Motion Game: Wipe Out the Bubbles

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ABSTRACT

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TEOH LIP KI

This project is to design and develop a webcam based motion game in real time with applying skin color detection method. There are four stages in developing this program which include capture images, render the bubbles on the captured images, developed the image processing function and detect the skin color feature, and determine interaction between the user's movement and the bubbles. This program can determine whether there is any interaction between user's movement and the object which appears on the screen. This program has use the HSV as color space detection and skin cluster in the RGB color space in detecting the user's movement. However this program only can detect the movement of user which has brighter skin color. The others object which contain the skin color feature also will be detected. This project did achieved the two specific objectives which are to design and develop a webcam based motion game in real time, and to incorporates the skin color feature in the webcam based motion game.

ABSTRAK

Permainan Pergerakan Badan: Menghilangkan Bebola

TEOH LIP KI

Kajian ini bertujuan untuk mereka dan memprogram sebuah permainan yang dapat berinteraksi dengan pemain melalui pergerakan badan dengan pengaplikasian kaedah pengenalpastian warna kulit. Terdapat empat peringkat dalam memprogramkan permainan ini, iaitu mengambil gambar, melukiskan bebola pada gambar yang ditangkap, pemprosesan gambar dan pengaplikasian kaedah pengenalpastian warna kulit, dan menentukan interaksi antara pergerakan pemain dan bebola. Program ini dapat menentukan sama ada interaksi berlaku sesama pergerakan pemain dan bebola. Program ini telah menggunakan pengenalpastian ruangan warna HSV dan mengenal pasti pergerakan pemain melalui warna kulit pemain dengan menggunakan ruangan warna RGB. Namun demikian, program ini hanya dapat mengenal pasti pergerakan pemain yang mempunyai warna kulit yang cerah. Pergerakan benda lain yang mempunyai ciri-ciri warna kulit juga dapat dikenal pasti. Kajian ini telah mencapai kedua-dua objektif spesifik, iaitu mereka dan memprogram permainan yang dapat berinteraksi dengan pemain melalui pergerakan badan, serta pengaplikasian kaedah pengenalpastian warna kulit dalam permainan ini.

Chapter 1

INTRODUCTION

1.0 Introduction

In this chapter of *Motion Game: Wipe out the Bubbles*, the introductory part include background of the project, problem statement, research objective, scope of the project, significance of the project, structure of the project, delimitation and limitation of the project. It will present the importance of the project.

1.1 Background of the project

The first video game console, the "Brown Box" has been introduced in 1967 which designed by German-born television engineer Ralph Baer and his coworkers (Stack, 2005). The first commercial video-game console, Odyssey which is the production of the Magnavox was marketed in Magnavox TV dealerships beginning in 1972 (Stack, 2005). Nintendo which is

originally a Japanese playing-card company releases the Nintendo Entertainment System in 1985 (Stack, 2005). About six years later, Sony launch the PlayStation which consider as the most popular console of the 32-bit era of video games in 1995 (Stack, 2005). Another ten years later, Sony releases the PlayStation Portable as a direct challenge to Game Boy's dominance of the handheld console market in 2005 (Stack, 2005).

The video game console which using the mouse, keyboard and other input devices are now facing the great challenge from the motion game. Nowadays the motion game has been introduced to the entire world. The motion game is the game which allows the players to interact with through using camera or webcam.

1.2 Problem Statement

The game evolution starts from the "Brown Box" until the PlayStation Portable, and nowadays motion game. The games' equipments from using mouse, keyboard and other input devices have been reduce to a camera or webcam.

The problems that will be face during developing a motion game such as detection and tracking method, image processing and environment condition.

There are more than one way to carry out the detection and tracking method. Many researchers did put a lot of hard work to implement the detection and tracking method. Tao Xia, Chaoqiang Liu and Hui Li (2005) suggested a moving object detection algorithm for video compression which include motion field study and object detection method. Masayuki Yokoyama and Tomaso Poggio (2005) proposed contour-based detection for the detection and tracking of moving objects.

In this project, the problem is how to develop a real time based motion game by using skin color feature as detection method.

1.3 Research objective

The objective of the project is divided into two categories which are general objective and specific objective.

The general objective is to design and develop a motion game which allow user to interact with the game in real time.

The specific objectives are:

(i) to design and develop a webcam based motion game in real time

(ii) to incorporates the skin color feature in the webcam based motion game

1.4 Scope of the project

The scope of the project is to develop a webcam based motion game which allows the user to interact with the game in real time. The system will detect the skin color feature in order to detect the user's movement.

The user can move his part of body to wipe out the bubbles which will drop from the top to bottom of the display window. The dropping bubbles will be wiped out as the user did interact with the bubbles. Else the dropping bubbles will disappear from displaying if not within the display window's size.

The user's movement which contain the skin color feature will be detect and read as input of the system. The movement detection can be calculated through the difference between two frames. In the other words, the system is able to detect the movement of the user without any marker or device attached to the user.

1.5 Significance of the project

This project will be design and develop a webcam based motion game which incorporates with skin color feature. Webcam is the only one input device needed which use to capture real time image. The user's movement will be captured to determine whether there is any interaction between user's movement and the bubbles which render on the image. The image processing will be applied on the captured image in this program to determine the objects' movement. Meanwhile the skin color feature will be applied to determine the objects' movement which consists of skin color feature. If the detection and tracking method are stable and accurate, it will provide another choice for the researcher to use in their research.

1.6 Structure of the Project

The project consists of six chapters which are introduction, literature review, research methodology, system development, discussion and conclusion.

The chapter one, introduction would be included background of the project, problem statement, research objective, scope of the project, significance of the project, structure of the project, delimitation and limitation of the study. The listed sub-chapters above are use to establish the research topic.

The chapter two, literature review would be included the related literature with the project. The previous project and works done by the researchers around the world were also included in this chapter.

The chapter three, research methodology would be included the conceptual design, system architecture, system flow and system specifications. The objective of this chapter is to discuss the general idea of the whole project to the readers.

The chapter four, system development would be included the development progress of the project. In this chapter, the implementation of the function in this project will be explained. Some screen shot of the project also will be included for easy understanding.

The chapter five, discussion and conclusion would be included discussion, strengths and weaknesses. The recommendations for the future work also will be included in this chapter.

1.7 Delimitation and Limitation of the project

For this project, there is only one input device needed which is webcam. Webcam is use to capture the real time image. This image will be processed and used to detect and determine the objects' movement which contain skin color feature.

There is no more other controller as input device as the user himself is the controller. His movement will be detected and read as an input to interact with the program instead of the button based controller. This program will determine whether there is any interaction between user's movement and the object which draw on the captured image and display on the window.

This program has use skin color feature to detect and determine the objects' movement. The skin color feature which applied in this program is suitable for mostly people which have the brighter skin color. As if the user wearing long sleeve shirt, the hand of the user will not be detected. Those who have darker skin color are also hardly detected through this program. Besides that, this program not only will detect human as matching the skin color feature, the other moving objects which contain the skin color feature in the real time also will be detected and read as input.

1.8 Conclusion

In this chapter, background of the project, problem statement, research objective, scope of the project, significance of the project, structure of the project, delimitation and limitation of

the project had been discussed. This chapter had provided the readers the foundation of knowledge about the project which is going to be carried out.

Chapter 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss on the detection and tracking system, the motion game application which can be found in the market, and skin color modeling and classification. It can present the fundamental of this study.

2.1 Detection and Tracking System

2.1.1 Block-based Motion Estimation and Moving Object Detection

A new algorithm of moving objects detection and description is proposed by Xia, Liu and Li (2005) as show in Figure 2.1. First, block-based motion estimation is used to obtain the coarse

motion vectors which is the vectors for each block, where the central pixel of the block is regard as the key point (Xia, Liu, & Li, 2005). These motion vectors are used to detect the boundary blocks, which contain the boundary of the object (Xia, Liu, & Li, 2005). To remove the block artifacts, the linear interpolation is used to make the coarse motion field a dense motion field and to detect whether the motion field is continuous or not (Xia, Liu, & Li, 2005). This refined dense motion field is used to define detail boundaries in each boundary block (Xia, Liu, & Li, 2005). The moving object is detected and coded (Xia, Liu, & Li, 2005).

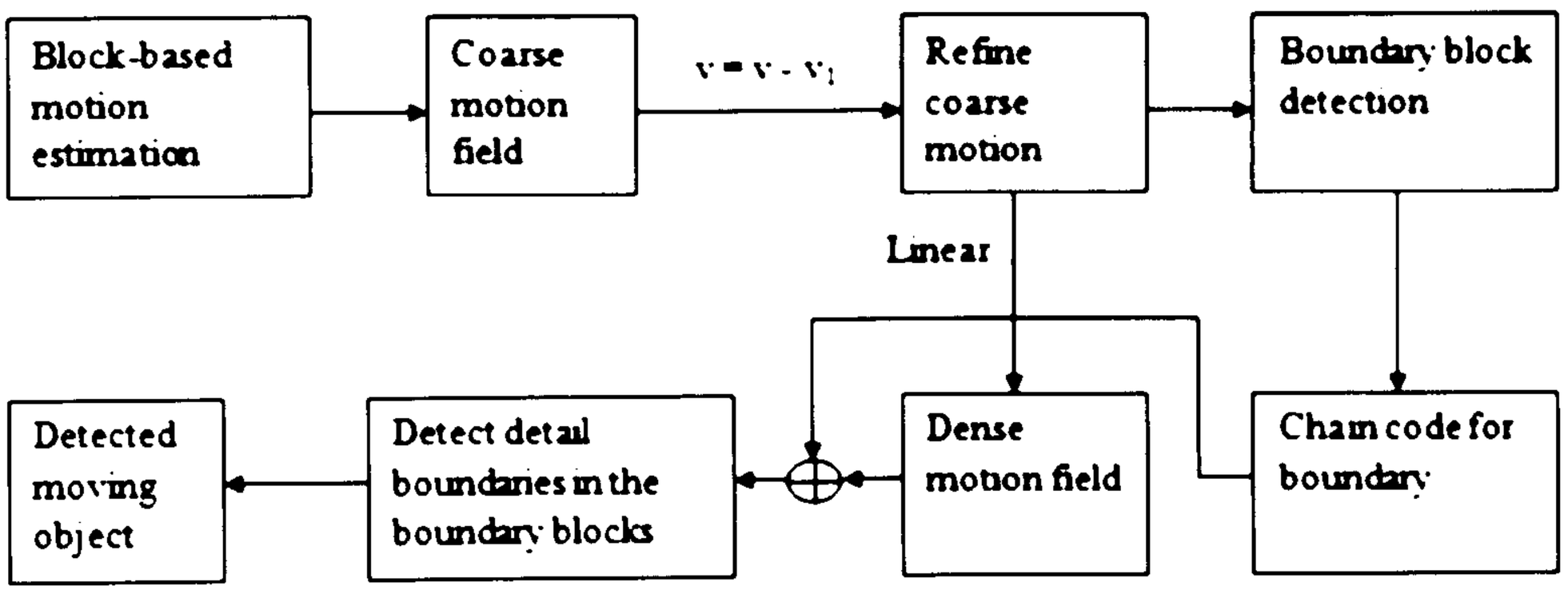

Figure 2.1 Process of moving object detection algorithm

The moving object detection algorithm can be divided into motion field study and object detection method (Xia, Liu, & Li, 2005).

In the motion field study, the motion vector associated with the points in one moving object should be linear interpolated if motion vectors are linear interpolated and the motion of all along the z-direction is the same (Xia, Liu, & Li, 2005).

The object detection method includes detecting boundary blocks, writing chain codes, and detecting boundaries in the boundary blocks (Xia, Liu, & Li, 2005).

By using the information of the motion vector field which generated by video compression, the blocks which contain moving object boundaries will be detected (Xia, Liu, & Li, 2005). The discontinuity of motion vector field exists and implies the existence of the

boundary in associated block as pixels in the same object satisfy the condition of linear interpolation (Xia, Liu, & Li, 2005).

8-neighboring connectivity is used to form the closed curve of boundary blocks which described by chain code (Xia, Liu, & Li, 2005). Initial search starts from block 0, then round the target block from block 1 to block 7, as the number 0 to 7 denotes neighboring blocks (Xia, Liu, & Li, 2005). The search will stop once a neighboring block is found as a boundary block, and the neighboring block will be regarded as current target block to start 8-neighboring blocks search iteratively (Xia, Liu, & Li, 2005).

Polygon is used to approximate the moving objects boundary (Xia, Liu, & Li, 2005). Therefore, each boundary block obtained in forming the closed curve of boundary blocks is replaced by a line segment (Xia, Liu, & Li, 2005).

The simulation result is presented as in Figure 2.2 as the object boundary which is connected in the motion field is also known as chain code (Xia, Liu, & Li, 2005). The short white lines are the motion vectors for each block, while the grey short line surrounded by short white lines denotes for the block which is not boundary block (Xia, Liu, & Li, 2005).

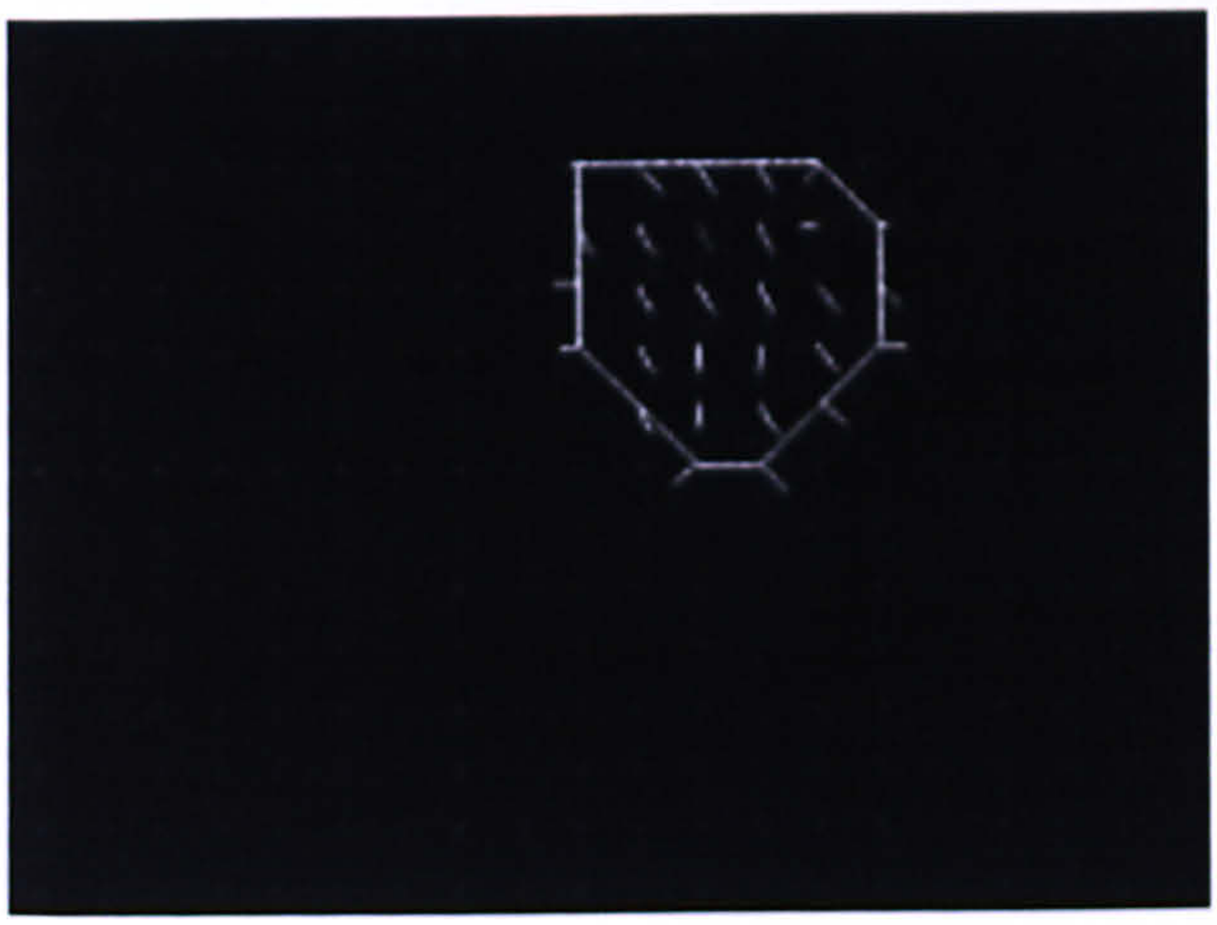

Figure 2.2 Boundary block detection

2.1.2 Active Contours for the Detection and Tracking of Moving Objects

Masayuki Yokoyama and Tomaso Poggio (2005) proposed contour-based detection for the detection and tracking of moving objects based on using lines computed by a gradient-based optical flow and an edge detector. The optical flow is based on using features which have strong magnitudes of the gradients (Yokoyama & Poggio, 2005).

The method for extracting contours of moving objects consists of four steps which are line restoration, line-based background subtraction, clustering, and active contours (Yokoyama & Poggio, 2005). The line restoration can be easily calculated as the moving edges are obtained as one pixel wide lines by the edge detector (Yokoyama & Poggio, 2005). Through subtracting background edges of the previous frame, the noise can be eliminated except for the reflection of non-rigid objects (Yokoyama & Poggio, 2005). The nearest-neighbor clustering with respect to the distance and velocity is used to eliminate most noise and made scenes low-clutter on outdoor-scenes except for the scenes which include interfering objects (Yokoyama & Poggio, 2005). Contours of the clustered lines are extracted by using the discrete energy function of a snake (Yokoyama & Poggio, 2005). Convex hull will be calculated for each cluster as the initial contour for the computation of the snakes (Yokoyama & Poggio, 2005).

In tracking detected objects, the similarity between an object of the previous frame and an object of the current frame being define using estimated positions of lines by optical flow (Yokoyama & Poggio, 2005). The two objects are considered same if the similarity is non-zero value (Yokoyama & Poggio, 2005). There are some states of tracked objects are defined as special case such as occluded, reappeared, merged and separated (Yokoyama & Poggio, 2005). As show in Figure 2.3, the method have been carry out for experiment on pedestirans which include several kinds of noise caused by illumination changes, small movement in the background, and reflection (Yokoyama & Poggio, 2005).

Figure 2.3 Pedestirans

2.1.3 Real-Time Motion Detection for Surveillance Application

Hyenkyun Woo, Min Ok Lee and Jin Keun Seo (2007) proposed a real-time motion detection algorithm for surveillance application based on a new level set-based energy functional. The proposed algorithm in the paper is for minimizing the energy functional combines automatically motion segmentation and denoising operation in real time (Woo, Lee, & Seo, 2007). The proposed algorithm also provides robust and efficient motion detection at various noise levels of image sequences (Woo, Lee, & Seo, 2007).

In conventional surveillance system, motion detection mostly based on the method of thresholding such as Mixture of Gaussian, Pfinder and *W4* (Woo, Lee, & Seo, 2007). Segmentation of moving object in these methods is achieved by pixel based threshold of the difference image between background and current image and morphological filter as a postprocessor (Woo, Lee, & Seo, 2007). Although these methods work well in day time, false positive and false negative alarms are induced by noise in the image sequences at night (Woo, Lee, & Seo, 2007).

Intelligent video surveillance systems attempt to reduce the burden on the security officers by applying motion detection algorithm (Woo, Lee, & Seo, 2007). The officers only need to focus on the monitors where movements of the object are detected (Woo, Lee, & Seo, 2007). Video compression algorithm has been used to store the records of video data on a limited capacity of storage (Woo, Lee, & Seo, 2007). However due to noise in the image sensor, the compression efficiency is deteriorated in a dark environment (Woo, Lee, & Seo, 2007).

To deal with the night and dark environment problem, adaptive bimodal segmentation which discriminates effectively between moving objects and noise especially at night has been proposed by Woo, Lee and Seo (2007).

Adaptive bimodal segmentation is based on solving a nonlinear partial differential equation, which combines automatically segmenting of motion and denoising operation at the same time (Woo, Lee, & Seo, 2007). As a result, the segmentation algorithm adopts to various noise level of the input image sequences (Woo, Lee, & Seo, 2007). Meanwhile the real-time performance is achieved without any special hardware accelerator (Woo, Lee, & Seo, 2007).

Experimental results using surveillance camera show that it is very efficient in segmenting moving objects regardless of environment conditions such as in a relatively dark region (Figure 2.4), in a day time (Figure 2.5) and in a dark environment (Figure 2.6) (Woo, Lee, & Seo, 2007). It has a very low false alarm rate even at night, when relatively few motion occur (Woo, Lee, & Seo, 2007). Figure 2.7 shows the segmentation performance comparison between the Mixture of Gaussian Model and the proposed model.

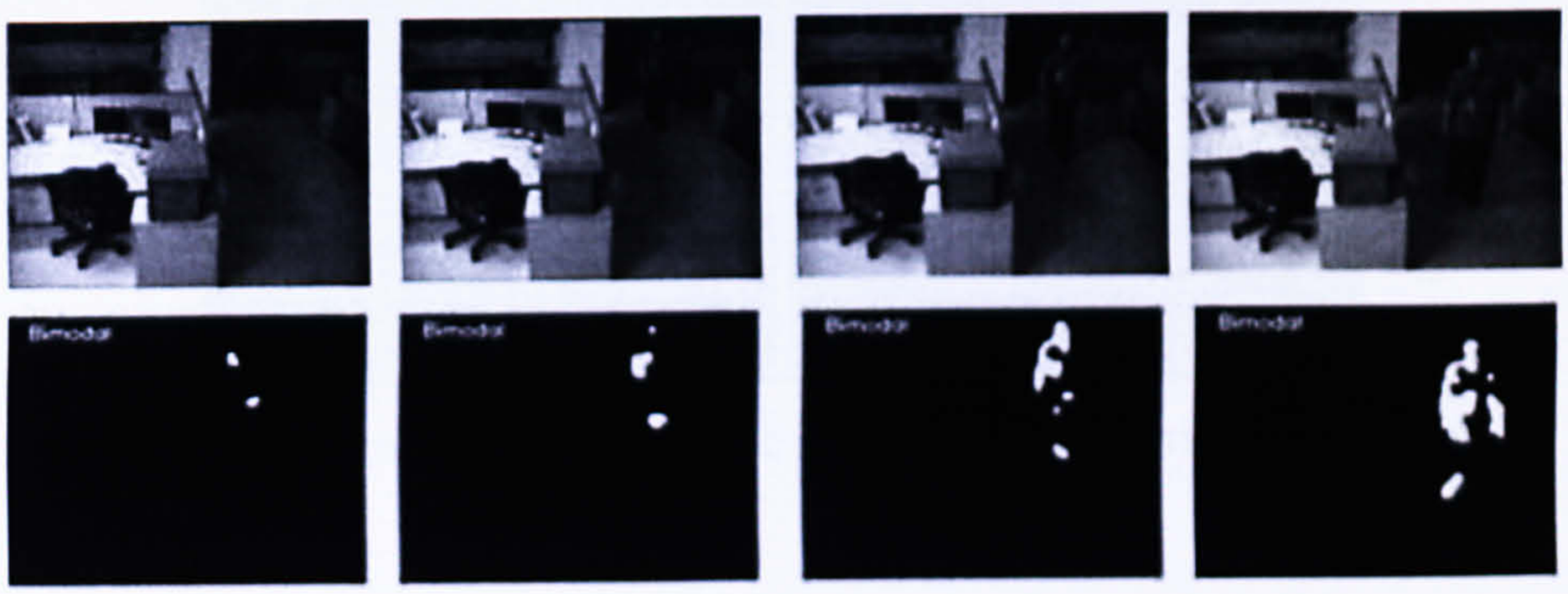

Figure 2.4 Segmentation of the moving object lying in a relatively dark region.

Top: the original image sequences.

Bottom: results using the proposed model.