Visible Light Communications for Healthcare Applications

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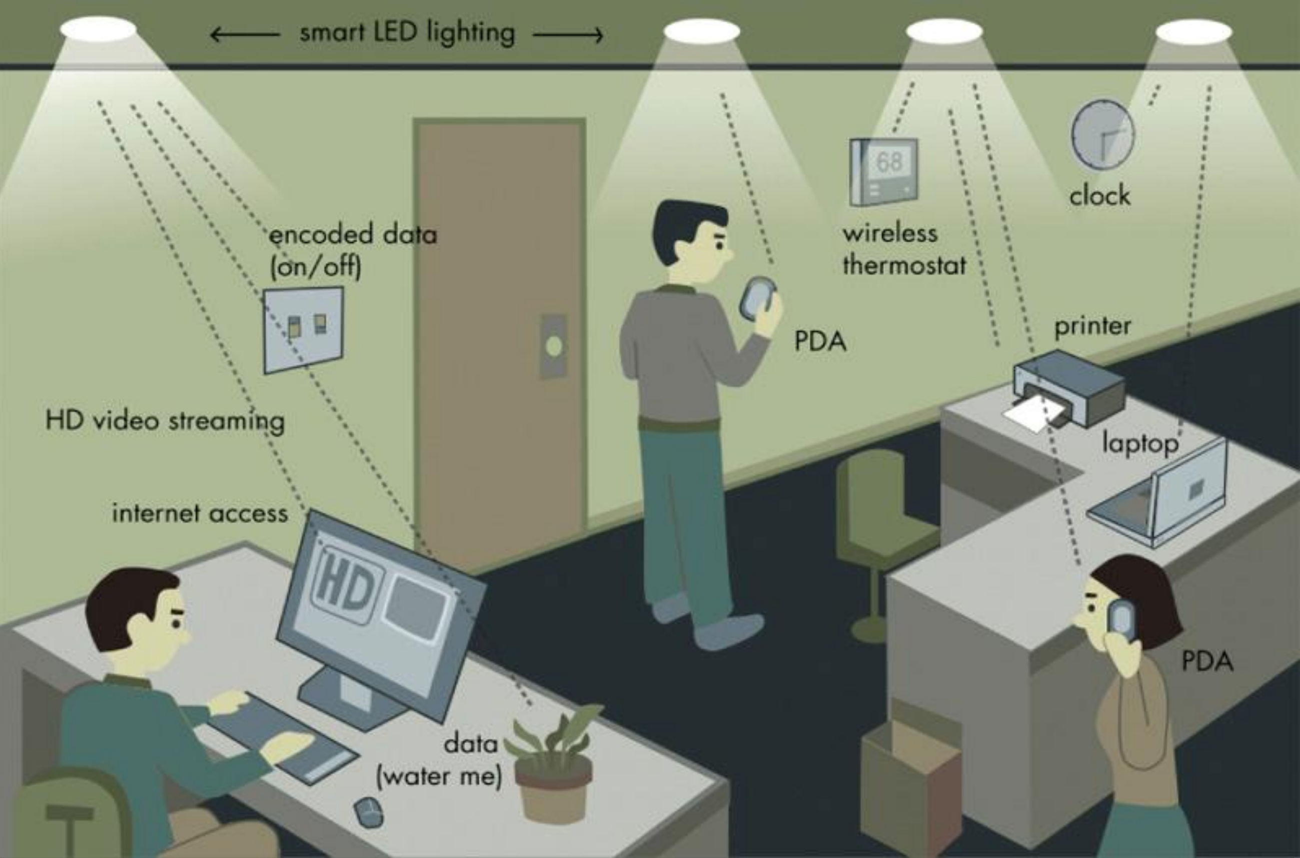

Fig.5: VLC system application

Summary:

- *VLC can provide better quality of healthcare service which agrees with contemporary healthcare management directives.*
- *Sun light can affect VLC system reliability, availability and performance.*
- *LED layout design can improve LEDs for illumination and communications purposes.*
- *VLC system reliability and availability are measured through indces to simulate most possible operations scenarios.*

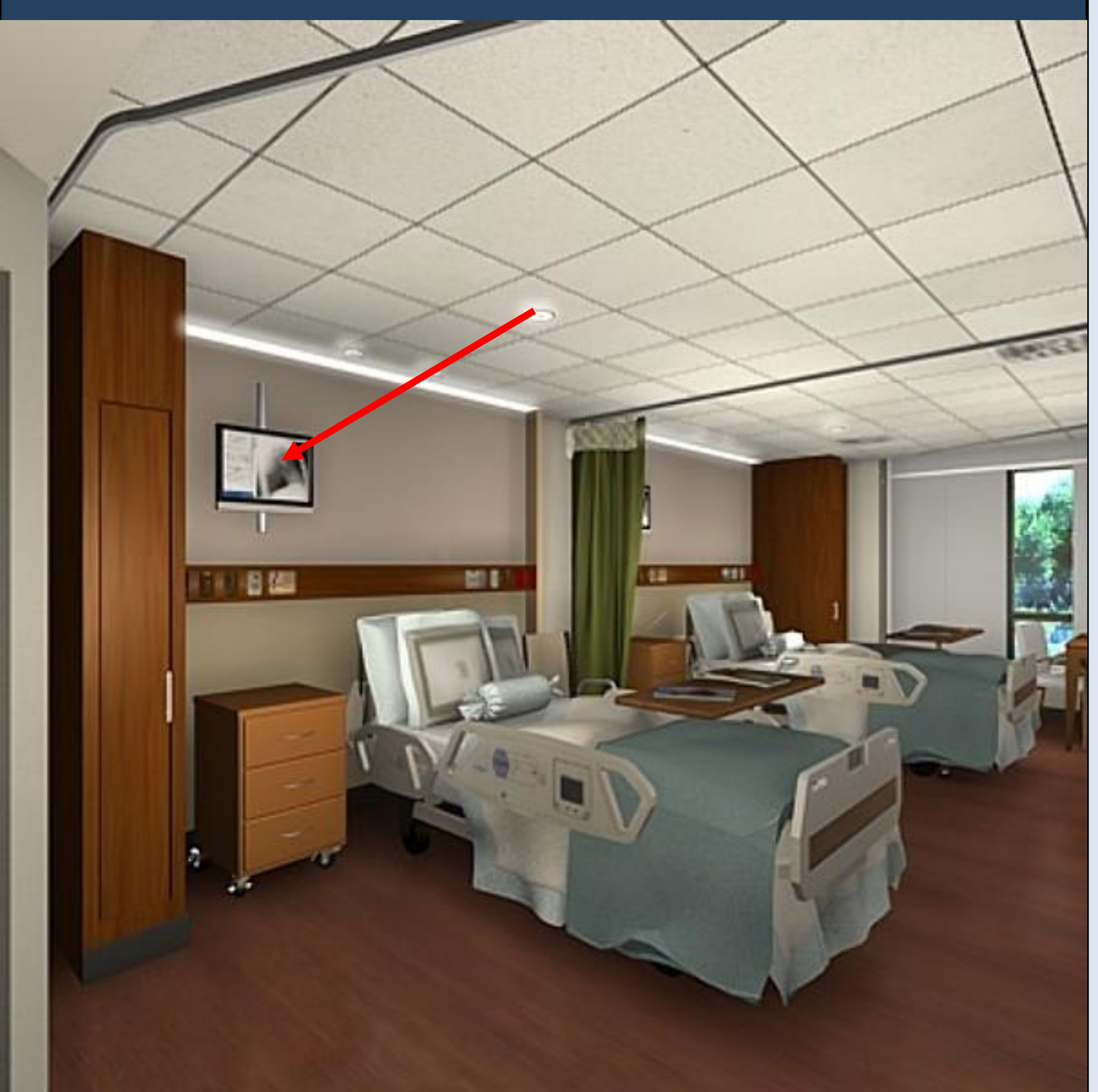

Fig.6: VLC system application

1- Introduction and Motivation

Visible Light Communications (VLC) is fast becoming an attractive alternative communications platform to both optical fiber and radio frequency (RF) implementations, because of its low cost, ease of deployment, license free spectrum operation and freedom from interference. With VLC system, lighting used for illumination is overlaid with a wireless communications capability. Radio frequency communications in the licensed band can provide higher capacity but spectrum licenses are expensive while RF in the unlicensed band is limited in bandwidth; both licensed and unlicensed band interferes with existing networking and indeed sensing infrastructures.

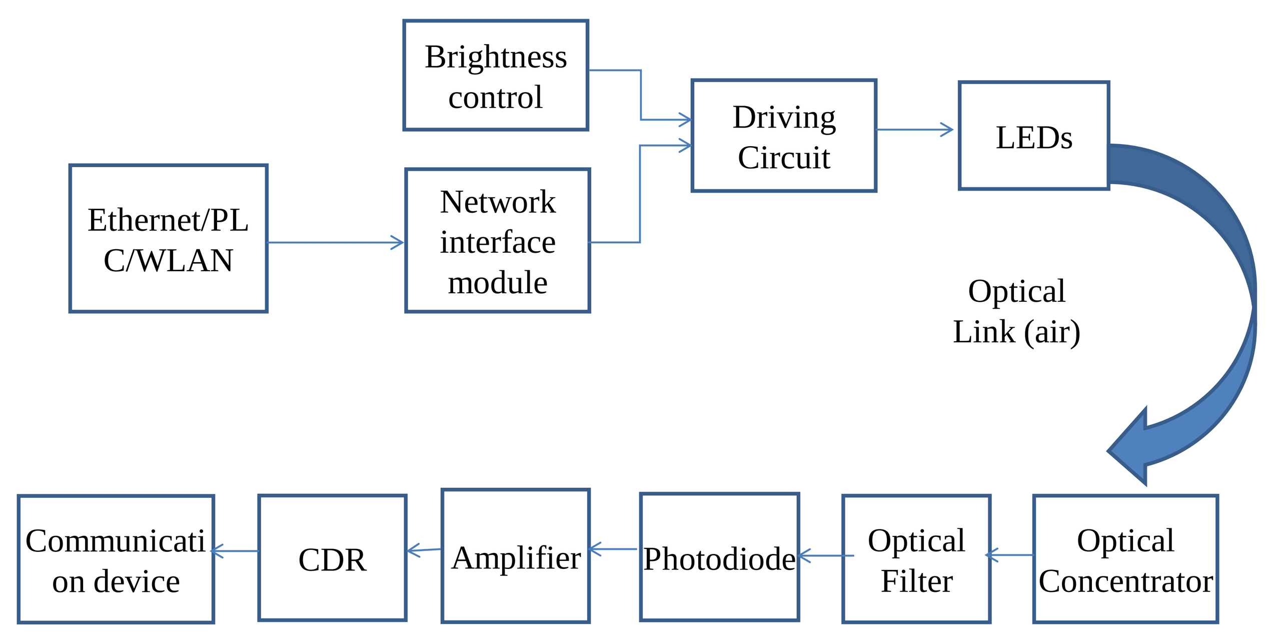

Fig.1 VLC communication System Block diagram

The research will report on the modelling of VLC system performance within intensive care environments for healthcare services/applications with particular focus on the characterisation of multipath reflection as a function of different room dimensions.

This analysis is the starting point that will lead to determining the feasibility of a reliable and high-speed wireless communication system for healthcare environments which will enable amongst other services, wireless monitoring of patients without interfering with core biomedical instrumentation. The research will evolve to address system reliability especially in relation to the impact of sunlight (as noise source).

1.Sun light impact

VLC system is threatened by the sun light as major source of noise, direct and indirect sunlight are highest level in the visible light band as shown in Fig.2. Sun light can affect system reliability and availability. Due to this high level of noise direct and indirect sunlight can provide , system designer consider possible scenarios and levels of sun light all over the year. This could affect BER and data rate that VLC system offer. Moreover it highlights the system reliability, availability and performance importance for this technology.

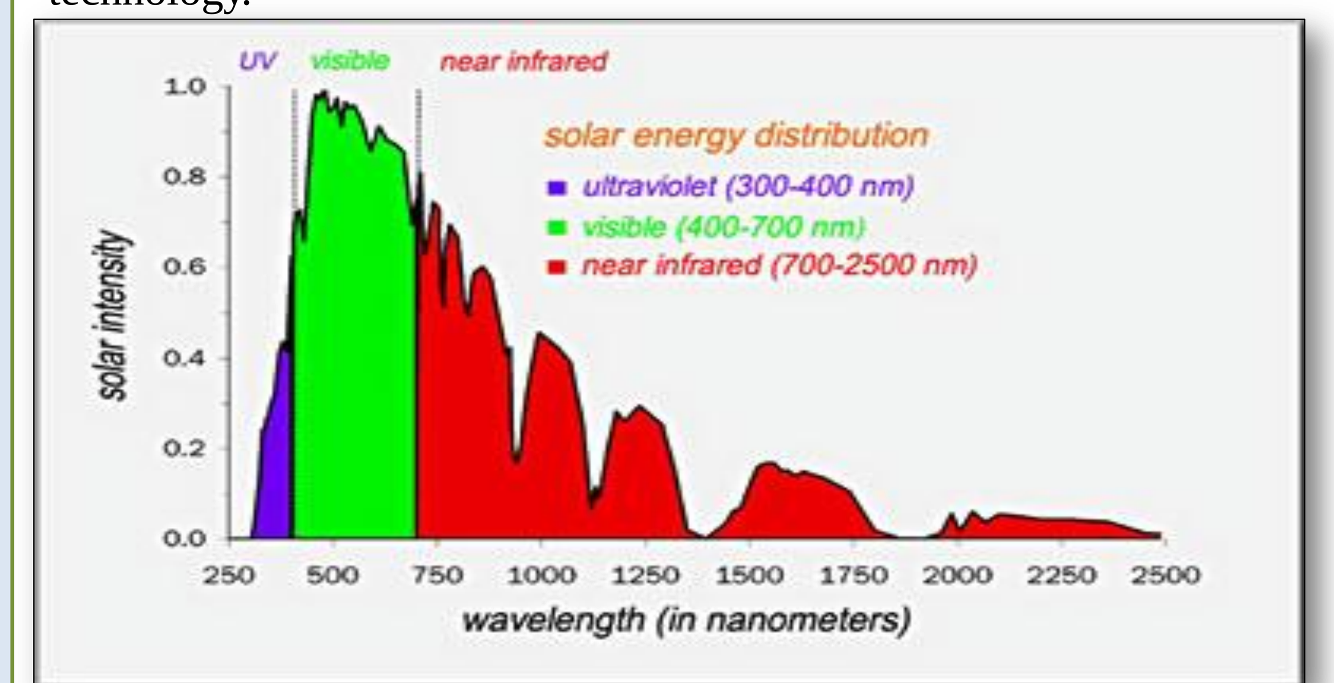

Fig.2 Sun light spectrum

2. Multiple reflections

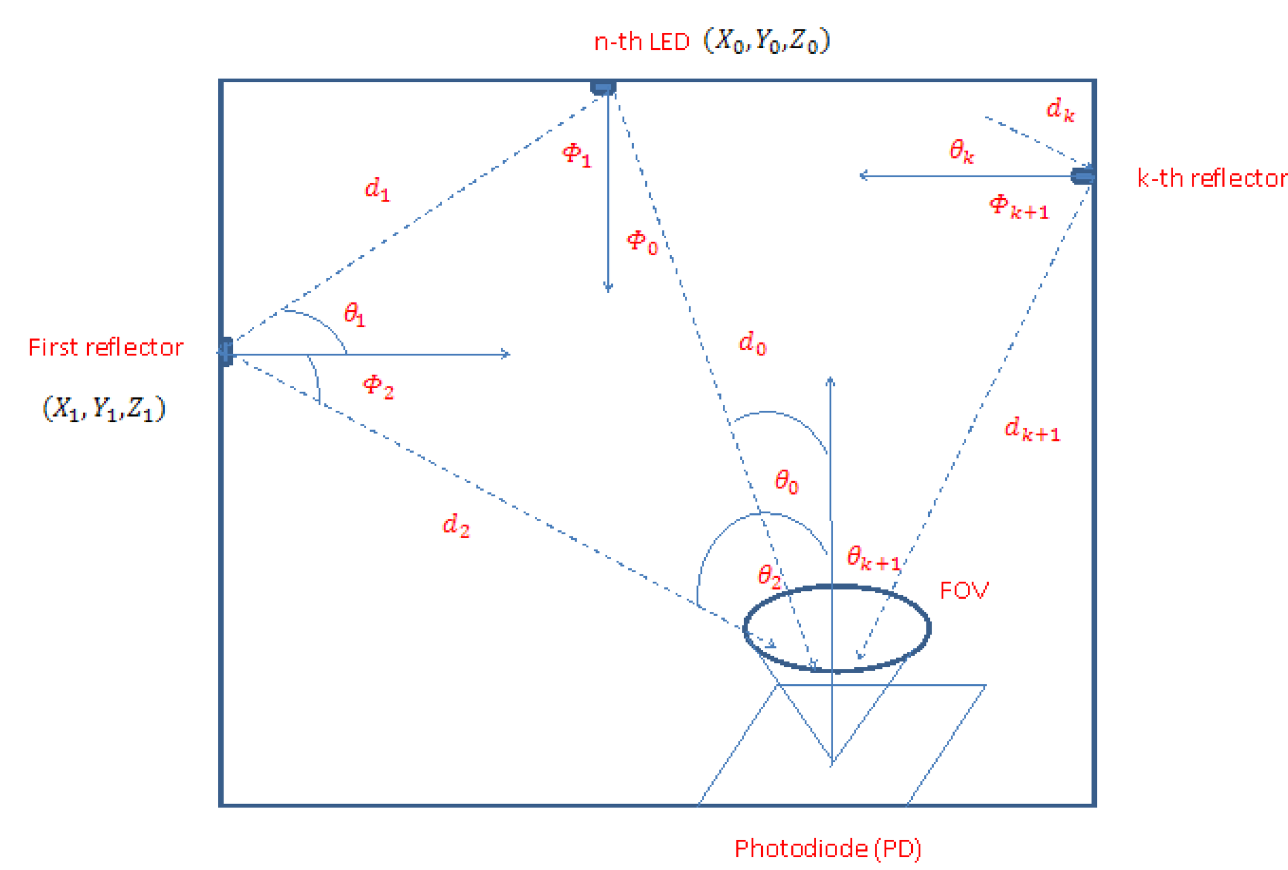

Fig.3 Geometry of the n-th LED and PD with reflectors

In designing a model for healthcare applications, beds dimensions, biomedical devices used, room layout were considered. Optical rays have multiple reflections (different reflective indices) in way from transmitters to receivers. Link geometry shown in Fig.1 is considered to calculate impulse response of multiple bounce of optical rays with multiple optical source the impulse response is given by

$$h(t) = \sum_{n=1}^{N_{LED}} \sum_{k=0}^{\infty} h^{(k)}(t; \Phi_n)$$

Where N_{LED} is the total number of LEDs, and we assume that the transmitted power from each LED has equal power. The response after k-bounces to the n-th LED source

$$h^{(k)}(t;\Phi_n) = \int_S \left[L_1 L_2 \ldots\ldots L_{K+1} \Gamma_n^{(k)} rect\left(\frac{\theta_{k+1}}{FOV}\right)\right] \times \delta\left(t - \frac{d_1 + d_2 + \cdots d_{k+1}}{c}\right) d_{A_{ref}}, k \geq 1$$

Where

L_{k+1} represent path-loss terms for each path.

$\Gamma_n^{(k)}$ in denote the power of reflected ray after k- bounces

S is the surface of all reflectors, and $\mathcal{A}$ref is the area of the reflecting element.

3. Reliability Analysis:

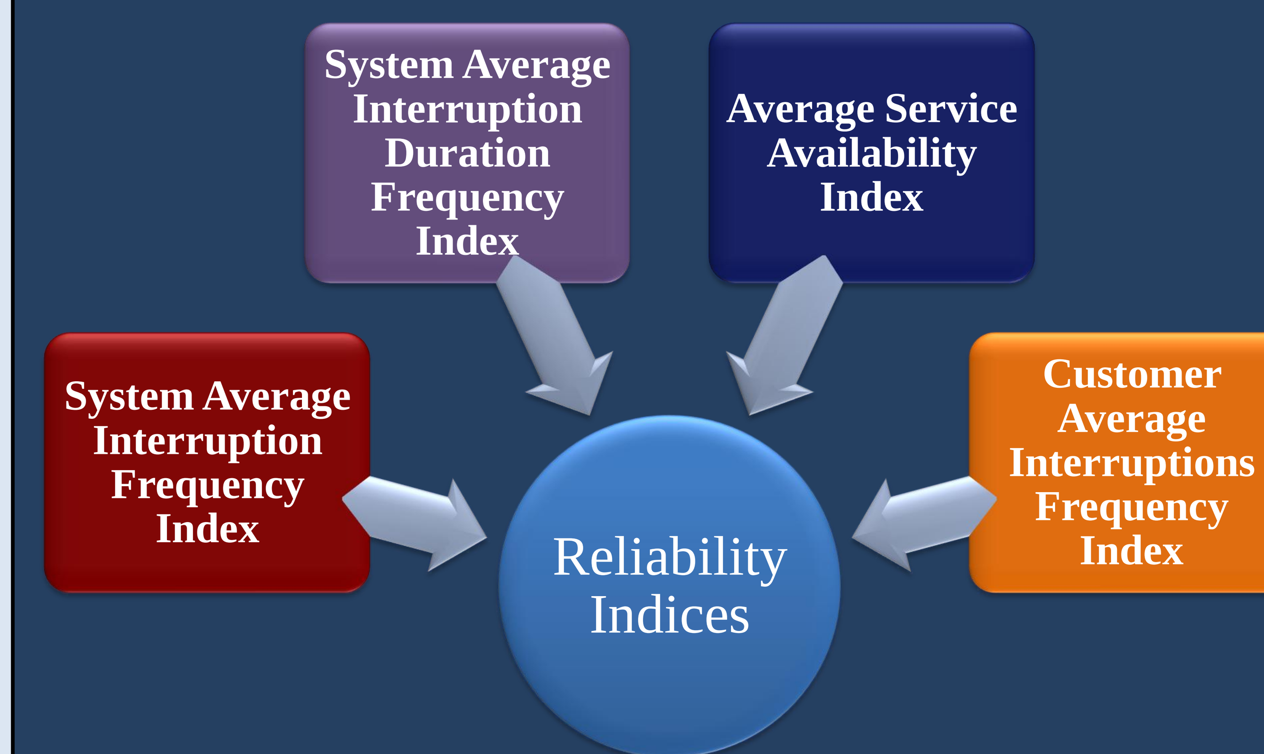

Fig.4 Reliability indices

Reliability analysis of visible light communication system focuses on the system's weak points from different communications scenarios. This analysis gives a good prediction way for communication system planners to work on offering a reliable communication system free of interruptions to all customers. This analysis is based on simulation of most possible scenarios and evaluates system performance through indices using Monte Carlo simulation technique.