VIRTUAL GUARD

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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Electronics)"

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With the name of Allah, The Most Loving and The Most Compassionate

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Abstract

This project entitle VIRTUAL GUARD is one of the general-purpose of computer-based closed circuit television(CCTV) surveillance system that use to detect intruder in private or restricted area by applying the image processing technique of detecting object. Ordinary CCTV can only be used to record incidents if it does occur. It works without preventing it and it is only useful to be an evidence for the investigation. But the purpose of developing this project is as the earlier prevention to avoid crime by giving alert or feedback from the object that was detected from captured video. In order to achieve the goal of this project, a few techniques in image processing will be use like image subtraction technique which is use to detect movement and object existence like an intruder which has been captured in the video. The captured video in this project will be convert into frame of images and being analyze by using MATLAB software that already consist all the techniques of image processing. The output of this project will be classified if there is any detection or not by using the value of total sum of pixel value from each image data. The classification is actually based on the threshold value. This project indirectly reduce weakness and careless of human guard observation as it give continuous 24-hour monitoring of surveillance video to alert security officers to an intruder potential.

Abstrak

Projek ini berjudul PENGAWAL MAYA adalah salah satu daripada tujuan-umum televisyen litar tertutup berasaskan komputer (CCTV), sistem pemantauan yang digunakan untuk mengesan penceroboh di kawasan milik persendirian atau berpagar dengan menerapkan teknik pengolahan gambar untuk mengesan objek. CCTV biasa hanya boleh digunakan untuk merakam kejadian jika ia berlaku. Ia berfungsi tanpa mencegah dan hanya berguna untuk menjadi bukti untuk penyiasatan. Tujuan sebenar pembangunan projek ini adalah sebagai pencegahan awal untuk mengelakkan jenayah dengan memberikan amaran atau maklum balas terhadap objek yang dikesan di dalam video yang dirakam. Dalam rangka mencapai objektif projek ini, beberapa teknik dalam pengolahan gambar akan digunakan seperti teknik pengurangan gambar yang boleh digunakan untuk mengesan gerakan dan kewujudan objek seperti penceroboh yang telah dirakam dalam video. Video yang diambil dalam projek ini akan ditukarkan kepada bentuk gambar statik dan yang dianalisis menggunakan perisian MATLAB yang sudah mengandungi semua teknik pemprosesan imej. Keluaran dari projek ini akan diklasifikasikan sama ada terdapat pengesanan atau tidak dengan menggunakan nilai dari jumlah nilai piksel dari setiap data gambar. Klasifikasi ini sebenarnya didasarkan pada nilai ambang. Projek ini secara tidak langsung mengurangkan kelemahan dalam pemerhatian oleh pengawal manusia kerana ia memberikan pemantauan 24 jam terus menerus dari rakaman video untuk memperingatkan pegawai keselamatan untuk sebuah potensi pencerobohan.

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INTRODUCTION

1.1 Project Background

1.1.1 Closed circuit television

If you consider video in the simplest of terms, video surveillance began with simple closed circuit television monitoring (CCTV). As early as 1965, there were press reports in various countries across the world suggesting police use of surveillance cameras in public places. When videocassette recorders hit the market, video surveillance became really popular. Analog technology using taped video-cassette recordings meant surveillance could be preserved on tape as evidence. A complete analog video-surveillance system consisted of a camera, monitor, and VCR. The old tube camera was only useful in daylight, and the VCR could only store eight hours of footage at best.[1]

The drawback was that after a while, owners and employees of such a system would become complacent and not change the tapes daily or the tapes would wear out after months of being re-used. There was also the problem of recording at night or in low light. While the concept was good, the technology hadn't yet peaked. The next step was the Charged Coupled Device camera (CCD), which used microchip computer technology. In the 1990's video surveillance made great strides in practicality by the introduction of digital multiplexing. When digital multiplexer units became affordable, it revolutionized the surveillance industry by enabling recording on several cameras at once (more than a dozen at time in most cases).[2]

1.1.2 MATLAB Software

Advantage of Matlab: Basically the advantage of using Matlab is that Matlab is an interpreted language for numerical computation. It allows one to perform numerical calculations, and visualize the results without the need for complicated andtime consuming programming. Matlab allows its users to accurately solve problems, produce graphics easily and produce code efficiently.[5]

Disadvantage of Matlab: The only problem with Matlab is that since Matlab is an interpreted language, it can be slow, and poor programming practices can make it unacceptably slow. If the processing power of the computing machine is low the Matlab software takes time to load and execute any code making the code execute very slowly.[5]

Reason for Selection: We used Matlab to develop our work, because Matlab provides Image Acquisition and Image Processing Toolboxes which facilitate us in creating a good and excellent code.[5]

1.2 Project Outline

The VIRTUAL GUARD is a general-purpose computer-based CCTV surveillance system for detecting potential criminal activity in public or even private areas. The system monitors all activity in the surveillance area that the majority of which is people innocently going about their normal business. It will alarm when the observed activities of particular pedestrians and vehicles match any of the pre-defined “suspicious behaviour criteria” programmed into the system. The system can provide automatic surveillance in many different situations, from parking areas and commercial districts, to housing, recreational and transport facilities. It is particularly suited to the protection of government or commercial buildings located on city streets or other public areas where it is not possible to install perimeter fences.[1][2] This system is just like an upgraded system because we can use the cctv that already installed in the area but with some additional in computer control system. For this project, we are applying virtual guard in private and restricted place as the security system. This system will use image processing technic that analyze the image from cctv to detect either there is crime potential object or not which will activate alarm system. To analyze the image we are going to use matlab software as it is easier compare to the other software.

Standard CCTV system only record activities happen around and only useful after a crime happened. But this project will develop a CCTV system that can prevent the crime potential activities in a restricted area before it happened. This project is about to develop an intelligent CCTV security system which not only monitor but also can react to the crime potential situation.[3] The data are collect from CCTV in video format which then will be analyze using a computer and finally it will give a result inform of output.[1]

1.3 Problem Statement

Standard CCTV system only record activities that happen around the camera view which will be useful after a crime happened as an evidence for the investigation process. But this project will develop a CCTV system that can react to the crime potential activities by giving a feedback from an analysis process in order to prevent the crime potential activities in a restricted area before it happen.

1.4 OBJECTIVE

The objective of this project is to develop a system that can detect existence of object in the interested region of image data using image processing technique. This system will be applied in security system to help human guard to be alert with crime potential activities that happen around the area. This system will indirectly help to reduce weakness and careless from human guard observation.

1.5 PROJECT SCOPE AND LIMITATION

This project has its scopes and limitations in order to make sure that it always stay on track and achieves its objective at the end of the process. This project can use any image processing techniques that available as long as the existence of object in the image data can be detected. As it objective only focus on detecting the existence of object in the interested region of image data, there will be no consideration if the object is a human or even a small animal that cross through the interested region of image data. Result of this project will classified the image as “alert” if there is an object exist in the region of image data and “nothing” if there is no object detected.

Chapter 2

LITERATURE REVIEW

2.0 Introduction

In this chapter, we are going to make some research by analyzing and comparing from the journal or thesis made and publish by the persons that have expertise and experience in image processing. By comparing and reffering to those paper, it is expected to be a guidance in order to achieves the project goals. Besides that, we also get the idea of how to get the best method, technique or even the way on doing the project throughout those review.

2.1 Human Motion

Visual analysis of human motion is currently one of the most active research topics in computer vision.[4] This strong interest is driven by a wide spectrum of promising applications in many areas such as virtual reality, smart surveillance, perceptual interface, etc. Human motion analysis concerns the detection, tracking and recognition of people, and more generally, the understanding of human behaviors, from image sequences involving humans.[4] This paper provides a comprehensive survey of research on computer-vision-based human motion analysis. The emphasis is on three major issues involved in a general human motion analysis system, namely human detection, tracking and activity understanding. Various methods for each issue are discussed in order to examine the state of the art. Finally, some research challenges and future directions are discussed. Bearing in mind a general processing framework of human motion analysis systems, we have presented an overview of recent developments in human motion analysis in this paper. The state of the art of existing methods in each key issue is described and the focus is on three major tasks:

detection, tracking and behavior understanding. As for human detection, it involves motion segmentation and object classiAcation. Four types of techniques for motion segmentation are addressed: background subtraction, statistical methods, temporal diOerencing and optical Kow. The statistical methods may be a better choice in more unconstrained situations. Tracking objects is equivalent to establish correspondence of image features between frames. We have discussed four approaches studied intensively in past works: model-based,active-contour-based, region-based and feature-based. The task of recognizing human activity in image sequences assumes that feature tracking for recognition has been accomplished. Two types of techniques are reviewed: template matching and state-space approaches. In addition, we examine the state of the art of human behavior description. Although a large amount of work has been done in this area, many issues remain open such as segmentation, modeling and occlusion handling. At the end of this survey, we have given some detailed discussions on research diJculties and future directions in human motion analysis. [5]

2.2 Statistical Multi-feature Analysis

Second jounal presents a new technique for the detection and description of moving objects in natural scenes which is based on a statistical multi-feature analysis of video sequences. In most conventional schemes for the detection of moving objects, temporal differences of subsequent images from a video sequence are evaluated by so-called change detection algorithms.[6] These methods are based on the assumption that significant temporal changes of an image signal are caused by moving objects in the scene. However, as temporal changes of an image signal can as well be caused by many other sources (camera noise, varying illumination, small camera motion), such systems are afflicted with the dilemma of either causing many false alarms or failing to detect relevant events. To cope with this problem, the additional features of texture and motion beyond temporal signal differences are extracted and evaluated in the new algorithm. The adaptation of this method to normal fluctuations of the observed scene is performed by a time-recursive space-variant estimation of the temporal probability distributions of the different features (signal difference, texture and motion). Feature data which differ significantly from the estimated distributions are interpreted to be caused by moving objects. The essential advantages of this technique compared to mere change detection are:

- The additional evaluation of texture features and motion parameters considerably increases the reliability of object detection, i.e. false alarms caused by camera noise, diffuse motion (e.g. leaves and trees in motion), changes of illumination and camera vibration are mostly suppressed while ‘real’ alarm situations are reliably detected.
- Due to the recursive estimation of the temporal distribution of the measurement entities for each detector cell, the typical characteristics of the scene are automatically learned, such that false alarms caused by location-dependent fluctuations can be suppressed.
- The computing power additionally required in comparison to mere change detection algorithms is very low, and processing rates of 3-10 frames/s can be achieved on standard processor platforms [7]

2.3 Human Tracking

The third jounal describe a method for tracking walking humans in the visual field. Active contour models are used to track moving objects in a sequence of images.[8] The resulting contours are then encodedin a scale-, location-, resolution-andcontrol point rotation-invariant vector. These vectors are usedto train and test feed forward error-back propagation neural networks, which are able to distinguish both static and dynamic human objects from other classes of object, including horses, dogs and inanimate objects. Experimental results are presented which show the neural network’s ability to successfully categorise objects which have become partially occluded. Classes of object can be distinguished by the network, andexperimental results are presentedwhich show how the representational vectors used as input patterns can be usedto identify, classify andanalyse the temporal behaviour of pedestrians. The detection process is basically performed by comparing two successive images captured by a fixed camera and identifying differing areas of one against another image. Then, the question is how adjacent two successive images must be. If the time interval between two successive images is too short compared to the movement of an object, these two images may not show clear differences and the detection process may fail to identify the movement itself. On the other hand, if the time interval is too long, the detection process may fail to catch up with an entering object. We solve the problem by employing three buffers as in Figure 2.1. Buffer0 is used to store a reference image, bufferl is used to store a current image, and buffer2 is used as a temporary buffer whose image is to refresh buffer0 whenever the predetermined time tmax has elapsed. We compare images stored in bufferO and bufferl to determine whether or not some moving object has entered the FOV of a camera.[9]

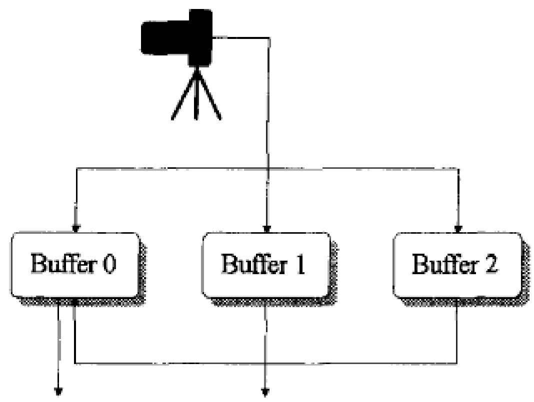


Figure 2.1: Connection of buffer and camera

2.5 Motion Detection using image histogram sequence analysis

This paper presents an unconventional approach for motion detection using image histogram sequence analysis. Functional and statistical models for image histogram sequence analysis are proposed . The relationship between the statistical characteristics of the image histogram sequences and the process of motion detection is established . The experimental results show that the proposed approach can be used for a reliable motion detection. In many cases we have to estimate whether or not there are some changes in an observed scene. Motion detection is the most important issue in these cases. The purpose of this work is to create a functional model of a system for motion detection using image histogram sequence analysis. Such a system can be used for security control of banks, shops, military objects, embassies, technological control of processes in real time and so on. The idea of creating a functional model of a system for motion detection is based on the assumption that all changes in an observed scene can be defined using image sequence analysis . Moreover, these changes can be estimated using some appropriate transformation . Such a transformation as an `image gray-level histogram' provides possibilities for creating a statistical model of the observed scene. The relationship between image sequences and their statistical characteristics has to be established.[11]

2.6 Image Segmentation by MAP-ML Estimation

This paper proposes a new image segmentation algorithm based on a probability maximization model. An iterative optimization scheme alternately making the MAP and the maximum likelihood (ML) estimations is the key to the segmentation. We model the MAP estimation with MRFs and solve the MAP-MRF estimation problem using graph cuts. The result of the ML estimation depends upon what statistical model we use. Under the Gaussian model, it is obtained by finding the means of the region features. It is shown that other statistical models can also fit in our framework. The main contributions of this work include: 1) a novel probabilistic model and an iterative optimization scheme for image segmentation, and 2) using graph cuts to solve the multiple region segmentation problem with the number of regions automatically adjusted according to the properties of the regions. The algorithm can cluster relevant regions in an image well, with the segmentation boundaries matching the region edges. Extensive experiments show that the algorithm can obtain results highly consistent with human perception. The qualitative and quantitative comparisons demonstrate that the algorithm outperforms six other state-of-the-art image segmentation algorithms. Result of segmentation are shown in figure 2.2 below.[12]

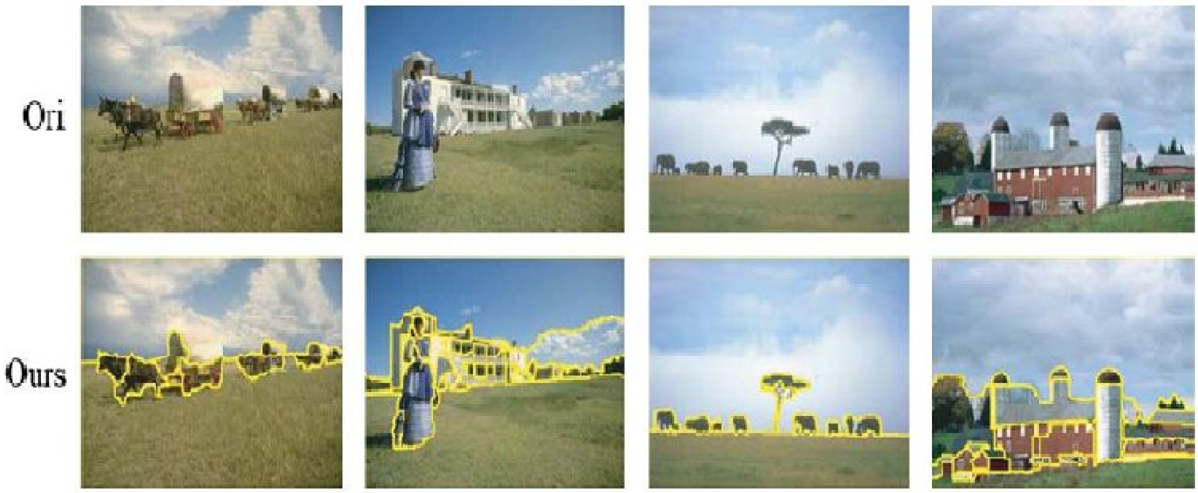


Figure 2.2. Image before and after segmentation.

2.7 Automatic Recognition of Suspicious Activity

This article present a digital processing based method of intruder detection. CCTV (Closed Circuit Television) camera images are processed and analysed. An object detection algorithm is used to determine whether a camera image contains a possible intruder, while further feature extraction processing can isolate the image containing any possible intruder for further analysis. An AI (Artificial Intelligence) based approach is used for analysing processed images. A technique for the detection and identification of postures is performed. The methods used are described along with the results obtained. Conclusions are drawn and proposals for commercial exploitation are made. Monochrome images from a fixed CCD (Charge Coupled Device) camera are captured and digitised to produce images of size 256x256 pixels with **8** bit (256 level) grey-tones. Each captured image is compared with a stored background rei-erence image by using an image processing function called image subtraction. The effects of random noise in the image are effectively eliminated prior to subtraction by median filtering both images. Figure 2.3 below shows the graph analysis for walking position and figure 2.4 shows the standing position.[13]

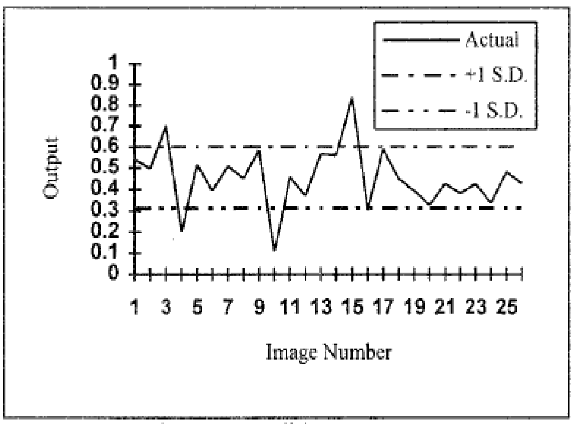


Figure 2.3. Walking Postures

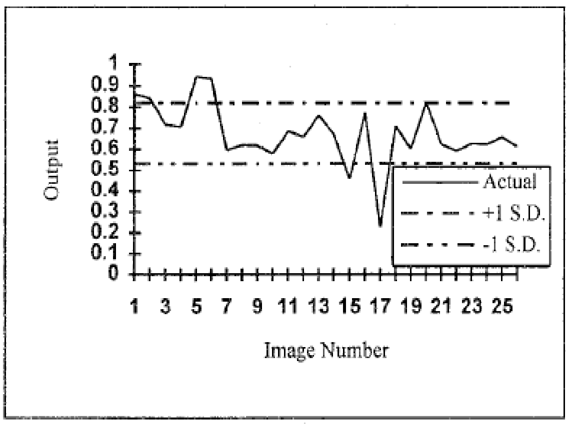


Figure 2.4. Standing Postures

2.8 Separation of Moving Object From Their Shadows

Since an object is always accompanied by its shadow, each extracted region of the object and its shadow is often assimilated into one region. On an analysis of the object's shape, the shadow region causes misunderstanding for detection of such moving object as an intruder. In order to detect moving objects by image processing, it is necessary to separate objects from their shadows. This paper introduces a separation technique of objects from accompanying shadows and presents a monitoring system facilitating detection and tracking for several moving objects. By using proposed separation method of the object and its shadow, tracking of movement loci of several objects was performed with in success of **80** %.

Figure 2.5 shows extracted areas of three moving objects in an outdoor scene under a certain fine day. In this scene, two objects (0bj.l and Obj.2) of three move from the left to the right on images and the other object (Obj.3) walks across in front of the camera from the right to the left in the scene. **As** shown in the figure, two regions of the 0bj.l and the Obj.2 are partially overlapped each other. After several frames succeeded, each region is overlapped and is assimilated to one region as shown in Fig.2.5(b). Thereafter, three objects are separated individually as shown in Fig. 2.5(c). In order to analyze the object's shapes and track their loci, it is necessary to separate the objects from their shadows.[14]

A shadow generally appears on a certain surface area of the ground in the outdoors when an object obstructs the light ray emitted from the sun. In this paper, the moving object, that is the intruder, is assumed to stand nearly in **an** erect posture. When the relationship between positions of the light source point and camera is given beforehand in addition to knowledge on the astronomical rules**,** direction and magnitude of the shadow are shown by the rule of projective geometry. The proposed separation method of the object and its shadow is shown in the following **4** steps.[14]

Step 1 : Labeling

By iabeling processing**,** each extracted region of moving objects is distinguished by the labeled character. Three regions are distinguished by label A and B as shown in

Fig.2.5(a). In the figure. the label A is assigned to the merged region of 0bj.l and Obj.2. The label B corresponds to the region of Obj.3.

Step 2**:** Core line

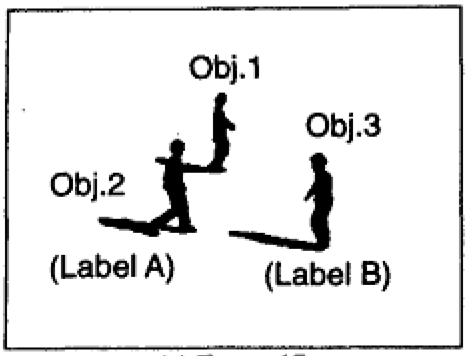
Two lines called as ‘core line’ are defined. Each line passes respectively around the center of the extracted regions of the object and the shadow ifi the image plane. The core line of an object could be extracted as the line which passes through a peak of object’s distribution function projected onto the vertical axis to the erect direction of the object in the image plane. The other core line of the shadow could be obtained from a distribution function projected onto the vertical axis to the direction of shadow. The intersection point of the two core lines is defined as the point on the boundary of the two regions of the subject and shadow. Fig.2.6 shows each core line of object and shadow on the region of A in Fig 2.5 .(a).

Step 3: Candidates of separation point

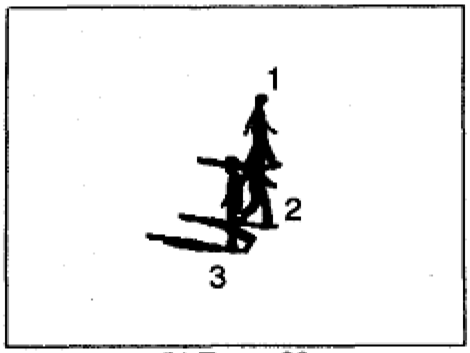
Fig.2.7 shows several candidate points for separation. Four core lines corresponding to objects and their shadows were obtained because two objects were merged into the one region assigned to the label A.

Step 4**:** Decision of the separation point.

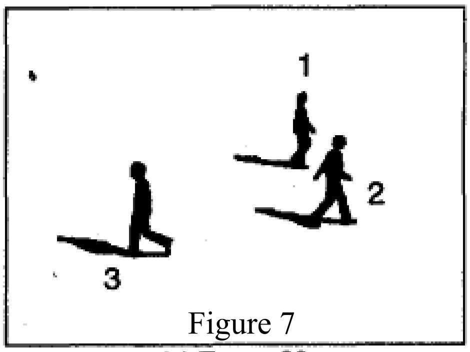
Each separation points of the 0bj.l and 2 is decided from the candidate points by using a template matching. Beforehand, a large number of templates were prepared into a computer file at every certain periods and distances in the image scene. Separation points are decided as the maximum similarity between the images of template and detection region of label A. In a case of label A, two separation points, ‘a’ and ‘c’, were obtained as shown in Fig.2.7.[14]



(a) Frame 17

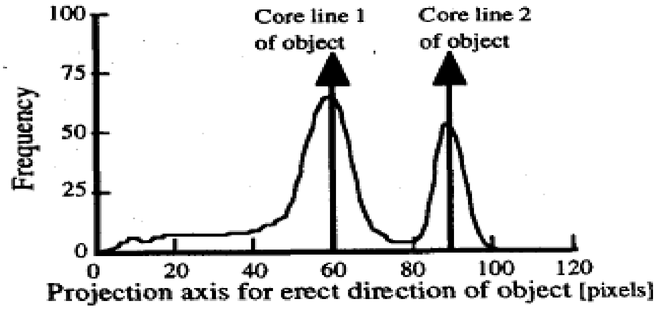


(b) Frame 20

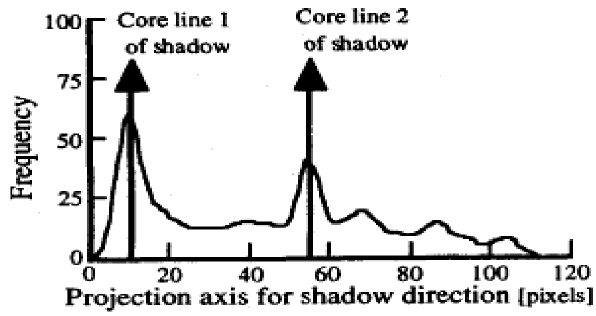


(c) Frame 23

Figure 2.5: Image data



(a) Core lines of object



(b) Core lines of shadow

Figure 2.6: Graph

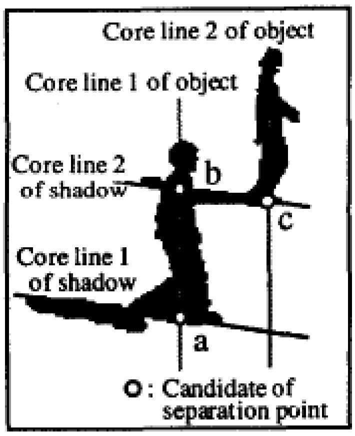


Figure 2.7: Point of separation