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Studi Alokasi Daya pada Komunikasi Cahaya Tampak (Visible Light) dengan Akses Jamak Non-orthogonal = Study of Power Allocation on Non-orthogonal Multiple Access Visible Light Communication

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Abstrak

Implementasi non-orthogonal multiple access (NOMA) pada komunikasi cahaya tampak atau visible light communication (VLC) memberikan akses jamak dengan membagi daya sinyal tanpa pemisahan frekuensi ataupun spektrum warna LED pemancar. Dengan konsep umum fair power, alokasi daya perlu dirancang dengan baik agar semua pengakses memiliki probabilitas kesalahan rendah dalam penerimaan sinyal. Penelitian ini memberikan kebaruan secara khusus yaitu model alokasi daya optimal dan adaptif untuk transmisi multi level downlink sistem NOMA VLC. Kontribusi keseluruhan dibagi atas tiga kategori yaitu formulasi batasan, model alokasi daya optimal, dan model dinamik untuk daya adaptif. Digunakan unilateral M-ary pulse amplitude modulation (PAM) untuk memberikan modulasi orde tinggi dengan sinyal non riil non imajiner yang cocok bagi VLC. Pada kelompok kontribusi pertama, penelitian mendefinisikan batasan penerimaan sinyal dan kapasitas sistem berbasis successive interference cancellation (SIC), menggunakan sensitivitas komponen dan orde PAM. Batasan error diberikan untuk deteksi bertahap SIC sebagai fungsi pengkode konvolusi, modulasi, dan rasio daya. Batasan dasar berbasis orde modulasi diberikan untuk alokasi daya akses jamak SIC. Selanjutnya penelitian mengajukan kontribusi penentuan daya optimal melalui optimasi rasio daya berbasis throughput dengan model Lagrange. Secara analitik solusi optimal diperoleh melalui kondisi Karush-kuhn-Tucker (KKT) untuk dua tipe sistem, yaitu pada best-effort-service, dan quality of service (QoS), dalam bentuk persamaan tertutup dengan kompleksitas rendah. Dalam kontribusi ketiga, penelitian mengajukan model dinamik berbasis sudut dan jarak pengakses sesuai model kanal VLC Lambertian. Model dinamik ini menjadi dasar untuk alokasi daya adaptif dengan estimasi kanal menggunakan extended Kalman filter (EKF). Kinerja setiap skenario dan strategi dianalisis dengan parameter observasi utama adalah error rate (ER) pada simulasi Monte Carlo. Simulasi akhir dilakukan untuk 2, 4, dan 8-PAM, dengan 2-5 pengakses. ER rata-rata 3 pengakses di bawah 10-6 dicapai oleh skema 2-PAM pada SNR di atas 35, oleh skema 4-PAM pada SNR di atas 60, dan oleh skema 8-PAM pada SNR 84. Alokasi dinamik menggunakan EKF dengan parameter sudut membutuhkan waktu proses 1:5 dibandingkan model EKF referensi.

.....Implementation of non-orthogonal multiple access (NOMA) on visible light communication (VLC) permits multiple access by rationing power among the signals for multiple users without splitting frequency or color spectrum on the LED transmitter. On regards to the fair power concept, power allocation needs to be carefully designed so that all users have a low probability of error. This research contributes specifically in proposing models optimal and adaptive power allocation in downlink VLC NOMA with higher order modulation. Contributions are categorized in three, the bounds of VLC NOMA, optimal power model, and dynamic model for adaptive power. Unilateral M-ary pulse amplitude modulation (PAM) is used to produce real and nonnegative signals which suits the system. On the first cathegory, the research defined the bounds of signal discernibility on receiver and system capacity based on successive interference cancellation (SIC), containing components sensitivity and PAM order. Error bounds were defined for the system based on SIC,

containing the convolutional code design, modulation order, and the power ratio. The bounds of power ratio allocation based on PAM order is defined. Secondly the research contributed the proposed the optimal power allocation, using Lagrangian optimization on the power ratio of throughput. Solutions are defined by using Karush-kuhn-Tucker (KKT) condition in closed form low-complexity solutions for two cases, that of best effort service and that of quality of service (QoS). For the third contribution, the research proposed a dynamic model based on user angle and distance, which were parameters of Lambertian VLC channel model. The model served as the core for adaptive power allocation with channel estimation using extended Kalman filter (EKF). Completing the discussion, the research also provided an adaptive power allocation scheme by channel estimation using extended Kalman filter (EKF), based on parameters of user's angle and distance. With error rate (ER) as the main observed parameter, Monte Carlo simulation was conducted for each observation. End simulations involved systems with 2-, 4-, and 8-PAM, serving 2-5 users. On 3 users, average ER below 10-6 was reached on 2-PAM at SNR above 35, on 4-PAM at SNR above 60, and on 8-PAM at SNR 84. Dynamic allocation using EKF with angle parameters has reduced the calculating time of 1:5 in comparison to the refered EKF.