

## Abstract

The purpose of the invention is the utilization of inactive subcarriers in orthogonal frequency division multiplexing with index modulation (OFDM-IM) systems to avoid deep fading sub-channels in frequency selective channel. The invention provides an alternative solution for legacy coding techniques that have been used to mitigate the effects of deep fading sub-channels in frequency selective channel for most of the practical OFDM-based systems.

In the invention, the inactive subcarriers in an OFDM-IM symbol are utilized to avoid deep fading subchannels in frequency selective channel by aligning the OFDM-IM symbol circularly according to channel state information (CSI) at the transmitter. Before the alignment procedure, interleaving is employed to distribute the inactive subcarriers randomly. Therefore, deep fading subchannels are aligned with the frequency bands of inactive subcarriers, because deep fading does not directly affect the inactive subcarriers. Thus, the invention provides a significant gain in bit error rate (BER) performance in frequency selective channel without any data rate reduction.

## Problem solved with the technology

In wireless communication, deep fading channels create a major problem for signal transmission in frequency selective channel. The power of the transmitted signal can decrease dramatically by deep fading channels and this causes errors in detection of data symbols. The invention solves the problem of the deep fading channels by aligning the OFDM-IM symbol according to the channel state information (CSI).

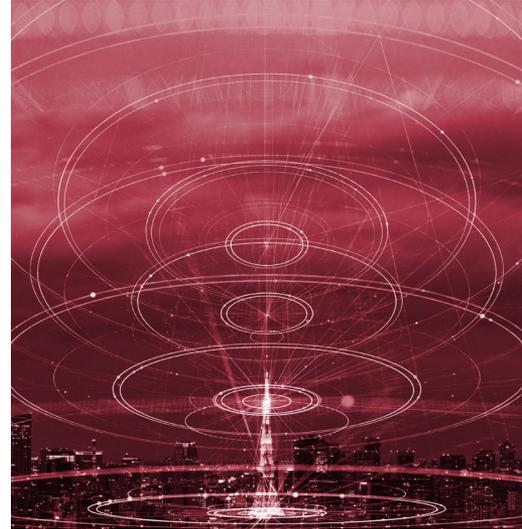
In the OFDM-IM symbol structure, unlike classical OFDM, a number of selected subcarriers are not used for signal transmission. Therefore, IM creates unused frequency bands in the frequency domain and they are utilized for avoiding deep fading sub-channels by an alignment circularly. On the other hand, coding techniques provides a solution with data rate reduction in OFDM-based systems.

The invention provides a solution for deep fading problem without any data rate reduction as being differently from the coding techniques that have been employed for most of practical wireless communication systems.

The invention can achieve less computational complexity from coding techniques.

Coding techniques can also be deployed for OFDM-IM systems. However, the invention can achieve more spectrum and energy-efficient communication without coding and data rate reduction in OFDM-IM systems.

Due to knowledge of the CSI at transmitter, the invention provides more secure communication than coding techniques.



## **Potential Application**

In wireless communication, the systems that they employ OFDM-IM as an enhanced modulation technique to OFDM can use the invention to avoid deep fading sub-channels in frequency selective channel. The invention requires the CSI at transmitter. Especially, machine-to-machine communication systems of 5G wireless networks are potential usage case for the invention. The companies that they have contributed wired/wireless communication standards.

## **Customer Benefits**

The invention offers a solution for deep fading problem without any data rate reduction as being differently from the coding techniques that have been employed for most of practical wireless communication systems. The invention can achieve less computational complexity from coding techniques. The invention provides more secure communication than coding techniques.

## **Market Trends**

Machine-to-Machine (M2M) Connections market size maintains the average annual growth rate of 4.69% from 18300 million \$ in 2014 to 21000 million \$ in 2017, The analysts believe that in the next few years, Machine-to-Machine (M2M) Connections market size will be further expanded. We expect that by 2022, The market size of the Machine-to-Machine (M2M) Connections will reach 26405 million \$.  
([www.marketwatch.com](http://www.marketwatch.com))

## **Additional Technical Information**

**Patent Info:** TR2018/20553

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