ABSTRACT

This thesis conducts an in-depth investigation of the differences between classical and quantum communication channels based on free space optics (FSO), especially the differences in the distribution and characteristics of FSO channels when classical and quantum communication is performed. This research is important because FSO is one of the candidate technologies for sixth generation (6G) networks. However, the differences between classical and quantum communication channels are not widely known, so this lack of knowledge makes it difficult to design the structure of the transmitter and receiver. In addition, the performance comparison between the capacity of classical and quantum channels is also unclear, so this uncertainty raises doubts in the development of quantum communication.

This thesis investigates and analyzes a various of classical and quantum channel models. Computer simulations are used to analyze the capacity of each channel model with fair parameters. The classical channel model assumes that atmospheric turbulence factors are expressed into the irradiance distribution, specifically analyzed through computer simulation and analytically using the closed-form expression. The quantum channel model, due to its difficulty and lack of references, is analyzed by assuming that atmospheric turbulence factors are expressed in terms of probability error of the received information. Basic channel models in classical information theory, such as the binary symmetric channel (BSC) and binary erasure channel (BEC), are also discussed to provide insight into the comparison of classical and quantum channel capacity.

This thesis succeeded: (i) classified a various of classical and quantum communication channel models for FSO, (ii) created closed-form expression to accurately calculate classical channel capacity, (iii) found that turbulence exerts a strong negative influence on channel capacity, and (iv) quantum channels have greater capacity than classical channels. Analysis of quantum channel capacity shows that no quantum channel model has experienced an extreme decrease in capacity to zero. In fact, as many as 4 out of 6 quantum channel models never reach zero capacity. The results of this thesis are expected to contribute to the development of classical and quantum FSO communication systems for 6G generation networks.

Keywords: FSO, classical channel models, quantum channel models, channel capacity.