ABSTRACT

Ph.D. Thesis

FRESNEL REFLECTION BASED FIBER OPTICAL SENSOR SYSTEM DESIGN AND TRANSMISSION OPTIMIZATION USING RELAY ASSISTED FREE SPACE OPTICAL COMMUNICATION

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In this thesis, the Fresnel reflection based fiber optic sensor array, that is able to measure the refractive index of the liquid in real time, is designed and the experimental characterization is performed. The optimization for the transmission time that provides the multiplexing of the pulses for the sensor array design in the optical fiber is realized. In the measurements which is carried out in the laboratory, the salt concentration changing with the refractive index inside the water, the degree of compliance to linear equation is obtained as 1, proves the accuracy of the measurement system. Besides, in this study the refractive indices of the different solvents are measured in high resolution and the results are compared with the values given in the literature. It is shown that, the short and long term stability perfomance is high for the designed measurement system.

The data, received from the Fresnel reflection based fiber optic sensor system, is able to be transmitted to the remote receiver via the relay assisted free space optical (FSO) communications systems. For this purpose, the performance analysis for the transmission distance of the FSO communications system is also studied. In this study, the outage probability for the relay assisted FSO communications systems in different configurations is analyzed under atmospheric turbulence and path loss effects. Based upon this point, an optimization problem for the transmission distance is defined, and this problem is solved using Differential Evolution (DE) and Particle Swarm Optimization algorithms with Matlab™ programming language. In the normal conditions, the maximum transmission distances for an outage probability which is in acceptable level, are obtained by utilizing the estimation of the optimal relay locations with the help of the simulations (software programming). Furthermore, the comparative performance analysis is carried out in detail for these two algorithms in FSO communications systems.

Key words: Atmospheric turbulence, DE, Fiber optic sensor, Fresnel reflection, FSO communication, Outage probability, PSO, Refractive index, Relay-assisted transmission.

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