UNIVERSITI PUTRA MALAYSIA

DEPTH FRAME LOSS CONCEALMENT FOR WIRELESS TRANSMISSION UTILISING MOTION DETECTION INFORMATION

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By

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DEDICATION

I dedicate this thesis to my dear beloved parents who have always been so supportive of my education.

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

DEPTH FRAME LOSS CONCEALMENT FOR WIRELESS TRANSMISSION UTILISING MOTION DETECTION INFORMATION

By

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June 2014

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Three dimensional (3D) television systems have received increasing attention, with the remarkable developments of video techniques. Transferring video over wireless channels, which is generally an error prone channel, is very susceptible to the transmission errors. 3D video is more vulnerable to transmission errors than conventional two dimensional (2D) video due to its left and right views. On top of that, existing error concealment algorithms for the 2D videos are not suitable to apply to the 3D video and they may even degrade the quality of the synthesized view in the 3D video.

In regard to quality of the 3D video, the main challenge is to provide a high quality synthesized view for the viewers. It can be achieved considering the structure of the 3D video using proper methods which are designed for the 3D video. In the 3D video transmission, whenever frame loss happens, there is a higher probability of depth frame loss than the colour frame due to less priority of depth frame in the transmission. Proper depth frame concealment should be applied in order to improve perceived quality of the video. Considering high packet loss rate in error prone channels like wireless channels, it is crucial to apply error concealment to compensate the frame losses in the transmission. While a number of algorithms has been proposed to address this issue, most of the existing approaches tend to increase the transmission in terms of sending redundant information regarding error concealment.

In this thesis, the aforementioned issues are addressed. By focusing mainly on concealment of depth frame loss at the decoder, the quality of transmitted 3D video is improved in the synthesised views. Two concealment methods, namely Decision Making based on Pixel Value (DM-PV) and Depth Frame Concealment based on Motion Detection (DFC-MD) are proposed to conceal the depth frame loss in the 3D video transmission. The methods are able to facilitate a frame copy algorithm and a high correlation of colour and depth frames to conceal depth frame loss. The first proposed method, inspired by DM-PV, makes its decision whether to copy the last frame or replacing a blank frame by pixel value of the corresponding frames in the

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colour sequence. The second method also facilitates the frame copy algorithm in the depth sequence, however, the high motion blocks inside the frame that intended to be copied are found and then they will be interpolated; furthermore, the low motion blocks remain unchanged in the frame.

The proposed error concealment method which is based on decision making by pixel value technique can prevent distortion on left and right views. The proposed method is able to improve the quality of video in comparison with frame copy algorithm. The feasibility and performance of the proposed method based on motion detection error concealment is evaluated analytically by considering different packet and frame loss rates. The results are compared with existing 3D video frame concealment methods in terms of PSNR for low depth intensity sequences and the average improvement is about 13%. Moreover, the proposed method can improve quality of video in terms of SSIM in comparison with the existing frame copy method for the 3D sequences with moderate depth intensity.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Sarjana Sains

PENYEMBUNYIAN KEHILANGAN RANGKA KEDALAMAN UNTUK TRANSMISI TANPA WAYAR MENGGUNAKAN MAKLUMAT PENGESANAN GERAKAN

Oleh

MOHAMADREZA RANJBARI

Jun 2014

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Baru-baru ini, sistem televisyen tiga dimensi (3D) semakin mendapat perhatian dengan perkembangan teknik video yang luar biasa. Pemindahan video melalui saluran wayarles, pada umumnya adalah sebuah saluran yang terdedah kepada kesilapan, amat mudah kepada penghantaran ralat. Video 3D adalah lebih cenderung kepada penghantaran ralat daripada video konvensional 2D disebabkan oleh titik paparan kiri dan kanannya. Selain itu , algoritma penyembunyian ralat yang sedia ada untuk video 2D tidak sesuai digunakan untuk video 3D dan ia juga boleh merendahkan kualiti paparan yang telah disintesis di dalam video 3D.

Dalam hal kualiti video 3D, cabaran utama adalah untuk menyediakan paparan yang telah disintesis yang berkualiti tinggi untuk penonton. Ini boleh dicapai dengan mempertimbangkan struktur video 3D dengan menggunakan kaedah yang betul yang direka untuk video 3D. Apabila kehilangan bingkai berlaku di dalam penghantaran video 3D, terdapat kebarangkalian yang lebih tinggi dalam kehilangan kedalaman bingkai daripada warna bingkai kerana kurangnya keutamaan di dalam kedalaman bingkai sewaktu penghantaran. Penyembunyian kedalaman bingkai yang sesuai hendaklah digunakan untuk memperbaiki kualiti video yang diamati. Memandangkan kadar kehilangan paket yang tinggi dalam saluran yang terdedah kepada ralat seperti saluran wayarles, ia adalah penting untuk menggunakan ralat penyembunyian untuk mengimbangi kehilangan bingkai sewaktu penghantaran. Walaupun beberapa algoritma telah dicadangkan untuk menangani isu ini, kebanyakan pendekatan sedia ada perlu menambahkan penghantaran dari segi menghantar maklumat berlebihan melalui ralat penyembunyian.

Isu-isu tersebut dapat ditangani di dalam tesis ini. Dengan memberi tumpuan kepada penyembunyian kehilangan kedalaman bingkai pada penyahkod, kualiti video 3D yang dihantar bertambah baik dalam paparan yang telah disintesis. Dua kaedah penyembunyian iaitu Membuat Keputusan berdasarkan Nilai Pixel (DM -PV) dan Penyembunyian kedalaman bingkai berdasarkan Pengesanan Pergerakan (DFC -MD) telah dicadangkan untuk menyembunyikan kehilangan kedalaman bingkai dalam penghantaran video 3D. Kaedah tersebut membolehkan algoritma salinan bingkai dan korelasi yang tinggi pada warna dan kedalaman bingkai untuk menyembunyikan kehilangan kedalaman bingkai. Kaedah yang pertama dicadangkan iaitu DM -PV

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menilai sama ada untuk menyalin bingkai terakhir atau menggantikan bingkai kosong dengan nilai piksel bingkai tersebut mengikut urutan warna. Kaedah kedua juga membolehkan algoritma salinan bingkai mengikut urutan kedalaman, sekiranya terdapat blok gerakan yang tinggi di dalam bingkai dijumpai, ianya akan disalin dan diinterpolasi, selebihnya blok gerakan yang rendah akan mengekalkan bingkai sedia ada.

Kaedah penyembunyian ralat yang telah dicadangkan yang berasaskan kepada keputusan yang ditentukan melalui nilai piksel boleh mencegah herotan pada pandangan kiri dan kanan. Kaedah yang dicadangkan mampu memperbaiki kualiti video berbanding dengan algoritma salinan bingkai. Kebolehlaksanaan dan prestasi kaedah yang dicadangkan berasaskan kepada penyembunyian ralat pengesanan pergerakan telah dinilai secara analitik dengan mempertimbangkan kadar paket dan kehilangan bingkai yang berbeza. Hasilnya telah dibandingkan dengan kaedah penyembunyian bingkai video 3D yang sedia ada dari segi PSNR untuk urutan intensiti kedalaman yang rendah dan purata pembaikan adalah sebanyak 15%. Walau bagaimanapun kaedah yang dicadangkan boleh memperbaiki kualiti video dari segi SSIM berbanding dengan kaedah salinan bingkai sedia ada bagi urutan 3D dengan intensiti kedalaman sederhana .

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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