Ph.D. in Information Technology: Thesis Defenses

July 10th, 2019

Room Seminari – 2.00 pm

Hamid ASLANI - XXX Cycle

"Printed Patch Antennas for Modern Wireless Communication Systems"

Abstract:

The increasing demand for higher bandwidth and higher speed wireless communication motivates the exploration of modern wireless communication. Ultra-wide band (UWB) technology is one of the most promising solutions for future communication systems due to the high data rate and excellent immunity to multi-path interference. Also, The IEEE 802.11ad and IEEE 802.11ay operating on 60 GHz mmWave are the two most expected wireless local area network (WLAN) technologies for ultra-high-speed communications. The 802.11ad standard (WiGig) provides throughput speeds of multi-Gb/s covering tens of meters by offering a wide beamforming channel in 60GHz ISM band channel.

In the proposed work, we will focus on both the above-mentioned technologies. As a first approach, a novel wide band microstrip patch antenna (MPA) configurations that can be used for UWB applications with enhanced performance is designed and discussed. The impedance bandwidth of the proposed antennas has been enhanced by using techniques such as patch slotting, as an improved technique. An impedance bandwidth between 5 -11 GHz has been achieved. The antenna performance has been characterized in terms of the reflection coefficient, peak gain and radiation characteristics.

We also present an efficient microstrip patch antenna (MPA) with superstrate Technique. The antenna configuration can be used for UWB applications. Based on the problem of interference in modern wireless communication systems. the proposed work has been extended in order to design an efficient UWB antennas with band rejection characteristics at WLAN band of 5.2 GHz. The Simulations were performed using different EM software such as Ansys HFSS which uses the Finite Element Method (FEM) and Finite-Difference Time-Domain method (FDTD). We follow the strategy as the first step by designing patch antenna operating in Ultra-Wide Band (UWB) frequency range and the next step, the UWB antenna is embedded with anisotropic filter structure (SRR) which has been demonstrated and its band rejection properties has been shown.

A numerical investigation and analysis of a high-gain printed antenna arrays is performed for mm-waves wireless applications. The structure presented based on microstrip arrays antennas, the proposed antenna is designed for 60GHz high gain backhaul transceiver systems. An array structure has been also proposed to cover 360 degree. In order to analyse and validate the electromagnetic performance of these antennas, a numerical analysis was performed by ANSYS HFSS, which employs the Finite Element Method (FEM).

Kapal DEV – XXX Cycle

"Synthesis of Attenuation Time Series Across FSO Link for the Design of a Backhauling Solution for 5G Networks"

Advisor: Prof. **Carlo Capsoni**

Abstract:

FREE Space Optical (FSO) communication is one of the most widely researched technology due to its very interesting characteristics such as high data rate, free license, no electromagnetic interference, light weight, small volume, secure due to narrow laser beam, portability, and low power consumption. However, some limitations due to weather dependency occur which include scattering and absorption, caused by gases and various hydrometers, fog being the most challenging issue which majorly impact on the performance of the FSO link. From the application perspective, we know that in order to provide 5G technology opportunity to users to utilize extremely large bandwidth need the use of a dense network with mini base stations at short range (few 100 meters) which could be connected in two ways i.e. wired or wireless. Solving backhaul connectivity is critical before any 5G small cell deployments can scale up. There is no way to even consider adding wired backhaul drops to thousands of sites in an urban environment which will be expensive require more time and physical efforts. In this respect, FSO links can handle the scale, they are easy to deploy, very large capacity and represent an economic solution over a distance of 100 meters. It is essential that operators planning for high density small cell deployment seriously consider FSO as an option before 5G rollouts begin. In order to use FSO for backhauling, our proposed work is very useful in providing the methodology to generate synthetic attenuation values of signal fading and its characteristics over different low visibility conditions even before the deployment. This research work is directed to propose a procedure for a synthetic attenuation time series synthesizer for low visibility events along terrestrial free space optical links useful for 5G backhauling networks design. To this aim, preprocessing for correct use of data had been done which includes identifying the low visibility events with optimal approach, bias removal on average and event basis, and identifying the best time integration value for all three databases. Later, it is demonstrated that visibility is suitable to derive attenuation time series on a slow time sampling but for fast time sampling, a general statistical technique is proposed. After doing an extensive literature, we selected a procedure for the development of a time series synthesizer among the ones proposed for mm wave and modified the procedure with the introduction of visibility time series at the input instead of using large set of attenuation time series. Also, fast variations obtained through the statistical technique will be superposed to slow fading which made the predicted synthetic attenuation time series more accurate. Finally, after executing detailed step by step procedure, synthetic attenuation time series is constituted by a synthetic component (Fast Fading) each superposed to a component obtained by manipulating measured data (Slow Fading). Large database of measured data collected at Politecnico di Milano and in other two experimental sites of the Europe are considered to validate the proposed work. We tested our procedure on all the events from the different sites and compared synthetic time series attenuation with the measured one on a statistical basis. This testing is based on number of indicators: mean value, standard deviation and RMSE. Overall, we found an excellent result as 88.88% events have 1 dB/km and 0.5 dB/km in terms of difference in mean and standard deviation respectively and RMSE difference is within the 1.5 when considering that it represents the

comparison of actual measurements on event basis with a statistical model based on the data from two sites. The performance of the proposed work is excellent in reproducing moderate visibility conditions in the presence of fog (with 88.88% accuracy), rain (100% accuracy) is found. In the case of Milan and Prague, the full model of generating the synthetic attenuation series is applicable and it gives very good results. Unfortunately, considering Milesovka, it works only on generating the slow fading attenuation time series because the measurements were of low sampling rate which doesn't allow us to identify fast variations. The proposed procedure can be in principle applied to any location provided visibility time series (very simple and inexpensive to collect) are available where the optical link is required to set up.

PhD Committee:
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