TEL AVIV UNIVERSITY אוניברסיטת תל-אביב
FACULTY OF ENGINEERING הפאקולטה להנדסה

**Amir Weiss,**
**Ph.D. student under the supervision of Prof. Arie Yeredor**

# Digital Signal Processing Techniques for Performance Enhancement of Electro-Optical Communication Systems

## Abstract

Electro-optical communication has become a significant part of the communication field in recent years, due to the appealing physical properties of the optical domain, such as practically unlimited bandwidth and low signal attenuation, combined with an increasing demand for faster communication of larger data volumes. Along with its excellent qualities for this purpose, the optical domain poses new technological challenges, induced by its unique physical properties, which warrants new creative solutions for problems arising in this context. At the same time, digital signal processing (DSP) techniques are developing rapidly along with the proper electronics required for their application. It is therefore only natural to combine these two worlds in order to overcome some of the problems which arise in the field of digital electro-optical communication.

In this work we address two fundamental problems related to digital electro-optical communication systems, using orthogonal frequency division multiplexing (OFDM) as the modulation technique. The first concerns the most common electro-optical modulator, known as the Mach-Zehnder Interferometer (MZI). The MZI has a non-linear transfer function which, when using high power signals, degrades the communication system's performance due to loss of orthogonality (the underlying working principle in OFDM) caused by the non-linear distortion. The second concerns the limitation induced by the transmission (and detection) of an electrical information signal modulating the light's intensity in non-coherent optical communication systems, therefore necessarily confined to be real-valued non-negative.

We use DSP tools in order to manipulate the information signal such that the overall system's performance, in terms of symbol error rate (SER), is enhanced. The first problem is addressed by applying digital pre-distortion, assuming a known statistical model of the information signal. The second is handled by a solution based on an iterative detection algorithm, which exploits a slightly modified transmission scheme, rather than using the classical scheme.

Both analytical and simulation results are presented, where for both problems the ultimate goal is an improvement in the SER curve; in the context of the first problem (which will not be presented at the seminar), the mitigation of the non-linear distortion is expressed by the ability to increase the signal power while maintaining the same level of distortion (induced by

the nonlinearity) compared to other methods; In the context of the second problem (which will be presented at the seminar), our proposed scheme enables to reduce the required transmitted optical power (compared to classical methods) while meeting the standard performance specifications.