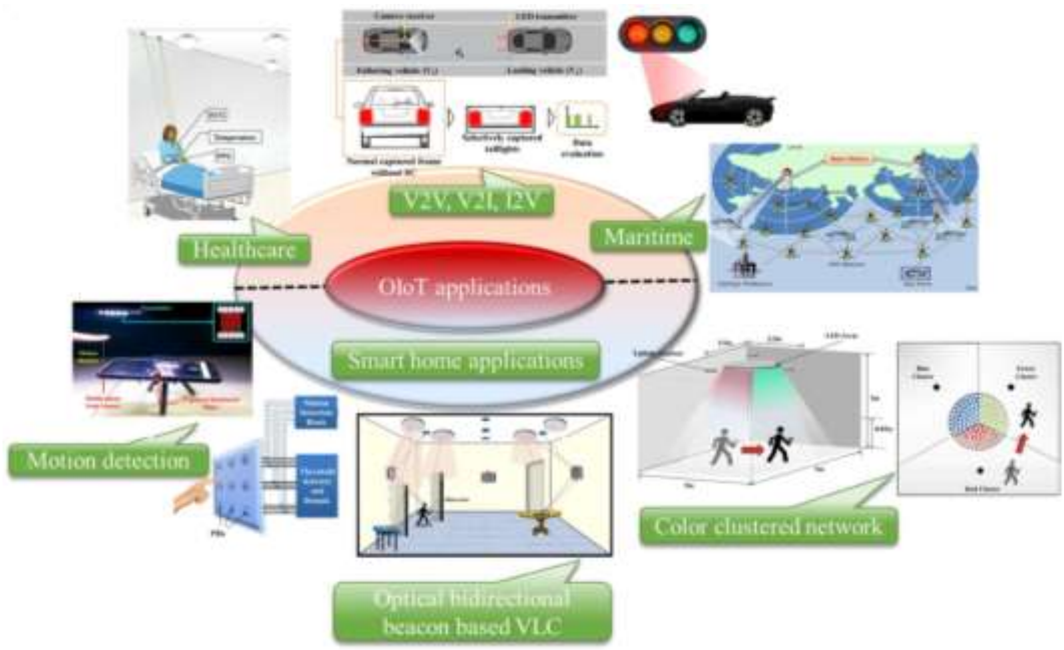

Figure 3. Optical camera communication applications [10]

to advanced medical equipment, so-called body-placed sensors).

The OCC solutions listed in Section 3 will help to deliver various applications both indoor and outdoor. Using sophisticated techniques such as multi-carrier synchronization, multiplexing of the wavelength division, and equalization the data rate can be increased to a few Gbps[24]. Machine to machine (M2 M) MIMO OWC-based communications is demonstrated in [32] as field trials at the BMW robot research site. Whereas effective D2D communications were explored in an indoor setting over a transmission range of 1 m and an extended distance of up to 3.5 m utilizing an optical repeater in[33]. Figure. 3 Shows OCC implementations inside different ecosystems. Initially, high-speed VLC may be used in areas where Wi-Fi access is restricted or low, i.e. hospitals (access to advanced medical equipment, so-called body-placed.

5. CONCLUSION

A description of the optical IoT networks has been given in this paper. The research centered primarily on future implementations and problems for optical IoT networks under 5 G requirements based on VLC and OCC. Given the strong potential of optical communication systems to allow the next phase of wireless communication networks, i.e., 5 G, we based our discussion on potential applications. The planned OCC is intended to encourage reliable and efficient VLC and OCC networks to provide high-speed networking in urban cities in the form of greener, simpler, and healthier communications technologies. The recent developments in OCC-based VLC and OCC that pave the way for the implementation of OC networks to realize cost-effective and productive smart ecosystems Our upcoming research works will address the problems presented for VLC and OCC systems as part of the more optical IoT networks.

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