Propagation model of the optical wave through dense fog in an urban environment

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The optical wireless communication system provides short horizontal links between buildings in urban environments. A basic system operates through atmospheric channel with line-of-sight communication links. The horizontal links often perform poorly in adverse weather conditions such as fog and low clouds. Because the size of a fog droplet is relatively close to the optical wavelength, fog droplets can modify light propagation characteristics or completely hinder the passage of light through a combination of absorption, scattering and reflection. The purpose of this study is to model the optical propagation channel in different fog conditions.

Fog droplets impede link performance by reducing available power at the receiver. We study the propagation channel characteristic by comparing the forward intensity of the received signal. A modified pulse vector radiative transfer equation is used to obtain the specific intensity of the received signal. The equation is solved numerically using the radiative transfer code. Our study focuses on the attenuation and the wave distortion of the received signal. The phase delay from multiple-scattering paths causes the distortion in the optical wave. The wave distortion induces error in the detection, and therefore, limits the throughput of communication. We relate the effects of dense fog with the wave distortion in the time domain. Understanding this relationship will provide the critical information necessary to design a system to improve the link performance. In this study, we also applied a simple solution of adjusting system parameters such as the receiver field-of-view and the receiver detection threshold to mitigate the wave distortion, hence reducing the degradation in the link performance.