A Study on Image Change Detection Methods for Multiple Images of the Same Scene Acquired by a Mobile Camera

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NOMENCLATURE

Acronyms

CCTVs	**Close-Circuit Televisions**
IR	**Infra-Red**
GPS	**Global Position System**
VMD	**Video Motion Detection**
3DOF	**Three Degrees of Freedom**
PZT	**Pan-Zoom-Tilt**
FFT	**Fast Fourier Transform**
MP	**Morphological Pyramid**
GA	**Genetic Algorithm**
RGB	**Red, Green and Blue**
HSV	**Hue, Saturation and Value**
AIR	**Automatic Image Registration**
UCHR	**Unimportant Changes Removal**
RoiD	**Region of Interest of the Subtracted Image**
SIFT	**Scale Invariant Feature Transform**
IdII	**Indoor Input Image**
NCC	**Normalized Cross-Correlation**
TP	**True Positive**
FP	**False Positive**
FN	**False Negative**
TPR	**True Positive Rate**
FNR	**False Negative Rate**
CPs	**Control Points**
Template_RI	**Human-Made Template**
AIO1_RI	**Area of Interest of Reference Image**

AOI1_II	**Area of Interest of Input Image**
3DOF	**Three Degrees of Freedom**
II	**Input Image for Outdoor Experiment**
ROI2_RI	**New Region of Interest of the AOI1_RI**
ROI2_II	**New Region of Interest of the RAOI1_II**
RAOI1_II	**Registered AOI1_II**
ZKA	**The Zitnick and Kanade Algorithm**
OMI	**Occlusion Map Image**
CMI	**Confidence Map Image**
OMI_II	**Occlusion Map Image of Input Image**
CMI_II	**Confidence Map Image of Input Image**
MSS	**Landsat Multispectral Scanner**
TM	**Landsat Thematic Mapper**
MR	**Magnetic Resonance**
PET	**Positron Emission Tomography**
HDS1_IIs	**First Hybrid Decision-Making System Input Images**
FIS1	**First Fuzzy Inference System**
CHM1_II	**Changed Mask Generated by the First Algorithm**
E_II-1(i, j)	**The Edged Image of the ROI2_II-1**
BW_II-1(x, y)	**The Binary Image of the E_II-1(i, j)**
HDS2	**Second Hybrid Decision-Making System**
FIS2	**Second Fuzzy Inference System**
CHM2_II	**Changed Mask Produced by the Second Algorithm**

ABSTRACT

Detecting regions of change while reducing unimportant changes in multiple outdoor images of the same scene containing fence wires (i.e., a chain-link mesh fence) acquired by a mobile camera from slightly different viewing positions, angles and at different times is a very difficult problem. Regions of change include appearing of new objects and/or disappearing of old objects behind fence wires, breaches in the integrity of fence wires and attached objects in front of fence wires. Unimportant changes are mainly caused by camera movement, considerable background clutter, illumination variation, tiny sizes of fence wires and non-uniform illumination that occurs across fence wires. There are several issues that arise from these kinds of multiple outdoor images. The issues are: (1) parallax (the apparent displacement of an object as seen from two different positions that are not on a line with the object) among objects in the scene, (2) changing in size of same objects as a result of camera movement in forward or backward direction, (3) background clutter of outdoor scenes, (4) thinness of fence wires and (5) significant illumination variation that occurs in outdoor scenes and across fence wires. In this dissertation, an automated change detection method is proposed for these kinds of multiple outdoor images.

The change detection method is composed of two distinct modules, which are a module for detecting object presence and/or absence behind fence wires and another module for detecting breaches in the integrity of fence wires and/or attached objects in front of fence wires. The first module consist of five main steps: (1) automated image registration, (2) confidence map image production by the Zitnick and Kanade algorithm, (3) occlusion map image generation, (4) significant or unimportant changes decision by the first hybrid decision-making system and (5) false positives reduction by the template subtraction approach. The second module integrates: (1) the Sobel edge detector combined with an adaptive thresholding technique in extracting edges of fence wires, (2) an area-based measuring in separating small and

big objects based on their average areas determined once in the calibration process and (3) the second hybrid decision-making system in classifying objects as significant or unimportant changes.

Experimental results demonstrate that the change detection method can identify and indicate approximate locations and possible percentages of significant changes whilst reducing unimportant changes in these kinds of multiple outdoor images. The study has utilized occluded regions in a confidence map image produced by the Zitnick and Kanade algorithm as potential significant changes in the image change detection research. Moreover, the study proves that the use of the Sobel edge detector combined with an adaptive thresholding technique is applicable in extracting edges of outdoor fence wires. In the future, the method could be integrated into patrol robots in order to provide assistance to human guards in protecting outdoor perimeter security.

STATEMENT OF ORIGINALITY

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Date

PUBLICATIONS

Tanjung, G., Lu, T.-F. and Lozo, P., 2009, "A new image change detection method for multiple outdoor images of the same scene containing fence wires acquired by a mobile camera", in Preparation for *International Journal of Advanced Robotic Systems*

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