ADAPTIVE CONTROL OF FEED-FORWARD LINEARIZATION FOR LASER NONLINEARITY COMPENSATION SYSTEM

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Dedicated to…

My beloved Family and Friends

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ABSTRACT

Radio over Fiber technology (RoF) is a promising solution to the next generation wireless access network because of its ability to transmit high capacity data and to be cost effective. However, RoF systems are analog systems which are sensitive to noise and distortions. The RoF links need to have good linearity in order to avoid nonlinear distortions. The primary limitation on the performance of the optical transceiver in RoF links is the nonlinearity of the laser source in the transmitter. The laser source nonlinearities generate intermodulation distortion products which can severely degrade the performance of the RoF links. Hence, various linearization schemes are proposed to compensate the nonlinearity of the laser source, such as feedback, predistortion, and feed-forward. Among the linearization technique, feed-forward linearization is considered as the most effective due to its ability to provide broadband distortion reduction at high frequencies, and reduction in all order of distortions regardless of the laser nonlinear characteristics. However, feed-forward linearization is a relatively sensitive scheme, where its performance is highly influenced by changing operating conditions. Hence, the feed-forward linearization system needs to be incorporated with adaptive properties in order to achieve optimization in linearization for more practical implementations. In this thesis, a laser transmitter feed-forward linearization system has been modeled in the commercial software OptiSystem 9.0. The laser transmitter feed-forward linearization system is integrated with the proposed adaptive control system developed in MATLAB through Visual Basic scripting. The results of the co-simulations have achieved significant reductions of over 20 dBm in the third-order intermodulation distortion products for operating frequencies from 5.1 to 5.8 GHz.

ABSTRAK

Teknologi isyarat radio melalui gentian (RoF) merupakan satu penyelesaian yang menjanjikan kepada rangkaian capaian wayarles untuk generasi akan datang. Ini kerana dijangkakan ia mampu untuk menghantar data yang berkapasiti tinggi dan juga keberkesanan dari segi kos pelaksanaan. Walau bagaimanapun, semua sistem RoF ialah analog dan mereka bersifat sensitif terhadap herotan dan hingar. Pautan RoF memerlukan kelinearan yang baik untuk mengelakkan herotan tak linear. Penghalang utama kepada prestasi penghantar-terima optik dalam pautan RoF ialah ketaklinearan sumber laser di pemancar. Ketaklinearan sumber laser menjana keluaran herotan saling modulatan yang boleh merendahkan prestasi pautan RoF dengan tinggi. Oleh itu, pelbagai jenis skim pelinearan telah diwujudkan untuk memampas ketaklinearan sumber laser; antaranya termasuklah teknik suap balik, praherotan, dan suap depan. Antara teknik-teknik pelinearan tersebut, pelinearan suap depan dianggap teknik yang paling efektif oleh sebab keupayaannya untuk membawa pengurangan herotan jalur lebar pada frekuensi tinggi dan pengurangan herotan dari semua tertib tanpa mengira ciri tak linear laser. Akan tetapi, pelinearan suap depan merupakan satu kaedah yang agak sensitif dan prestasinya sangat terpengaruh oleh perubahan keadaan operasi. Oleh itu, sistem pelinearan suap depan perlu dibangunkan dengan sifat ubah suai untuk mencapai pengoptimuman dalam pelinearan bagi pelaksanaan yang lebih praktik. Pada tesis ini satu sistem pelinearan suap depan pemancar laser telah direkabentuk menggunakan perisian simulasi komersial OptiSystem 9.0. Sistem pelinearan suap depan pemancar laser tersebut digabungkan dengan satu sistem kawalan ubah suai yang dibina menggunakan MATLAB melalui penskripan Visual Basic. Hasil simulasi bersama tersebut telah mencapai pengurangan ketara yang melebihi 20 dBm terhadap keluaran herotan saling modulatan tertib ketiga untuk frekuensi operasi antara 5.1 ke 5.8 GHz.