Mobile Ubiquitous Free Space Optical Communication Systems using White Light Emitting Diodes

By

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ABSTRACT

The primary objective of this research work was to develop a ubiquitous free space optical (FSO) network with scalable distance-bandwidth and bandwidth-density products using a multi-hop approach. The overarching technology goal of this research is to design and develop simultaneous illumination and communication dual usage systems based on high power light emitting diodes (LED) based general light sources. Some of the current technology gaps include: (a) balancing line of sight (LOS) in conjunction with increasing data rates at larger distances, (b) mitigating noise from natural and human-made signals at the receiver, (c) achieving symmetric communications with differing output levels from illuminators and receivers, etc. Some of the barriers for FSO technology are: Line-of-Sight (LOS), Bandwidth, Network Security, Mobility and Bit-Error Rate (BER). In this project, we addressed some of the barriers by using the characteristics of optical signal transmission through free space and the operating features of high power LEDs and large area semiconductor solar cells acting as the photodiode. We have been able to successfully design and demonstrated an *ubiquitous,* single-hop, *mobile, non-LOS* system that communicated at *50 kbps up to a distance of 6 m.* In our system design, we used (a) white and blue high power LEDs (120° divergence,1-Watt power), (b) bi-directional communication using LEDs as simultaneous emitter & photodetector (*large diode capacitance remains an issue*), (c) large area solar cells as photo-detectors and (d) MOSFET based switching circuit for modulating high flux LEDs. FSO research has been an active area for a long time. Most of the prior research involved invisible light sources (infrared) and for out-door communication systems using high power lasers. The scope of the current project was different since we investigated the feasibility of high flux visible illumination sources that have significantly different modulation and transmission characteristics for communication purposes. High Bandwidth Internet and LAN connectivity using solid-state lighting could be potential applications using our concepts demonstrated in this thesis.