AUTOMATIC CLASSIFICATION AND RECOGNITION OF CORAL REEFS FROM UNDERWATER VIDEO IMAGES

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MASTER OF SCIENCE IN ARTIFICIAL INTELLIGENCE
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October 2006

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This thesis presents a new approach to automate the classification and estimation of

coral reef based on computer vision techniques by performing classification and

recognition on digitized video obtained from surrounding reef ecosystem. By knowing

the state of the coral reefs, marine scientist can predict fish yield or determine how the

reef system is coping with the environment in a less tedious and less time consuming

way. In this project, the objective is to classify and recognize a predetermined reef

benthos groups. These groups are alive coral, dead coral, sand and rubble. As for the

alive coral group, possible higher level of taxonomic classification is performed to

discriminate the classes of branching, digitate and tabulate solely based on digital video recording. The research methods and designs are based on a set of computer vision processing tasks such as digital video indexing, image segmentation, colour processing, object detection and scene analysis and description. Based on some experiments, it is proposed to use histogram intersection technique at the initial stage to efficiently extract relevant video frames at certain interval for image analysis. Later, a hybrid model of scene analysis that unifies a scene model and an object model is employed. Scene model controls the enforcement of benthos components relationships whereas the object model carries salient features of benthos categories like statistical texture descriptors necessary for specific class recognition. A process of colour quantization in HSV space is carried out to perform image segmentation for separating the abiotic region (dead coral, sand and rubble) and biotic region (alive coral and others) of an image, facilitating further feature extraction steps. Its effectiveness and practicability had been demonstrated by various experiments that were carried out. A complete system starting from video indexing to the classifying of types of coral reef and generating ground truth data is described by applying the actual samples data taken from selected sites of islands in peninsular Malaysia. In addition to being a comparative study, a set of underwater images is extracted from a video transect to provide a benchmark data set for training, testing and validation of this system. In conclusions, a new automatic method for estimating the reef benthos community group distribution, which significantly reduces the time consume for analysis, and normally used tedious manual estimation technique have been successfully developed.

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PENGKLASIFIKASIAN DAN PENGCAMAN TERUMBU KARANG SECARA

AUTOMATIK DARIPADA IMEJ VIDEO DALAM AIR

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Tesis ini mempersembahkan satu pendekatan baru untuk mengautomasikan
pengklasifikasian dan anggaran terumbu karang menggunakan teknik penglihatan
komputer. Klasifikasi dan pengcaman ini dijalankan ke atas video digital yang
diperolehi daripada persekitaran ekosistem terumbu karang. Dengan mengetahui
keadaan terumbu karang, pakar sains marin boleh meramal hasil ikan atau mengetahui
keadaan kehidupan sistem terumbu karang dengan lebih mudah dan menjimatkan masa.
Objektif utama projek ini adalah untuk mengcam beberapa kumpulan hidupan terumbu
karang yang tertentu iaitu terumbu karang hidup, terumbu karang mati, pasir dan
terumbu batu karang mati. Bagi kumpulan terumbu karang hidup, paras taksonomi yang

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lebih tinggi akan cuba dicam untuk terus menjalankan pengkelasan bagi jenis terumbu karang 'branching', 'digitate' dan 'tabulate' berdasarkan rakaman video digital. Kaedah-kaedah bagi kajian ini adalah berasaskan pemprosesan penglihatan komputer seperti pengindeksan video digital, segmentasi imej, pemprosesan warna, pengesanan objek dan analisis permandangan. Berdasarkan hasil eksperimen, penggunaan teknik persilangan histogram dicadangkan pada peringkat awal bagi mengekstrak rangka imej video untuk dianalisis dalam julat tertentu. Kemudian, satu model analisis permandangan hibrid yang menyatukan model permandangan dan model objek digunakan. Model permandangan mengawal perlaksanaan hubungan komponen hidupan terumbu karang manakala model objek menyimpan ciri bagi kategori kumpulan seperti nilai-nilai statistik bagi pengcaman kelas yang tertentu. Proses 'quantization' warna HSV juga dijalankan untuk mensegmentasikan imej bagi menhasilkan kawasan abiotik (terumbu karang mati, pasir dan pecahan terumbu karang mati) dan kawasan biotik (terumbu karang hidup dan lain-lain) yang seterusnya memudahkan pengekstrakan ciri. Keberkesanan kajian ini didemonstrasikan dalam pelbagai eksperimen yang telah dijalankan. Satu sistem yang lengkap bermula daripada pengindeksan video sehingga pengkelasan dan penjanaan 'ground truth data' dibincangkan dengan menggunakan sampel-sampel data sebenar yang terpilih di beberapa lokasi di pulau-pulau di Semenanjung Malaysia. Untuk menjadikan kajian ini lebih bernilai, satu set imej telah diekstrak daripada transek video sebagai penanda aras bagi latihan, ujian dan pengesahan sistem yang telah dibangunkan. Sebagai kesimpulan, satu kaedah automatik untuk menganggar taburan komuniti terumbu karang yang mampu menjimatkan masa dan tenaga manusia telah berjaya dibangunkan dalam projek ini.

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