

INDOOR BROADCASTING USING VISIBLE FREE SPACE OPTIC OVER
BROADBAND POWERLINE COMMUNICATION

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Dedicated to my beloved family especially my wife “Samira”, my lovely daughter “Nahal”, my parents and my supportive supervisor – Associate Prof Ir Dr Abu Sahmah Mohd Supa’at. Thank you very much for being supportive, helpful and understanding.

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ABSTRACT

Visible Free Space Optic (VFSO) is a new and attractive technology, which employs visible light generated by white light emitting diode (LED) for optical wireless communications. In addition, it is possible to use ubiquitous powerline cables as a communication medium among other fixed network equipments which is powerline communication (PLC) technology. An integrated system of VFSO and PLC uses existing powerline cables and white LEDs as a communication channel hence it has the advantage of low operating cost and provides easy data transmission. The current integrated system encounters some problems due to PLC multipath, noise, and no practical modeling for white LEDs, which degrades significantly the performance of the whole system. Therefore, this study presents the optimum orthogonal frequency division multiplexing (OFDM) modulating signal power, proper DC biasing point, and LED dynamic range to solve system degradation. Moreover, a practical LED model is also presented, and the performance of the integrated system in terms of OFDM signal power versus bit error rate in the presence of broadband PLC impulsive noise, multipath issue, and additive white Gaussian noise optical channel is studied. Based on indoor applications, the primary purpose for VFSO link is the general lighting designation with the standard brightness level and the secondary purpose is for data transmission. Therefore, to have a high quality VFSO link besides ensuring sufficient horizontal brightness of the place, high data rate of optical communication links with low bit error rate are also achieved. The radiometric parameters of white LEDs using simulation and experiment are reported. Optimum 15dBm OFDM signal power, (3.2V, 350mA) biasing point, and 1Vp-p dynamic range for white LED has the data rate more than 28Mbps/second with the bit error rates lower than 10^{-6} . Moreover, at least 400lx of indoor lighting was also fulfilled. So, the new integrated system is considered as a good alternative for other indoor wireless system counterparts.

ABSTRAK

Nyata Ruang Optik (VFSO), adalah satu teknologi baru dan menarik yang dijana menggunakan cahaya nampak dari Diod (LED) putih untuk komunikasi optik wayarles. Selain itu, mana-mana kabel elektrik boleh digunakan sebagai medium komunikasi dengan peralatan rangkaian tetap yang lain seperti teknologi Komunikasi Talian Kuasa (PLC). Sistem bersepadu VFSO dan PLC menggunakan kabel elektrik yang ada dan LED putih sebagai saluran komunikasi, jadi sistem ini mempunyai kelebihan dari segi kos operasi yang rendah dan penghantaran data yang mudah. Sistem bersepadu yang ada mengalami beberapa masalah berpunca dari PLC jalan berbilang, bunyi bising, dan tiada model yang praktikal untuk LED putih yang merosotkan lagi keseluruhan prestasi sistem. Oleh itu, kajian ini mengemukakan isyarat kuasa OFDM optimum modulasi, DC titik pincangan yang sesuai dan julat dinamik LED bagi membina sistem degradasi. Sebagai tambahan, model praktikal LED juga dibentangkan dan prestasi sistem bersepadu dari segi kuasa isyarat pemultipleksan pembahagian frekuensi ortogon (OFDM) melawan kadar ralat di hadapan bunyi impulsif jalurlebar PLC dan isu jalan berbilang dan saluran optik tambah putih gaussian bunyi bising dikaji. Berdasarkan kepada aplikasi tertutup, tujuan utama pautan VFSO ialah susunan pencahayaan umum dengan kecerahan piawai dan tujuan sekunder adalah penghantaran data. Oleh itu, untuk mendapatkan pautan VFSO berkualiti tinggi selain daripada memastikan kecerahan mendatar yang mencukupi pada tempat hubungan, kadar data komunikasi optik yang tinggi dengan kadar ralat bit rendah juga dicapai. Parameter radiometrik putih LED dengan menggunakan simulasi dan eksperimen adalah dilaporkan. Optimum 15dBm OFDM isyarat kuasa, (3.2V, 350mA) titik pincangan, dan 1 V_{p-p} julat dinamik untuk LED putih mempunyai kadar data lebih dari 28Mbit/saat dengan ralat bit yang lebih rendah daripada 10^{-6} . Selain itu, sekurang-kurangnya 400lx pencahayaan tertutup telah diselesaikan. Jadi, sistem bersepadu yang baru boleh dianggap sebagai alternatif yang baik untuk sistem wayarles tertutup di dalam bangunan yang lain.