

Convocatoria de I Premios del Capítulo Español conjunto del IEEE en Comunicaciones y Procesado de señal al mejor Trabajo Final de Máster (TFM) y mejor Tesis Doctoral (PhD) en Comunicaciones y Procesado de Señal

El jurado de los premios ha resuelto conceder los premios siguientes:

PREMIO MEJOR TESIS DOCTORAL EN PROCESADO DE SEÑAL

Nombre: Juan Parras Moral

Título de la Tesis Doctoral: Adversarial detection games in network security applications with imperfect and incomplete information

Abstract:

This Ph.D. thesis deals with security problems in Wireless Sensor Networks. As the number of devices interconnected grows, the amount of threats and vulnerabilities also increases. Namely, in this thesis, we focus on two family of attacks: the backoff attack, which affects to the multiple access to a shared wireless channel, and the spectrum sensing data falsification attack, which arises in networks which try to make a decision about the state of a spectrum channel cooperatively.

First, we use game theory tools to model the backoff attacks. We start by introducing two different algorithms that can be used to learn in discounted repeated games. Then, we motivate the importance of the backoff attack by showing analytically its effects on the network resources, which are not shared evenly as the attacking sensors receive a larger part of the network throughput. Afterwards, we show that the backoff attack can be modeled, under certain assumptions, using game theory tools, namely, static and repeated games, and provide analytical solutions and also algorithms to learn these solutions.

A problem that arises for the defense mechanism is that it is possible that the agent is able to adapt to it. We then explore what happens if the agent knows the defense mechanism and acts in such a way that it is able to exploit the defense mechanism without being discovered. As we show, this is a significant threat to both attacks studied in this work, as the agent is able to successfully exploit the defense mechanism: in order to alleviate this attack, we propose a novel detection framework that is successful against such attack.

However, we can even develop attack strategies that do not need the agent to know the defense mechanism: by means of reinforcement learning tools, it is able even to exploit a possibly unknown mechanism simply by interacting with it. Hence, these attack strategies are a significant threat against current defense mechanisms.

We finally develop a defense mechanism against such intelligent attackers, based on inverse reinforcement learning tools, which is able to successfully mitigate the attack effects.

PREMIO MEJOR TESIS DOCTORAL EN COMUNICACIONES

Nombre: Ahmad Adnan Moh'd Shafeq Qi'dan

Título de la Tesis Doctoral: Blind Interference Alignment for Visible Light Communications based on the network topology

Abstract:

Visible light communication (VLC) is a wireless optical technology through which baseband signals are transmitted using illumination sources such as the light emitting diodes (LED). Compared to traditional radio frequency (RF) wireless technologies, VLC occupies an interval of the electromagnetic spectrum between 400 THz and 800 THz, and hence it may provide high data service in very high density scenarios. Furthermore, VLC does not interfere with any RF device and it has low cost and low power consumption.

Notice that, VLC networks provide both illumination and communication simultaneously. Each light source illuminates a confined area. Moreover, an indoor environment is typically composed of several LEDs that provide uniform illumination.

Therefore, the main drawback of VLC technology is the interference. In this sense, the transmit precoding (TPC) schemes typically proposed for RF systems can be considered. However, TPC schemes require accurate Channel State Information at the Transmitter (CSIT), which similarly to RF systems results challenging to achieve in VLC. Recently, a scheme referred to as Blind Interference Alignment (BIA) was proposed as a means of achieving a growth in degrees of freedom (DoF) regarding the amount of users served avoiding the need for CSIT. BIA is based on the use of a reconfigurable antenna at the receiver side, which can select a channel response among a set of linearly independent responses. The implementation of BIA for VLC may provide several advantages such as no need for CSIT, ensuring a positive transmitted signal and no correlation among the channel responses of the users. In this sense, each user must be equipped with a special optical receiver referred to as reconfigurable photodetector in order to provide linearly independent channel responses. However, the implementation of BIA for VLC networks is not straightforward. Typically, VLC scenarios comprise a large number of transmitters serving multiple users, which in turn cause degradation in the performance of BIA, specifically, due to the inherent noise increase and the channel coherence block requirement. This dissertation investigates the problem of enhancing the performance of VLC networks in absence of CSIT through BIA schemes. First, the implementation of BIA schemes for VLC is analyzed introducing the concept of the reconfigurable photodetector. After that, we first propose several BIA schemes based on the network topology with aim of overcoming the limitations of BIA schemes in the state-of-art. Assuming a uniform VLC network, two BIA schemes are proposed based on the network topology given by the connectivity of users. The simulation results demonstrate a significant increase in the user rate compared with traditional BIA assuming full connectivity between the users and all the transmitters of the network. Moving to non-uniform VLC networks, different cell formations methodologies are derived following both network centric (NC) and user centric (UC) approaches, which divide the VLC network to several static and elastic clusters, respectively. For UC, each cluster is composed of several transmitters merged according to the deployment of optical transmitters and also to the distribution of the users. The proposed combination of UC cell formation and BIA schemes provide higher user rates compared with TPC schemes such as the minimum mean square error (MMSE) or zero-forcing (ZF). Moreover, the proposed scheme is more suitable for VLC networks than the traditional BIA scheme in terms of noise enhancement and channel coherence requirements.

Secondly, a hybrid VLC/RF network is considered in this work. That is, the VLC systems may operate together with a RF systems such as WiFi in the same scenario. In this sense, BIA is considered for the VLC network while OFDM is proposed for the RF tier. We consider vertical handover from VLC to WiFi for the users that would otherwise penalize the performance of the VLC network. Moreover, load balancing techniques are proposed in order to maximize the overall network rate. Thus, we investigate two load balancing (LB) algorithms referred to as centralized and decentralized solutions. The centralized algorithm provides an optimal solution with high computational complexity that increases exponentially with the number of transmitters and users. Conversely, the decentralized algorithm is proposed in order to formulate a more tractable optimization problem while providing a sub-optimal solution with less complexity.

Finally, the resource allocation (RA) problem is investigated for different network typologies in VLC based on BIA schemes. Notice that, uniform resource allocation is not the optimal solution to allocate the resources of the network. This is because not all the users need to use their resources fully. In this sense, we propose an optimal algorithm to allocate the resources for each user within a specific cluster. Although the proposed algorithm calculates the optimal bandwidth for each user, it is not practical given its high complexity even for a low number of transmitters and users. Alternatively, a sub-optimal algorithm is proposed with the aim of reducing the complexity. For this algorithm, the users play an important role for solving the resource allocation problem by sharing the resources required to satisfy their demands from their corresponding transmitters. The results show noticeable improvement for VLC networks.

Y han resuelto dejar desiertos los premios a mejor trabajo final de master en procesamiento de señal y en comunicaciones.

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