TERRESTIAL IMPLEMENTATION OF UNB SUPER CAMERA AND IMPROVEMENTS TO UNB-PANSHARP

Abstract

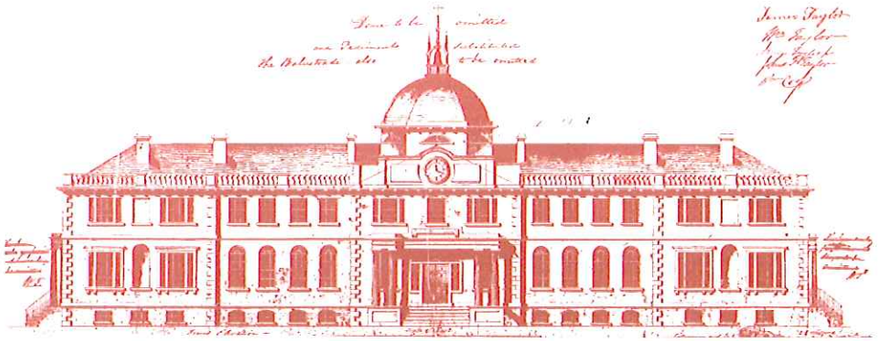
Camera sensitivity is a significant challenge for many imaging applications, especially in low light conditions. Image recognition and presentation in low light conditions is highly dependent on camera sensitivity. Issues acquiring colour images in low light conditions are amplified because of the fact that the colour images are acquired in a narrow spectral band. To address this issue it is possible to collect images in black and white (B/W). The wide spectral coverage of such B/W cameras can improve the sensitivity of the resulting images with the same sensors, but the colour will be sacrificed in this strategy. Using lower resolution colour cameras is another solution to increase the signal-to-noise ratio. In satellite systems, to improve the sensitivity of the images, a pair of high resolution B/W and low resolution colour cameras are used. Fusion of the images of those cameras will result in a high sensitivity and high resolution colour images. This thesis investigates the potential to implement this technology in a terrestrial configuration, using a security camera application as an example.

UNB Super-Camera is a high resolution monochrome camera coupled with a lower resolution colour camera which, when processed using UNB PanSharp technique, produces high resolution colour video. In order to implement UNB Super-Camera for a terrestrial application, a system with four components was designed (data collection, processing, display / storage and framework software). The data collection review included issues associated with the camera, and its associated hardware requirements. Data processing included frame-to-frame co-registration, photogrammetric calibration and orientation that facilitated image fusion, motion detection and tracking and 3D positioning. Data display / storage was facilitated with a standard monitor and computer storage facilities. The key component of the system design and implementation is the framework software which is .NET based and has been designed and developed to facilitate the real-time operation of the UNB Super Camera system. The system was been successfully implemented and the results obtained were assessed as to their quality using the criteria of sensitivity, resolution and colour rendering.

The results of the assessment proved that the UNB super-camera had measurably higher sensitivity and resolution and colour rendering in comparison with the same generation of available high resolution colour cameras, especially in lower lighting conditions.

Despite this improvement, the fused images / videos had colour distortions and stain in very low lighting indoor cases and sunshine condition in outdoor cases. Investigation into these issues showed that the different spectral coverage of the high resolution monochrome camera and low resolution colour camera was the source of the problems. To address the contaminations, four methods -- including Fixed Coefficient, Adaptive Component, Monochrome Correction and Differential Filtering -- were proposed and investigated. Implementation of these strategies showed that the differential filtering method provided the best results. However, all of the methods were successful in recovering the distortions and stains in different lighting conditions, to varying degrees. In addition, the sensitivity, resolution and colour rendering of the results were further improved.

Beside the spectral coverage effects, a debayering issue has also appeared in this project. Debayering effects of the low resolution colour were inherited by the high resolution fused videos. To address this issue, a combined Gaussian debayering and binning strategy was proposed. Although the resulting debayered and binned video was slightly blurred in comparison with the original debayered and binned low resolution colour, the resulting fused video frames using this method led to measurably higher-quality frames. Moreover, this method was computationally faster in comparison with the other methods, which is important in real-time applications.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Sina Adham Khiabani

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Ph.D. Candidate

Sina Adham Khiabani

Graduate Academic Unit

Geodesy & Geomatics Engineering

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July 3, 2015

10:00 a.m.

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Selected Publications:
S. Adham Khiabani, M.R. Mobasheri, M.J. Valadan Zoej, M. Dehghani. "Atmospheric effects' reduction on Spaceborne InSAR products using GPS and MERIS data in order to improve the ground subsidence measurements", National Journal of Geosciences, 2012.

Selected Conference Presentations:
Adham Khiabani S., Y. Zhang and F. Fathollahi, "Image quality assessment of 2-chip colour camera in comparison with 1-chip colour and 3-chip colour cameras in various lighting conditions – Initial results". Conference proceeding in SPIE DSS, Annual conference, Baltimore MD, May 2014.

Adham Khiabani S., Y. Zhang and F. Fathollahi, "Influence of image compression on the quality of UNB pan-sharpened imagery. A case study with security video image frames". Conference proceeding in SPIE DSS, Annual conference, Baltimore MD, May 2014.

Adham Khiabani S., Y. Zhang, "Review and experiment of the different methods for moving object extraction from a live video". Conference proceeding in ASPRS 2012 Annual conference, Sacramento, California, March 2012

Adham Khiabani S., Y. Zhang, "Improvement of background subtraction method for real time moving object detection". Conference proceeding in ASPRS 2012 Annual conference, Sacramento, California, March 2012

Adham Khiabani, S., Zhang, Y., "Depth Extraction of moving objects using a very narrow angel set of cameras." 32nd Canadian Symposium on Remote Sensing. Sherbrooke, Quebec (June 13 -6, 2011)

Adham Khiabani S., M.J. Valadan Zoej, M.R. Mobasheri, M. Dehghani, "Atmospheric effects removal of ASAR-derived InSAR products using MERIS data, GPS" in ISPRS 2008 Congress, Beijing, China