# Robust Background Subtraction for Quick Illumination Changes

Shinji Fukui[1], Yuji Iwahori[2], Hidenori Itoh[3],
Haruki Kawanaka[4], and Robert J. Woodham[5]

[1] Faculty of Education, Aichi University of Education, 1 Hirosawa, Igaya-cho, Kariya 448-8542, Japan
sfukui@auecc.aichi-edu.ac.jp
[2] Faculty of Engineering, Chubu University, 1200 Matsumoto-cho, Kasugai 487-8501, Japan
iwahori@cs.chubu.ac.jp
[3] Faculty of Engineering, Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Nagoya 466-8555, Japan
itoh@ics.nitech.ac.jp
[4] Faculty of Info. Sci. and Tech., Aichi Prefectural University, 1522-3 Ibaragabasama, Kumabari, Nagakute-cho, Aichi-Gun 480-1198, Japan
haruki@aichi-pu.ac.jp
[5] Dept. of Computer Science, University of British Columbia, Vancouver, B.C. Canada V6T 1Z4
woodham@cs.ubc.ca

**Abstract.** This paper proposes a new method to extract moving objects from a color video sequence. The proposed method is robust to both noise and intensity changes in the observed image. A present background image is estimated by generating conversion tables from the original background image to the present image. Then, the moving object region is extracted by background subtraction. Using color gives more accurate detection than a previous method which used only monochrome data. Color images increase the computational load. The method addresses this problem by using the GPU's throughput. Results are demonstrated with experiments on real data.

## 1 Introduction

Real-time extraction of moving objects from video sequences is an important topic for various applications of computer vision. Applications include counting the number of cars in traffic, observing traffic patterns, automatic detection of trespassers, video data compression, and analysis of non-rigid motion.

Among the segmentation approaches of moving object, "Background subtraction" is the most basic and speedy approach. However, it works well only when the background image has the constant brightness, and fails when the brightness of the moving object is close to that of the background.

"Peripheral Increment Sign" (PIS)[1] is also proposed for the condition in which the illumination is not constant in a video sequence. It is applicable to

L.-W. Chang, W.-N. Lie, and R. Chiang (Eds.): PSIVT 2006, LNCS 4319, pp. 1244–1253, 2006.

the real-time implementation because the filtering process is simple, but the segmentation of the moving object itself is still liable to be affected by noise.

As for the "Normalized Distance"[2], which was proposed to give a better result even with the effect of illumination change, it is also based on the background subtraction, and is liable to be affected by noise and fails when the degree of brightness is low or when the observed one has the similar texture as the background.

In [3], an approach to estimate the background occluded by a moving object is proposed. It uses the texture and the normalized intensity to the effect of the illumination change, because the texture and the normalized intensity are illumination invariant. This approach assumes the linear change of illumination intensity, and is not applied to the nonlinear intensity changes.

On the other hand, the probabilistic approach using mixture Gaussian model are proposed to remove the shadow region of a moving object from the estimated moving region[4]-[6]. These methods need learning process to extract moving objects and are not applied to the quick illumination changes.

This paper proposes a new method to extract moving objects from a color video sequence. The proposed method is robust both to noise and to intensity changes caused by scene illumination changes or by camera function. A present background image is estimated by generating conversion tables from the original background image to the present image. Then, the moving object region is extracted by a method based on background subtraction. Since the background image, which excludes the moving object itself, is estimated from the observed image and the original background image, the method is applicable to nonlinear intensity changes.

The proposed approach uses a color video sequence and gives more accurate detection than our previous method[7] which used only monochrome data. On the other hand, color sequences increase the processing load, in general. The method addresses this problem by using a Graphics Processing Unit (GPU) throughput. Results are demonstrated on experiments with real data.

## 2 Proposed Approach

Figure 1 shows the outline of the proposed approach. The proposed approach consists of two processes. The first process estimates the present background image. The second process extracts the moving objects based on background subtraction.

### 2.1 Generation of Estimated Background Image

Let the RGB color values at $(x, y)$ in the original background image, $BG$, be denoted by $BG(x, y) = (BG^R(x, y), BG^G(x, y), BG^B(x, y))$. Let those in the observed image at time $t = 1, 2, \ldots$, be denoted by $I_t(x, y) = (I_t^R(x, y), I_t^G(x, y), I_t^B(x, y))$. The region with no moving objects at time $t$ is defined as the background region, $A_t$.