出國報告（出國類別：參加國際研討會並發表論文）

參加第 40 屆「國際卡拉漢安全技術研討會議」心得報告

服務機關：國立聯合大學

姓名職稱：韓欽銓、副教授

派赴國家：美國　肯塔基州萊辛頓市

出國期間：95/10/15~95/10/21

報告日期：95/11/30

一、摘要

國際卡拉漢安全技術研討會議（International Carnahan Conference on Security Technology，簡稱 ICCST），源起 1967 年於美國創立，今年會議舉行場所位於肯塔基州中部聞名的風景的藍草地區的中心：來克星頓，此次參加會議，並發表論文，為期將近六天的行程，其間行程緊湊，但獲得成果豐碩，參與人員涵蓋十多先進國家之國安、軍情與司法警調單位主管和安全科技企業主管與國際大學院校師生，提供一個理論、實務與政策討論的機會，會中邀請美國國家 Los Alamos 實驗室安全室主任 Roger Hagengruber 博士進行專題報告，針對美國國家六大重大威脅做詳細的呈述與分析，值得我國參考，此次論文重點持續於『反恐議題』上，涵蓋 19 項議題，其中資訊安全技術與生物特徵辨識兩大類主題更是本次會議的重點，善用資訊科技以降低資訊統合與分享所帶來的負面效應，資訊隱藏與資料保護機制是國防安全機制上不可或缺的架構，而 911 攻擊事件之後，個人身份的識別相對凸顯其重要性，尤其在機場安全控管上，更是重要。卡拉漢國際會議致力于電子安全技術的研究與開發方面探討，提供與會者交換彼此想法，傳播新的和現有技術的一個重要論壇，本次參加此研討會，除與各國學者做學術技術交流之外，還發表一篇文章，並引起與會人士興趣，與大會一致肯定

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1. 目的

國際卡拉漢安全技術研討會議（International Carnahan Conference on Security Technology，簡稱 ICCST），卡拉漢國際會議致力于電子安全技術的研究與開發方面探討，提供與會者交換彼此想法，傳播新的和現有技術的一個重要論壇，同時，鼓勵參加者能夠藉由此一會議，發揮他們於工作上的影響力，能夠長期提供或幫助其他人，在安全議題之技術或經驗上的協助。此一研討會議係源起 1967 年於美國創立，隸屬美國電機電子工程師學會(IEEE)，爲國際上安全科技領域存在最久、最具權威之學術研討會議，本會固定於每年十月份召開國際學術研討會議，每兩年交由非美加地區國家主辦。其組織分爲國際執行委員會議（爲大會之實際行政決策機構）、技術諮詢委員會議（負責技術與論文審查）及國際研討會議等三層組織。亦是國際上少數以「中華民國 Republic of China」稱呼我國之國際學術組織。本次參加此研討會，除與各國學者做學術技術交流之外，還發表一篇文章，並引起與會人士興趣，與大會一致肯定。

2. 過程

此次參加 2006 年「第 40 屆國際卡拉漢安全技術研討會議」，並發表論文，爲期將近六天的行程，其間行程緊湊，但獲得成果豐碩，其行程概述如下：

(一) 10 月 15 日：晚上搭乘華航 CI−008 航機啓程，經過十多於小時飛行，抵達美國洛杉磯國際機場，並於美國時間當日深夜轉搭國內線航線，經芝加哥國際機場，並於 10 月 16 日抵達肯塔基州的萊辛頓市 Bluegrass 機場。

(二）10 月 16 日：上午十時許抵達肯塔基州萊辛頓市，立即辦理報到手續，並參加晚間大會舉辦簡單的歡迎酒會，並與國內外的與會學者、官員交流。

(三) 10 月 17 至 19 日：參加研討會議，並於 10 月 17 日下午 3:00~5:00 發表論文：I 利用色彩特徵，於公共開放空間中之限制區域，非法進入者之偵測(llegal Entrant Detection at a Restricted Area in Open Spaces Using Color Features)。

(四) 美國時間 10 月 19 日晚上由萊辛頓市啓程，經芝加哥國際機場，於 10 月 20 日凌晨由洛杉磯轉機返台(CI-007)，並於 10 月 21 日上午抵達桃園國際機場。

此次會議的議程概略表列如下：

(一) 10 月 16 日：報到、歡迎酒會聯誼活動。

(二)10 月 17 日：

（1）08:30~10:00：開幕式，大會總主席 Mr. Larry Sanson 致歡迎詞與萊辛頓市市長 Teresa Ann Isaac 致詞，此外並邀請美國國家 Los Alamos 實驗室安全室主任 Roger Hagengruber 博士做專題演講。

（2）10:30~12:00：感測器（Sensor）I

（3）13:30~15:00：感測器（Sensor）II

（4）15:30~17:00：Video Advances(視訊資料之進階安全應用)

(三) 10 月 18 日：

（0）Keynote: Mr. Tom Lazarick, Professor of Drexel University

（1）08:30~10:00：Biometrics（生物安全認證）I

（2）10:30~12:00：Biometrics（生物安全認證）II

（3）13:30~15:00：Biometrics（生物安全認證）III

（4）15:30~17:00：Biometrics（生物安全認證）IV

（5）18:30~22:00：大會晚宴（演講及頒發佳作論文獎）

(四) 10 月 19 日：

（1）08:30~10:00：Information Protection and Assurance（資訊保護與安全保證）I

（2）10:30~12:00：Information Protection and Assurance（資訊保護與安全保證）II

（3）13:30~15:00：Networks(網路安全)

（4）15:30~16:45：Analyses(安全分析)

詳細會議議程與論文發表名稱，於附件資料表列。

3. 心得

此次會議舉行場所位於肯塔基州中部聞名的風景的藍草地區的中心：來克星頓，會議地點為 Radisson Plaza Hotel，參與人員涵蓋美、英、加、澳、瑞、德、紐、星、日、韓十多先進國家之國安、軍情與司法警調單位主管和安全科技企業主管與國際大學院校師生，會中除邀請肯塔基州萊辛頓市市長 Teresa Ann Isaac 至致意歡迎蒞臨並簡介市政之外，並邀請美國國家 Los Alamos 實驗室安全室主任 Roger Hagengruber 博士進行專題報告，針對美國國家六大重大威脅、清晰表列及分析導致威脅之因素並提出以低成本執行安全評估降低威脅之具體方法。

此次論文重點持續於『反恐議題』上，本年度之研討重點細分包括資訊、通訊安全、

反恐技術、密碼學、反核子武器擴散、機場安全維護、感應偵測追蹤技術、次致命武器系統、電腦系統網路入侵偵測、電腦病毒、生物認證系統甚至賭場安全管理等 19 項。安全科技業由傳統之錄影監測逐步發展至今日以反恐怖活動爲主之資訊安全、網路安全、生物安全、電子系統安全、實體及重大設備與基礎建設之安全，另新一代電子系統則朝向超低功率微系統、低輻射熱零件、低電磁波干擾與高環境應用韌性發展。除了安全系統之 sensor 硬體設計之外，尚包括資訊安全技術與生物特徵辨識兩大類主題，其中，當資訊分享所帶來的好處大於資訊保密時，應考量藉由資訊等級及種類之定義、分發與管制等，並善用資訊科技以降低資訊統合與分享所帶來的負面效應。網路駭客攻擊與病毒肆虐日益嚴重，資訊隱藏與資料保護機制是國防安全機制上不可或缺的架構，尤其防範電腦設備或機密資料遭受竊取，以確保整個國家之安全，911 攻擊事件之後，個人身份的識別相對凸顯其重要性，尤其在機場安全控管上，更是重要。

近年來生物特徵已普遍受到大家的重視，其最重要的因素是大家認爲密碼不再是保護自己隱私的唯一方法，尤其人類基因的解碼定位，使生物特徵受到大家的矚目，開始探討足以代表本人的生理或行爲特徵，可做爲身份的確認，尤其是他們具有獨特性與不易複製等特性，在網路盛行的今天，更需找尋足以代表本人於網路國界上通行之”通關密語”，而不必擔心被人冒用；常見的生物特徵爲指紋(fingerprint)、視網膜、虹彩、語音(voice)、掌紋/掌形(palmprint/hand shape)與臉譜(face)等等，例如指紋特徵長久以來，許多研究學者一直致力於此議題，尤其是犯罪研究上，而簽名特徵則是大家於支票上或重要文件上公認爲代表本人的確認方式。生物特徵確認(biometric authentication)技術是一種抽取人體生理上獨特器官資料(body code)或行爲資料(behavior)作爲確認的特徵，進行判斷測試樣本是否爲本人所有，還是由不法人士偽造的確認機制。

一般而言，我們可以將生物特徵分成兩類：生理(biological) 特徵與行爲(behavior)特徵，而從確認演算法角度而言，則分爲靜態特徵(static features)與動態特徵(dynamic features)；靜態特徵大多指生理特徵，主要擷取生理器官上的資料，例如指紋、視網膜、掌紋/掌型與臉譜等等，而動態特徵則是以個人行爲模式爲主要根據，例如語音、手勢、走勢、簽名、臉部表情變化等。此次會議中，生物特徵確認的場次，高達四次，爲所有主題之冠，藉由每一個人身上獨有之生理或行爲特徵，正確無誤的確認身份，以防止恐怖攻擊事件發生，是每一個國家積極努力的目標。

今年年會論文篩選非常嚴格，錄取發表之國際論文僅 47 篇，其中台灣獲錄取者僅 3 篇。此外會場還有安全器材廠商展示先進的資安產品與系統，會場展示加拿大、英國和美國 Senstar & Sttellar 等先進安全科技公司共十餘項的商用雷達偵測、周邊安全與網路系統研究成果。卡拉漢國際安全技術研討會研討主題相廣泛，根據今年主辦單位提供資訊，在美國「 911 」、英國倫敦、西班牙馬德里、巴里島及近期之塑膠液體炸彈等恐怖攻擊事件後，美國更加重視安全科技之研發與恐怖活動之預測與防範技術之開發，會中美國國防部、國土安全部、能源部、Sandia 桑地亞國家實驗室等研究機構均就相關事件提出檢討報告並羅列具體改進、提供未來應變建言及展示近期科研成果，對全球投入反恐具相當貢獻。

4. 建議事項

本研討會屬於安全議題的研討會,此次國內參加的學界研究人員不多,但仍有有國安局與調查局單位人員參與，此次一共錄取發表之論文 47 篇，其中台灣獲錄取者僅 3 篇，發表論文主題則於公共空間之間監控系統、網路資料資訊安全與影像鑑識科學等議題，此些題目皆是安全防護重要之議題，尤其是 911 攻擊事件之後，進而又有英國倫敦、西班牙馬德里、巴里島及近期之塑膠液體炸彈等恐怖攻擊事件，其安全防範更應受到重視，尤其是機場安全等課題，更需要與參與的學者與國安人員經驗交換，此一類型之會議，應鼓勵相關單位人員參與。

同時，英國國土科技發展局(Home Office Scientific Developing Branch)亦派員於會中介紹該單位之使命與工作內容，該單位擁有 200 多餘爲的科技與技術人員，並致力於學術界與產業界結合，運用科技技術打擊犯罪，例如於機場防止走私、犯罪現場指紋資料採集與鑑識或是處理數以千百計之 CCTV 視訊資料，皆是該單位之使命，國內調查局也於本次會議中，介紹國內於犯罪之鑑識科學上的成果，成立專業之網路安全監控實驗室，與英國 HOSDB 的目標一致，類似之專責機構需要大量經費與人力，需要政府編列預算，逐一實現，更重要的事，人才的培育不易，需要教育單位與教師，投入心力培養相關的專業人才。

在 21 位的執行委員會議中指導委員，國內就佔兩位，皆是國安單位人員，可見此一議題之研討會已受國內重視，建議多多鼓勵國內研究單位參加，藉此彼此了解，尤其國內目前之資訊安全相關產業蓬勃發展，各種安全監控之軟硬體技術可與世界先進技術接軌，甚至可超越，藉由此一研討會，除可提升我國在國際間的學術地位，亦可以國外友邦之國安人員進行交流，一舉數得。卡拉漢國際年會議經常鼓勵參加者，經由他們於社會中的工作影響力，協助與會得人士於安全議題上的經驗傳承與諮詢，卡納漢會議長遠以來，也支持願意提供負責安全的當局和代理一個的管道，將付諸於安全和法律層級過程中，所需要使用或是將來需要的技術與實施流程，努力地將每一次相關訊息傳遞出去，以確保某些單位，尤其是對工程相關背景陌生的單位，能夠提供充分而正確的訊息，亦可藉由此一研討會機會，多方與友善的國安單位接洽，以強化我國防安全。

附錄

1. 與會活動照片：

大會總主席致詞

萊辛頓市市長 Teresa Ann Isaac 致詞

美國國家 Los Alamos 實驗室安全室主任 Roger Hagengruber 博士專題演講

論文發表：利用色彩特徵，於公共開放空間中之限制區域，非法進入者之偵測

FINAL PROGRAM

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FINAL PROGRAM

PURPOSE

This international conference is directed towards the research and development aspects of electronic security technology. It establishes a forum for the exchange of ideas and dissemination of information on both new and existing technology. Conference participants are encouraged to consider the impact of their work on society. The Carnahan Conference also provides a basis for long-range support and assistance to authorities and agencies responsible for security, safety and law enforcement in the use of available and future technology. A conscious effort will be made to communicate the significance of developments to other interested groups. Liaison is maintained with professional societies and information media not especially related to engineering.

CONFERENCE VENUE

Located at the heart of Central Kentucky's famed scenic Bluegrass Region, Lexington is known around the world for champion racehorses and fine bourbon.

Lexington is the center of the world's Thoroughbred horse industry and is where the top racehorses are bred, born, trained, officially registered, bought and sold, retired to stud and buried. In the Bluegrass, you can meet previous Derby champions - or perhaps catch a glimpse of a future winner on the world's most famous horse farms. Keeneland Race Course, a beautiful park reminiscent of those in England, holds race meets annually in April and October and sales throughout the year. The Kentucky Horse Park, a 1,200 acre park dedicated to all breeds of horse, offers visitors a chance to interact with horses and will be the first North American host of the World Equestrian Games in 2010. Lexington truly is the Horse Capital of the World!

Nearly 100% of the world's bourbon is produced in Kentucky! Visit the home of true Kentucky bourbon where time-honored methods developed in the early 19th century are still used today. Woodford Reserve, Buffalo Trace, Four Roses & Wild Turkey offer tours that unlock the mysteries and heritage of the United States only native spirit.

Lexington's beauty and activities span the four seasons. Meet past and future Kentucky Derby winners and get a behind-the-scenes look at the multi-billion-dollar Thoroughbred industry on personalized horse farm tours. Visit The Kentucky Horse Park the world's only state park dedicated to the horse. Get a taste of the racing industry with Keeneland Race Course's early morning workouts and breakfast at the Track Kitchen. Arrange a hub-and-spoke tour to nearby Shaker Village community. Enjoy afternoon teas and garden tours while exploring a herb farm or historic homes. Explore the area's Civil War sites or take an educational distillery tour and learn the history of bourbon. Plan an antique shopping excursion among over 200 area stores.

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2006 IEEE ICCST Program-Final

Monday, October 16, 2006

6:00–8:00pm
Registration and Reception (Radisson Hotel, Mezzanine floor)

Tuesday, October 17, 2006

8:00am–5:00pm
Registration

8:30–10:00am
Welcome Address – Mayor Teresa Ann Isaac
ICCST Opening Address – Mr. Larry Sanson,
Conference Chairman, ICCST
Keynote Address : Mr Roger Hagengruber, Chief Security Officer, Los Alamos National Laboratory

10:00–10:30am
Coffee Break

10:30–12 noon
Session 1: Sensors I
Session Chairman: Mr. Gordon Thomas

Proximity Detection and Ranging Using a Modified Fluorescent Lamp for Security Applications
John Cooley, Al Avestruz, Steven Leeb

A Proposed Motionless Laser Scanning Architecture for Perimeter Security
Kaveh Sahba, Kamal E. Alameh, Clifton Smith

Power Options for Wireless Sensor Networks
Bradley C. Norman

Practical High -Frequency Sonar for Intruder Detection in Very Shallow Environments
Steven Younghouse

12:00-1:30pm
Lunch

1:30-3:00pm
Session 2: Sensors 2
Session Chairman: Mr. Brian Rich

A System and Method for Enhanced Psychophysiological Detection Of Deception, Assured Client Verification with Remote Processing
Colonel(USA-Ret) William I. Ames Jr., Jean Louis Gouin

Mobile RAVIN: Intrusion Detection and tracking with organic airport radar and video systems
Ann Barry, David Mazel

Force Protection Sensor Selector
Lindamae Peck, Richard Bates

Security Simulation for Vulnerability Assessment
Brian Hennessey, Bradley Norman, Robert B. Wesson

3:00-3:30pm
Break

3:30–5:00pm
Session 3: Video Advances
Session Chairman: Mr. Daniel Pritchard

Considerations for Implementing an IP Based, Video Assessment and Surveillance System
Cole Shaw, Jack Connell, Robert M. Riley

Quality Enhancement of Security Image Information
Milos Klima, Karel Fliegel, Jan Svihlik

Illegal Entrant Detection at a Restricted Area in an Open Space Using Color Features
Chin-Chuan Han, Jau-Ling Shi, Kai-Chiun Yan

Imagery Library for Intelligent Detection Systems (i-LIDS)
A Standard for Testing Vision Based Detection Systems
Paul Hosmer

Wednesday October 18, 2006

8:30–10:00am
Session 4: Biometrics I
Session Chairman: Mr. Rick Lazarick
Keynote Speaker: Mr Tom Hewett, Professor Drexel University

Biometric Access Control and Crisis Management for Athletic Events
Christos K. Dimitriadis, Despina Polemi

Implementing Ergonomic Principles in a Biometric System:
A look at the Human Biometric Sensor Interaction(HBSI)
Eric Kukula, Stephen J. Elliott

Multimodal Biometric System Based on Hand Geometry and Palm-Print Texture
Miguel A. Ferrer, Carlos M. Travieso, Jesús B. Alonso

Face Recognition Using a Radial Basis Function Classifier
Marcos Faundez-Zanuy, Enric Monte-Moreno

10:00–10:30am
Break

10:30–12:00noon
Session 5: Biometrics II
Session Chairman: Mr. Michael Jonckheere

Architecture of a Search Engine for Massive Comparison in an Iris Biometric Sytem
Judith Liu-Jimenez, Raul Sanchez-Reillo, Almudena Lindoso, John G. Daugman

Analyzing User Password Selection Behavior for Reduction of Password Space
Roman V. Yampoiskiy

Keystroke Dynamics Verification Using a Spontaneously Generated Password
Shimon Modi, Stephen J. Elliott

Aliveness Detection for Iris Biometrics
Andrezej Pacut, Adam Czajka

12:00–1:30pm
Lunch

1:30–3:00pm
Session 6: Biometrics III
Session Chairman: Mr. Alfonso Bilbao

On the Vulnerability of Fingerprint Verificaion Systems to Fake Fingerprint Attacks
J. Galbally-Herrero, J. Fierrez-Aguilar, F. Alonso-Fernandez, J. Ortega-Garcia, M. Tapiador

Improvement in Security Evaluation of Biometric Systems
Raul Sanchez-Reillo, Judith Liu-Jimenez, Michael G. Lorenz, Luis Entrena

Perceptions of Retinal Imaging Technology for Identifying Livestock Exhibits
Christine R. Blomeke, Brian M. Howell, Stephen J. Elliott

Hill-Climbing and Brute-Force Attacks on Biometric Systems:
A Case Study in Match-on-Card Fingerprint Verification
M. Martinez-Diaz, F. Alonso Fernandez, J. Fierrez-Aguilar, J. Ortega-Garcia, J. A. Siguenza

3:00–3:30pm
Break

3:50–5:00pm
Session 7: Biometrics IV
Session Chairman: Mr. Mark Stroud

An Instant Messaging Intrusion Detection System Framwork:
Using character frequency analysis for authorship identification and validation
Angela Orebaugh

A Study to Develop a Consensual Map of Security Expert Knowledge Structure
David J. Brooks

Evaluation of Supervised versus Non-Supervised
Databases for Hand Geometry Identification
Miguel A. Ferrer, Marcos Faundez-Zanuy, Carlos Travieso, Joan Fabregas, Jesús B. Alonso

An Assessment of Dynamic Signature Forgery and Perception of Signature Strength
Stephen J. Elliott, Adam Hunt

6:00–11:00pm
Banquet

Thursday October 19, 2006

8:30–10:00am
Session 8: Information Protection and Assurance I
Session Chairman: Mr. Clifton Smith

CALEA Compliant Secure Voice Over IP System
Nagaraja Thanthry, Christopher Goodrich, Ravi Pendse

A Novel Mechanism for Improving Performance and Security of
TCP Flows over Satellite Links
Nagaraja Thanthry, M. Deshpande, Ravi Pendse

On-Board Encryption in Earth Observation Small Satellites
Roohi Banu, Tanya Vladimirova

Quantifiable Security Metrics for large Scale Heterogeneous Systems
Syed Naqvi, Prof. Michel Riguidel

10:00–10:30am
Break

10:30–12:00noon
Session 9: Information Protection and Assurance II
Session Chairman: Mr. So-Lin Yen

The Unexpected Value of Hybrid RMS Risk Management
Ross Paul Goeres

Asynchronous Cryptographic Hardware Design
John Teifel

An Architecture for Multi-Security Level Network Traffic
Edward L.Witzke, Steve Gossage, Dallas J. Wiener

A Product Based Security Model For Smart Home Appliances
Davar Pishva, Keiji Takeda

12:00–1:30pm
Lunch

1:30–3:00pm

Session 10: Networks
Session Chairman: Mr. Tom Wood

Security Threats in Wireless Sensor Networks
Hiren Kumar Deva Sarma, Avijit Kar

Experimental Validation of an Intelligent Detection and Response Strategy for Complex Infrastructure Attacks and False Positves Using Firewalls
Emmanuel Hooper

Virtual Perimeter Security (VPS) in Physical Protection System
Bradley C. Norman, Douglas G. Adams

Control of Perimeter Surveillance Wireless Sensor Networks Via Partially Observable Marcov Decision Process
Lucas W. Krakow, Edwin K. P. Chong, Kenneth N. Groom, John Harrington and Yun Li, Brian Rigdon

3:00–3:15pm
Break

3:15–4:45pm
Session 11: Analyses
Session Chairman: Mr. John D. Veatch

Maritime Vessel Stopping
Less than lethal means of stopping waterborne vessels
Simon Peaty MSc

Evaluating Risk from Acts of Terrorism with Belief and Fuzzy Sets
John Darby

Profiling Toolmarks on Forensic Ballistics Specimens: An Experimental Approach
Clifton L. Smith

The Study on Planning and Building a Cyber
Forensic Laboratory in MJIB, Taiwan R.O.C.
So-Lin Yen, Sou-Chan Chen

4:45–5:00pm
Conference Closing
Mr. Larry Sanson, Conference Chairman

Back-up Papers

Security and Information Systems for Air Company
Rudolf Volner, Vladimír Smrz

Intelligent Language Comprehension System for Automatic Data Analysis
Chung-Lung Tsai, Thomas Chiang Chuang

Illegal Entrant Detection at a Restricted Area in Open Spaces Using Color Features

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Abstract

Developing an automatic and intelligent system to detect, track, recognize, and analyze moving objects could save human power in monitoring centers. In this study, the color features of an employee's uniform were extracted to identify the entrance legality in a restricted area of an open space. The body of an entrant was segmented into three parts for locating the region of interest (ROI) using a watershed transform. Dominant color features extracted from the ROI were classified for preventing the illegal entrance. Some experiments were conducted to show the feasibility and validity of the proposed system.

Keywords: *video surveillance, legality detection, color structure descriptor, color feature, watershed transform*

1. Introduction

Due to cost-down of capturing devices, monitoring cameras are widely used in public areas. Currently, many realizable systems using computer vision and image processing techniques intelligently detect, track, recognize, and analyze objects, especially human beings[6, 5]. In an open space, people can move around freely without any limitation. However, there is no entrance control in restricted areas like at information desks in airports, cash counters in shops, pharmacy/nursing stations in hospitals, . . . , etc. Important data or money must be protected in these areas. Surveillance systems observe the entrants and try to grab their face images for ID identification or legality verification. Grabbing clear frontal face images is a common and effective approach for computer-based recognition systems. Different from the entrance control applications, face images in low resolution, in side views, or in a back view, are frequently grabbed from still cameras in an open space. Successfully grabbing recognizable face images for legality verification has a low probability. Poor image quality decreases the monitoring performance. Fortunately, there is a common point in restricted areas: all legal entrants dress in uniforms. In this study, the color features of a uniform were extracted for verifying the legality of entrants.

Illegal entrance could be considered as an abnormal event. Due to the poor quality of face-based verification, other object features such as trajectory, shape, color, and motion data, are adopted to detect the abnormal events. These features have been widely used in content-based image retrieval (CBIR) fields[10]. Trajectory features are the most used for rare event detection at intersections, parking lots, or freeways for intelligent transportation systems (ITS) [11, 7], at airports[4], or on campuses[9]. Motion features are also popular for human behavior analysis. They are extracted from video streams in both uncompressed and compressed domains. Human motion extracted from motion-history images[3], motion-energy images[3], moment features[13], and polar-based histograms[1] are used to analyze human actions. It is known that human behavior is represented as a sequence of actions in the spatio-temporal domain. All approaches use the hidden Markov model (HMM) to solve this spatio-temporal problem. However, humans seldom behave as robbers with fierce motion or an abnormal trajectory in restricted areas. Their actions frequently appear to be similar to those of legal users. That means motion and trajectory features are not suitable in restricted areas. Uniform color is another cue for the verification of entrance legality.

In many pattern recognition applications, three common steps, *preprocessing, feature extraction,* and *classification*, are sequentially performed. In this study, moving object detection, tracking, segmentation, and region of interest (ROI) location were classified as the preprocessing step. A background subtraction based object detection was first performed and then targets were tracked based on the color structure descriptors. Next, the detected block image was segmented using watershed transform in four steps: *image simplification, gradient computation, rain-falling processing,* and *block merging.* In identifying the human body parts, circularity and human body model-based schemes were designed for identifying the head region, the upper body, and the lower body. The ROI was thus determined for extracting the colors of the uniform. A neural network-based verification was conducted to determine the entrants' legality.

The rest of this paper is organized as follows: Moving object detection and tracking are presented in section 2. Next, human body segmentation to find the ROI was designed using watershed transform as described in section 3. The legality of an entrant was determined in section 4 using color features of the uniform. In section 5, some experimental results were conducted to show the validity of the proposed approach. Finally, some conclusions are given in section 6.

2. Moving Object Detection and Tracking

Moving object detection and tracking are essential processes in video surveillance. In this study, the background subtraction-based technique was adopted to identify the changing pixels. Next, a labeling process was performed to cluster the blob components of objects. Each object was bounded in a bounding box from the connected components. Subsequently, the detected objects were tracked and re-labeled. Generally, the size and position of an object were predicted using historical data. Histogram-based matching is an effective approach for identification, especially in the case of 'merging'. Exact labels of objects were assigned in new frames.

Instead of the color histogram, the color structure descriptor (CSD) of MPEG-7 standard was adopted for object representation during the tracking of the objects. The color data of an object in RBG color space were first converted to HMMD color space data (*Hue, Max, Min, Different*). The *hue* value ranged from $0°$ to $360°$. The *min* and *max* features represent the minimum and the maximum values of the R, G, and B values. The *diff* and *sum* features denote the different feature($diff = max - min$) and the summation feature (e. g. $sum = (max + min)/2$), respectively. According to the MPEG-7 standard, color data were quantized into 64 bins. The CSD expresses the local color structures in an image. To obtain the CSD of an object, the color data within a window were quantized and counted. This window was called the *structuring element* (SE) and set as 8 by 8. If one color appeared within the SE, the number in the corresponding bin was increased by one. The SE slid from top to bottom and from left to right. The CSD of size 64 was generated. The distance metric of CSD between two objects was defined as the summation of the absolute difference values, e.g., the L_1-norm based distance. More details could be referred in References[10].

3. Human Head/Body Segmentation and Identification

In this section, the human body segmentation algorithm proposed by Park and Aggarwal[12] was modified to find the head, the upper body, and the lower body for identifying the ROI.

3.1. Segmentation of Human Body Using Watershed Transform

The metric in CIELab color space is similar to that of human vision perception. Object images in RGB color space are thus converted to CIELab color space images before the process. Park and Aggarwal[12] proposed an expectation maximization (EM) algorithm to estimate the Gaussian components of color distribution for image segmentation. Each region with a similar color belongs to the same cluster. It takes a lot of computational time to obtain the segmentation results. The watershed transform-based approach was applied for efficiently segmenting the human body regions. Four steps, *image simplification, gradient computation, rain-falling processing,* and *block merging,* were performed in watershed transform for body segmentation.

The main function of image simplification was to filter out noise and to blur the images. For the sake of simplification, morphology-based closing operations by partial reconstruction $\varphi^{(\text{res})}(\delta_n(f), \varphi_k(f))$ were performed as follows[14]:

$$\varphi^{(\text{res})}(f, r) = \varepsilon^{(\infty)}(f, r) = \varepsilon^{(1)}(\varepsilon^{(1)}(f, r)) \ldots, r). \quad (1)$$

In the second step, the morphological gradient[8] was generated for obtaining the gradient magnitude defined as $G(f) = \delta(f) - \varepsilon(f)$. Three gradient images G_L, G_a, and G_b on channels L, a, and b were generated and integrated to obtain an effective gradient image $g = \max(w_L G_L, w_a G_a, w_b G_b)$, where weights were set as $w_L = 1, w_a = 2$, and $w_b = 2$, respectively.

Third, a rain-falling process was executed for region growing using a pre-labeling strategy. Two advantages were presented in this strategy: the over-segmentation problem was solved, and the rain-falling process for the pre-labeled pixels became unnecessary. Therefore, the watershed transform process was performed. Initially, if the gradient magnitude of a pixel was lower than a specified drowning level t, this pixel was marked as the candidate of an initial region. Here, t was set as 0.6 of the average value of the gradient image. After all pixels were examined in this step, a labeling process was performed to obtain the initial regions and the new labels were assigned under the drowning level t. The direction of unmarked pixels was defined to point to the neighbor with the lowest gradient magnitude. All unmarked pixels were assigned a region label by following their gradient downhill to the initial region.

The block merging rules were based on the block features such as size, color, and adjacency in the fourth step. These features for a specified block A_i were represented by the block size $|A_i|$, the mean vector of block color $\mu_i = [\mu_L, \mu_a, \mu_b]$, the boundary set $\Psi(A_i)$, and the adjacency rate $\beta_i(A_j) = \frac{|\Psi(A_i \cap A_j)|}{|\Psi(A_j)|}$ of two blocks A_i and A_j. The merging rules were designed as follows:

Rule Adjacency: If the adjacency rate was larger than a given threshold T_1, e.g., $\beta_i(A_i) > T_1$ or $\beta_j(A_i) > T_1$, the two blocks were merged.

Rule Color Consistency: If the color distance between two adjacent blocks was smaller than a predefined value, e.g., $|\mu_i - \mu_j| < T_2$, the two blocks were merged. The L_2-norm based distance was adopted in this step.

Rule Size: If the size of block A_i was smaller than a threshold T_3, e.g. $|A_i| < T_3$, block A_i was merged to the adjacent block with the highest color similarity.

Three merging parameters T_1, T_2, and T_3 were set as 0.7, 15, and 50, respectively. For instance, Figs. 1(a), (b), and (c) show an original image, the results of watershed transform, and the merged result, respectively.

3.2. Identification of Human Body Parts

In order to find the ROI, a circularity-based measure and a merging scheme were designed for identifying the head, the upper body, and the lower body. Compared with the other body parts, the human head is a region with stable and obvious features[2]. In this study, the circularity measurement was adopted to evaluate the merged blocks for finding the head region. The lower and the upper body parts were determined based on the ratio of the human body.

The circularity measurement C is formulated as $C = \frac{\mu_A}{\sigma_A}$, μ_A and σ_A represent the average distance and the standard derivation of distances from all boundary points to the centroid of block A. The merging sequence of blocks was based on the y coordinates of the blocks' centroids. The finding steps are described as:

Step 1: Sort the y coordinates of the blocks' centroids from top to bottom, initialize a list $\mathcal{R}_0$ as an empty set, and set an iteration index $k = 1$.

Step 2: Add the top unselected block A_i to list $\mathcal{R}_{k-1}$, i.e. $\mathcal{R}_k = \mathcal{R}_{k-1} \cup A_i$, to obtain a new block.

Step 3: If the size of block $\mathcal{R}_k$ is larger than $N/3$, terminate this procedure, and set the head region by choosing the region with the skin color and the largest circularity value. If not, choose the region with the largest circularity value.

Step 4: Compute the circularity value C_k for region $\mathcal{R}_k$. Increase the iteration index k by one and repeat the above Steps 2 to 4.

After finding the head region, the upper body part was set as the region of length $2L$, e.g. twice that of the head region. The rest of the regions of a moving object were classified as the lower body. When the color of the upper and the lower parts was similar, the parts were merged in the segmentation process. This scheme can also separate it into two parts. The upper body was considered as the ROI in a 7-11 shop, and the entire body was treated as the ROI in a laboratory. Three regions for the illustrated images were identified as shown in Fig. 2.

4. Construction of Uniform Color Model

In this section, the color features of a uniform are extracted and classified for determining legality. An example for dominant color extraction is given. The image data of legal entrants were collected in the training phase. Using the segmentation algorithm for the human body in the previous section, the ROIs of human bodies were successfully identified as shown in

Fig. 3(a). The colors of the uniform were automatically modeled in CIELab color space. Since the number of dominant colors within the ROI was unknown, it had to be determined first. The images as shown in Fig. 3(a) were segmented into several blocks. Carefully analyzing the block colors within the ROI, all pixels with similar color were grouped together. Each block could be represented by its mean vectors and classified using the components of channels a and b. Moreover, blocks smaller than 5% of the ROI were ignored. The *maxmin-distance-based* clustering algorithm was adopted to cluster blocks as shown in Fig. 3(b). Each small circle represents a segmented block. Two dominant color prototypes within the ROI were obtained in this illustration.

The distribution of each color prototype was computed from the pixels belonging to the same cluster. It could be formulated in the following steps.

1. Compute the mean μ and the standard derivation σ of each color prototype.

2. Remove those pixels whose distances to the cluster center are larger than a threshold value(3σ).

3. Remove the isolated pixels using the morphology-based clustering technique.

4. Bound the region using a convex hull.

The above steps identified the range of each dominant color. The range was bounded by a convex hull represented in several polynomial functions. In the given illustration, the distributions of two dominant color prototypes, blue and green, are displayed in Figs. 3(c) and 3(d), respectively. Since the range of dominant colors have been identified, the pixels belonging to the dominant colors were counted(Fig. 3(e)).

Since the entrants freely moved in a monitored space, the poses were varied with the time. Besides, the appearance of every entrant was also different. Because of the above causes, the ratios of dominant colors within the ROI were different at different times. Using the ratios of dominant colors within the uniform regions was not enough to determine legality. The spatio relations between color pixels also helped discrimination. Similar to the CSD-based representation, a structure element of size 8 by 8 slid the ROI, and the numbers of dominant colors were counted to generate the feature vectors of the uniform. In the given example, the numbers of two dominant colors within the structuring element were counted as shown in Fig. 3(f).

Consider the feature vectors of dimensionality n to be inputted into a Backpropagation neural network-based (BPNN) classifier. In this study, this well-known classifier was applied to perform the verification task. The BPNN architecture was designed as a three layer-based network including an input, a hidden, and an output layer. There were n, $\frac{n+1}{2}$, and 1 neurons in each layer, respectively. Positive and negative training samples were collected from video streams. Fully connected links were established and trained for finding the better weights. Each entrant's uniform features were extracted and verified by the designed BPNN for legality verification.

5. Experimental Results

The proposed method was implemented in a 7-11 shop and in a laboratory. In the 7-11 shop, the restricted area was set at the cash counter, and in the laboratory, it was set at several personal desks. When the centroid of an entrant was located at an area, the detection procedure was triggered. Eight illustrations are given from Figs. 4 to 7. In each figure, two image sequences were identified for the legality. Illegal entrants were detected and bounded in the red rectangles. In order to show the detection rate, 65 video sequences, 40 legal and 25 illegal, were collected in a 7-11 shop. 15 legal and 15 illegal entrants were randomly selected in the training phase. The others were used for testing. The false acceptance rate (FAR) and false rejection rate (FRR) were 0.1 and 0, respectively. Similarly, 30 video sequences were collected in a laboratory; 16 were used for training. The FAR and FRR for the other video data were both 0.067.

According to the performance requirement, the event decision should be made within a few seconds. In the proposed approach, detecting and tracking moving objects needed 0.11 seconds per frame in both experiments. The legality identification included two sub-processes: the body segmentation and the uniform color extraction. The needed time depended on the object sizes and the block number within the ROI. The object sizes and the block number in a 7-11 shop were larger than those in a laboratory. Therefore, the legal identification in a 7-11 shop needed 0.37 seconds per frame, and it needed 0.14 seconds per frame in the laboratory. In summary, two image frames in a 7-11 shop and four image frames in a laboratory were processed in one second for illegality detection.

6. Conclusions

In this study, the color features of the uniform were extracted to determine the legality of entrants. This approach is suitable for use in a large space where the image resolution is low, the image quality is bad, or where there are back face images. In addition to the detection and tracking of moving objects, ROI identification and dominant color extraction were the main tasks used for representing the uniform. The CSD of the uniform color was extracted and inputted into the NN-based classifier for the legality decision. In future, the video clips of illegal entrances will be collected and indexed for further retrieval.

References

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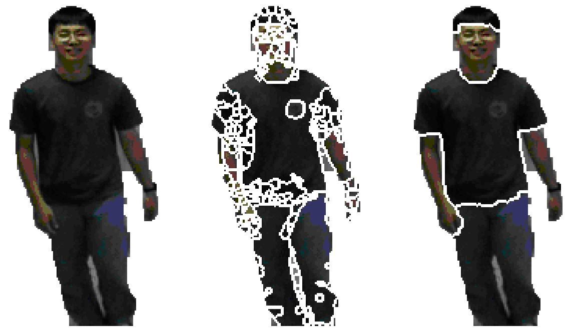
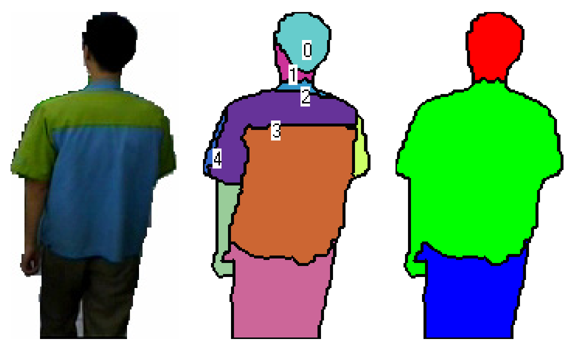


(a) (b) (c)

Figure 1. The segmentation results using watershed transform. (a) A detected object, (b) the segmentation result using watershed transform, and (c) the block merging results.



(a) (b) (c)

Figure 2. The identi£cation of a head region using a circularity-based measure.

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Acknowledge

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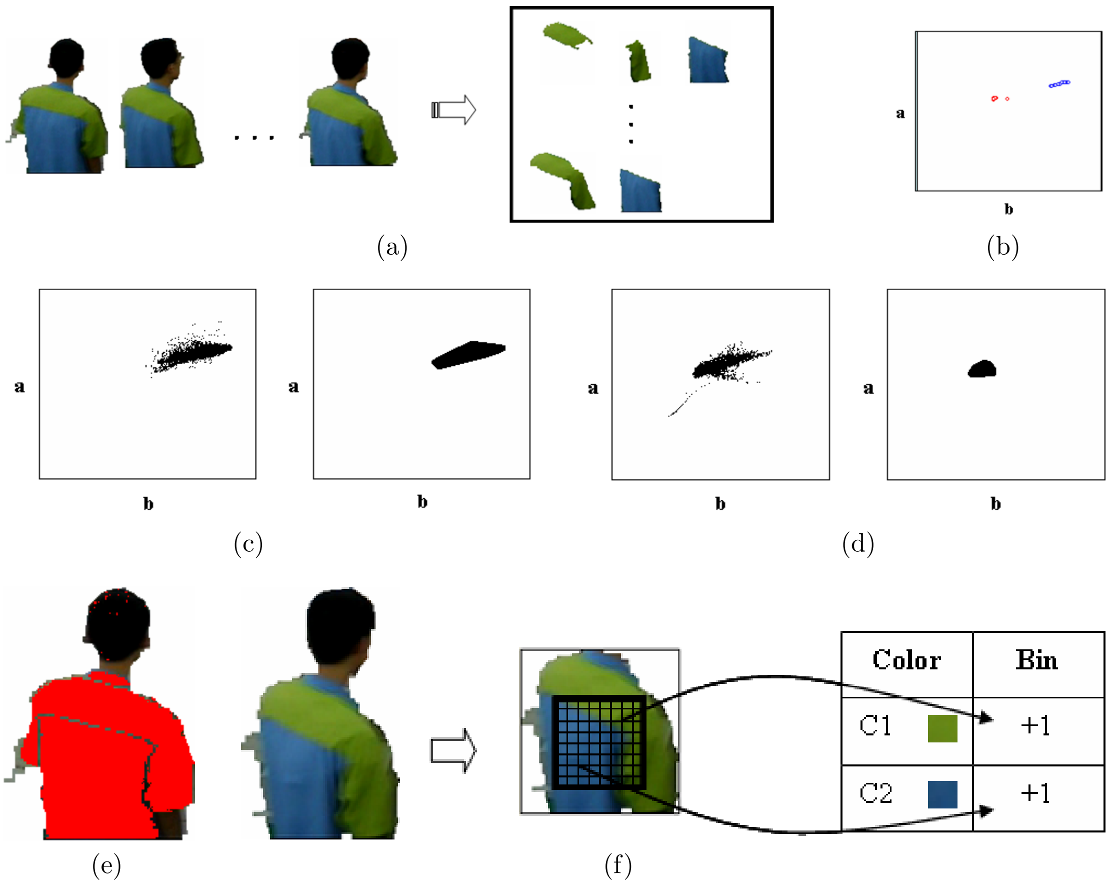
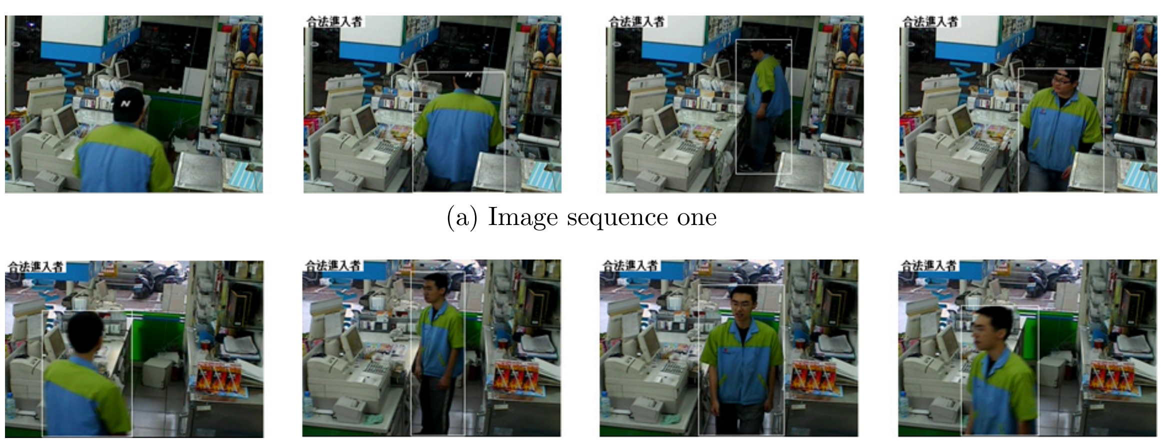


Figure 3. The generation of dominant colors within the ROI. (a) the ROI images of training samples, (b) the classi£cation instances, (c) the prototype of a blue color, (d) the prototype of a green color, (e) the pixels belonging to the dominant colors, and (f) the CSDs of dominant colors within the ROI.



(a) Image sequence one

(b) Image sequence two.

Figure 4. Two legal entrants in a 7-11 shop.

(a) Image sequence one

(b) Image sequence two.

Figure 5. Two illegal entrants in a 7-11 shop.

(a) Image sequence one

(b) Image sequence two.

Figure 6. Two legal entrants in a laboratory.

(a) Image sequence one

(b) Image sequence two.

Figure 7. Two illegal entrants in a laboratory.