行政院國家科學委員會專題研究計畫 成果報告

兩性平權之智慧生活空間的設計與實作
研究成果報告(精簡版)

計 畫 類 別 ：個別型
計 畫 編 號 ：NSC 96-2629-E-431-001-
執 行 期 間 ：96 年 11 月 01 日至 98 年 01 月 31 日
執 行 單 位 ：佛光大學資訊學系(所)

計 畫 主 持 人 ：駱至中
共 同 主 持 人 ：范國清
計畫參與人員： 碩士班研究生-兼任助理人員：林志展
碩士班研究生-兼任助理人員：林秀
博士班研究生-兼任助理人員：陳映濃

報 告 附 件 ：出席國際會議研究心得報告及發表論文

處 理 方 式 ：本計畫涉及專利或其他智慧財產權，2 年後可公開查詢

中 華 民 國 98 年 04 月 29 日

行政院國家科學委員會專題研究計畫 成果報告

兩性平權之智慧生活空間的設計與實作

The Design and Construction of Intelligent Surveillance Systems for Better Safety Protection of Female

計畫編號：NSC 96-2629-E-431-001
執行期限：96 年 11 月 1 日 至 98 年 1 月 31 日

主持人： 駱至中 佛光大學資訊學系 副教授
共同主持人：范國清 國立中央大學資訊工程系 教授
計畫參與人員： 陳映濃 中央大學資訊工程系 博士生
林志展、林秀 佛光大學資訊學系 碩士生

一、中英文摘要

在目前的台灣社會中，因社會治安案件頻傳而許多無辜民眾受害，其中又以女性受害的比例居高。之所以會有這種現象，一方面是因為女性的抵抗能力較為不足，另一方面是我們現有對於女性的安全機制是存有許多死角的，而其原因在於所裝設的監控攝影機是被動式的，它們只能事發之後提供搜證和追蹤，卻無法及時反應以避免悲劇發生。因此，我們在本研究專題中計畫將以三年時間分三階段設計一個以視覺為基礎之智慧型監控與防護系統，此一提案系統將針對開放區域之女性安全，透過監控與各項智慧型與自動化偵測和辨識技術提供可預警及防護。提案系統的主要功能與目的即在於將像是女性專有空間有男性進入、暗夜中女性被人尾隨、…等等各種危險事件及早偵測出來，以強化對女性的安全防護。之後，同一智慧型監控系統模式還能更進一步地擴充其防護範圍，加入對容易發生意外的老年人跟小孩(女性為主)監控，避免更多意外情形的發生。在整個研究專題的第一階段（即本研究成果報告內容）中，我們係以特定女性專有空間的安全性監控與防護為主，透過架設在開放場所的攝影機，針對區域內所有人物進行性別偵測。監控過程中，我們會先對人物進行臉部偵測、再辨識其性別，之後根據目前的區域環境，像是女性廁所或是女性專有的特定空間如果有男性闖入，將提前發出警告，預防意外發生。未來在第二階段，我們將針對像是女性被人尾隨了幾個路口後被歹徒脅持…等等各種可能發生意外的危險狀況，進行偵測與預警以強化公共空間女性安全防護能力。本年期研究中，我們將利用架設在每個路口的攝影機來達成目標，這部份包括了性別、特定人物和危險事件樣模(pattern) 的定義與偵測，在可能發生意外的情形之下自動的提出警告。在本研究計畫的第三階段預計會針對容易發生意外的老年人與小孩(仍以女性為主)進行監控，隨時偵測目標是否處於危險狀態中，像是老年人發生跌倒，小孩獨自一人等可能造成危險之狀態提供預警，希望可以提高整個系統的泛用性。最後，則要將所有技術作完整的整合，產生出一套可真正降低危險事件以強化女性安全防護的智慧型監控系統。

Abstract

In current Taiwan society, social criminal events frequently occur, especially for those woman victims. The reasons that cause this phenomenon are twofold. First, the self-defense capability of woman is weaker relatively. Second, the security mechanism in our society conceals some blind points. The mounted surveillance devices are passive. Only after-happening events can be traced. The passive devices can not react actively. In this project, we plan to devise a vision-based surveillance system for open spaces to ensure the security of woman. It can provide pre-caution warning by detecting abnormal and dangerous events before happening, such as the intrusion of man in woman-only spaces, the following of woman by strangers in the dark, and the care of elder and younger woman. In the first phase (this year), we focus on the monitoring of woman-only special spaces. Through the mounted cameras, we perform gender recognition first through face detection to determine the sex of enterer. Then issue alarms to warn the intrusion of non-woman in woman-only spaces, such as woman toilets and breeding room. After that, in the second phase of this proposed research, we plan to detect the events of following and kidnapping of woman in dangerous places through behavior analysis. Finally, in the third phase, we'll emphasize on the care of elder and younger woman, such as the falling and accidents that frequently occur in stay-alone places. With the developing of the techniques in the three years, we will integrate all the techniques to form an event detection system to ensure the security of woman either in private or open spaces.

關鍵詞：智慧型監控、智慧型與自動化偵測、女性專有空間。

二、緣由與目的

近年來社會上治安案件頻傳，其中特別值得我們注意的是： 絕大部份的治安案件的受害者都包含了較為弱勢的婦女、老人與小孩，而我們現今在各公共空間裝設監視攝影機的密度雖已經大幅的提高，但是社會治安案件的發生數量卻依舊居高不下。這些監視攝影設備僅是以被動式的設計裝設，它們目前的功能因而只能消極地在搶劫、性侵害、妨害自由等社會治安案件發生之後，以被動的查詢功能提供相關單位搜證和追蹤線索以緝捕罪犯，但卻無法及時反應以避免悲劇發生。有鑑於此，如果我們可以從現有的監控環境佈署中結合影像處理、自動化偵測及辨識、人工智慧等技術來加強這些監控攝影機的功用，針對一些限制區域作安全性的提升，由被動式的攝錄影轉進為主動式的智慧型監控、預警和安全防護，即可有效提升婦女安全防護並預防意外事件之發生。因此，本研究計劃案的主要目標即是針對婦女老人跟小孩，設計並實作一個以視覺為基礎之智慧型監控與防護系統，其中利用攝影機主動式的監控限定的場所，以成熟穩定的智慧型視覺與自動化偵側及辨識機制全面性地提升攝影機監控之效能，以準確且預先發出警告達防範未然之目的，減少社會事件的發生更強化公共空間中對女性安全防護能力與程度。

三、相關研究

與本計畫中的相關研究部分，最重要的在於針對目標物行為去區分為正常與異常兩種情況，由於異常資料較不易取得，因此大部份的研究會針對正常行為來討論。過去關於物體正常行為的研究，可分為監督式與非監督式兩種，所謂的監督式即需事先定義判斷的準則；反之，非監督式即自動地學習資料的分布，找出資料的主要特徵。而監督式的方法可分為下列幾種：

(1) Dynamic time warping (DTW)：DTW 是一種以 template 為基礎的 dynamic programming 比對方法，過去常用於語音辨識上，而近幾年也常被用來比對物體的行為，像是 Bobick et al. [2]使用 DTW 的方式來辨識一段連續的手勢。

(2) Finite state machine (FSM)：FSM 最主要的地方為定義狀態轉換圖，而所謂的狀態是用來比對輸入資料與測試資料的關係，像是 Wilson et al. [3] 即使用 FSM 來表示連續的手勢特徵。

(3) Hidden Markov Models (HMM) : HMM 為一種以機率為基礎的辨認模式，可以用來處理複雜的資料，一般分為兩個階段:「訓練」和「比對」。在訓練階段，必須事先決定 HMM 的狀態個數,並計算出轉態轉換機率， 來產生與輸入特徵想對應的 symbols；而在比對階段，即利用轉態轉換機率來計算輸入特徵所產生的一段 symbol sequence。過去 HMM 常用在語音以及手勢辨識上，而最近常被使用在人體走勢方面的辨識。

非監督式的方法大部分都使用 self-organizing neural network 來訓練資料，也有少部份使用其他的訓練方法，以下分別介紹過去式曾經所使用的非監督學習方法：

(1) Gaussian Mixture Model (GMM) : GMM 為一種機率密度分布的函式(PDF)，過去常用在語音辨識上，對於軌跡的研究，一般來說會使用 PCA 或是 ICA 擷取出軌跡的特徵,並用 GMM 來 model 此 PCA 或是 ICA 所表示的軌跡,像是 Bashir et al. [12]將軌跡利用曲度分割成許多區段，並用 PCA 來表示此區段軌跡,接著再用 GMM 來 model 此 PCA-based 的區段軌跡分布。

(2) Self-Organizing Neural Network (SOM) : SOM 為一種自我學習的非監督式類神經網路，可自動的學習資料的分布，而不需事先定義資料的特性，像是 Johnson et al. [13]用特徵向量來表示一個軌跡點的位置與速度的資訊，並用兩個競爭式的類神經網路來學習軌跡的分布，Johnson 也將此方法應用到人與人之間的互動,像是握手等;Sumpter et al. [14]將 Johnson et al. [5]的第 2 層類神經網錄加入回饋的階段，使其更能表示物體的行為；而 Hu et al. [15]也改良了[5]的類神經網路架構,使其訓練的速度更快也更有效率；Owens et al. [16]利用 self-organizing neural network 來找出特徵向量的分布，並用此分布來判斷是否有異常的軌跡特徵。

四、研究成果

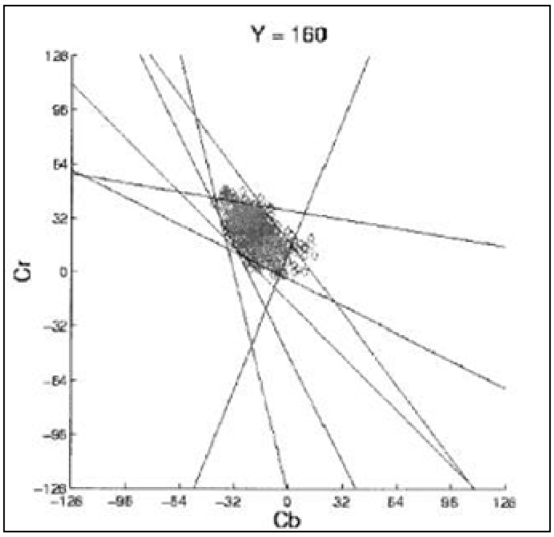
本次研究內容係屬一個規劃為三年期/三階段之研究計畫的第一階段研究。在本階段的研究中，我們透過架設在限定空間中的攝影機，對此限定空間狀況進行監控，並對進入的目標進行臉部偵測、辨識其性別，以便提前發出警告預防意外發生。在接續的第二階段研究規劃中，我們將針對婦女安全防護進行更進一步的安全監控。為了防止搶劫事件及婦女遭到挾持的行為，我們在第二階段使用多項影像處理及自動化偵測與辨識的相關方法，在婦女人身安全出現威脅時，能夠偵測出威脅事件。未來在第三階段的研究中，我們則要以智慧型視覺機制對在公共空間/環境中之老年婦女及幼女更進一步的保護，提升了特別對老年人、婦女以及幼女的安全監控。

在特定的空間中要能正確的達到安全性的監控，首先要能達到的目標是正確的將前景物給偵測出來，由於攝影機的架設位置和架設廠所的敏感性問題(女性廁所，更衣室)，所以我們只能規劃出一個受限制的區域，在此區域內作性別的偵測跟安全性的監控，在此我們將面對的問題是如何正確的根據現有影像可以將性別卻判斷出來，我們在此將以尋找膚色區域的方式來偵測人臉,之後利用 Active appearance model 的方式將人的五官定位出來,再透過事先收集的男性與女性的五官特徵，透過訓練的方式，來達到正確辨識初期性別的目標，所以我們將設計一個以特定區域安全監控為基礎之系統，不斷的對特定區域內的目標物進行臉部偵測、五官定位與性別辨識，以達到預防意外發生的目標，除了具有一般視迅監控設施之特性外，我們亦希望達成：自動對目標進行臉部偵測、臉部五官定位、性別辨識、異常判定、與發出警告等功能。以即時處理(Real-time)與高精確性(High-accuracy)為目標，進行設計與執行。由於區域監控系統之偵測範圍比小，故鏡頭可固定拍攝某方位之畫面，不會有死角的問題。本研究計畫共完成八個模組，分別為(1) 人臉偵測模組、(2) 人臉五官定位模組、(3) 五官特徵訓練模組、(4) 性別偵測模組、(5) 搶劫事件偵測模

組、(6) 挾持行為偵測模組、(7) 跌倒偵測模組、以及(8)年齡偵測模組。分別針對各模組進行說明如下：

I：人臉偵測模組

主要目的為偵測限制區域內的人臉，我們將建立起膚色模組，以供之後的追 蹤模組所使用，所用的方法為改良式的 YCbCr 膚色偵測的方法，在近年的研究中，最常使用之色彩空間包含 RGB、HSV、YCbCr、YIQ 與 UVW…等，由於亮度變化會造成同一種顏色在 RGB 空間呈現不同結果，所以本系統改用亮度分離性與膚色收斂性皆較高的 YCbCr 模組，該模組含亮度元素(illumination)與 blueness(Cb)、redness(Cr)兩項色彩資訊來進行偵測。[圖-1] 中的黑色部分代表 YCbCr 模組中膚色區塊所在。本系統之膚色判定採取下列兩種演算法的交集：Georgios 等人提出的改良式 YCbCr 以及 ARAKI 等人提出的 RGB 膚色率(Skin-color ratio)。所有像素經由 CCD 攝影機擷取之 RGB 色彩轉換至 Y、Cb、Cr 三值後，便作為膚色判定之參數。而在偵測的過程中，會影響系統偵測膚色區域效能的因素為光線，在不同的光線下會導致人偵測的人臉區域有所誤差，我們使用對數相減法來降低區域光度不均，來降低光線的影響。 [圖-2]所示為其原始影像及膚色區域。



[圖-1] 膚色區域在 YCbCr 空間中的分佈

[圖-2] 原始影像及膚色區域

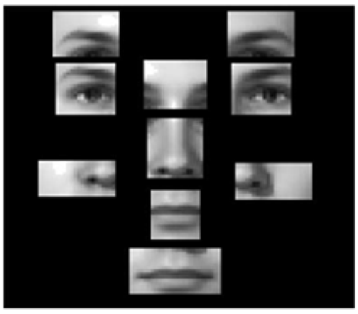
II：人臉五官定位模組

此模組主要的目的是將我們已經偵測的人臉區域中的五官定位出來，以利之後的模組作訓練與比對，人臉五官的偵測一班的方法為：直接在已經偵測出來的膚色區域中偵測五官，其常用的方式為「顏色區域極小值法」、「灰階值投影法」或是根據臉部比例切割出特定區域之後再由此區域去尋找像是眼睛、鼻子、耳朵、嘴巴等五官。但是上述的方法容易受到光線等 APPEARENCE 環境因素的影響。因此，為了增加系統的穩定性，我們採用 Active Appearance Model (AAM)的方式將五官給定義出來。所謂的 AAM 是指將要 training 的影像，標出所謂的控制點，這些控制點通常為臉的輪廓，再經過 PCA 的方式處理並將每張影像經由 WARP 表示出的 mean shape 上(作 shape-normalize)，即可簡化一張影像的灰階資訊，竟而得到 AAM 的表示方式。 [圖-3] 所示就是由一張輸入的影像，跟 training 初的 AAM shape 參數作最佳化的結果，其完整過程就是逐漸收斂到正確的位置上。

[圖-3] AAM 五官收斂過程

III：五官特徵訓練模組

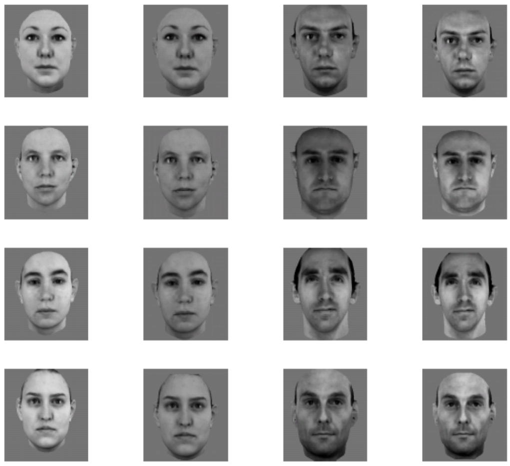
此模組的主要目的是針對收集來的五官特徵進行訓練以提供下個模組辨識之用，我們如何來斷定一個人的性別，在此我們打算使用 component-based 的方式，我們將收集大量女性和男性的臉部影像，利用上一個模組所提供的方式，將人臉五官定位且切割出來(如[圖-4]所示)，然後再用 Adaboost 的訓練方式來得到一個可以辨識性別的分類器，所謂的 AdaBoost 是一個很強的分類器，他結合了多個 weak 分類器成為一個強大的分類器，每一個 weak 分類器處理一種特徵，此特徵具有強大的鑑別力，但是不可能完全分對，所以再加入另一個 weak 分類器，針對第一個 weak 分類器分錯的部分作處理，一直重複這步驟直到可以很正確的達到我們的要求為止，所以我們在此利用這個特點每一個 weak 的分類對應這一個五官，然後組成一個可以辨識性別的分類器，以供下個模組偵測辨識之用。[圖-5]所示則所收集之部分男性與女性的臉部影像，其間已經去除頭髮以減少影響。



[圖-4]　人臉五官局部切割之情形

IV：性別偵測模組

在此一模組中的主要目的是，針對偵測出的臉部影像，透過訓練模組得到的分類器，來加以辨識，進而判斷是否要對此限制區域發出警告，此一模組將會打偵測出的影像，根據AAM找出五官位置，進而抽取出五官特徵，將其組合成一個向量，供分類器判斷其性別，之後根據我們是先定義的限制區域，一但偵測出有男性進入，就發出一個警告，來達到限制區域安全性監控的目的。



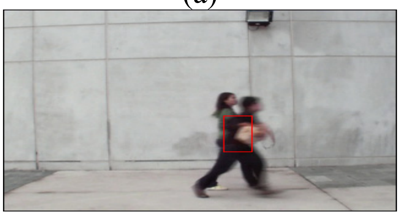
[圖-5] 測試用的部分男性與女性的臉部影像

在在本研究的第一階段，我們已完成了上述四個模組的設計及雛型系統實作，其內容即為本次研究之主要成果。而我們可以很準確的找出在公共開放空間中所有人的性別之後，我們將利用此系統來特別對女性做更進一步的安全性保護。在一些公共的環境裡，我們常可以聽到婦女被搶劫的情形，除此之外，更有婦女遭到挾持的行為，以及間接或直接發生的摔倒行為。為此，在計畫的第二階段中，我們將針對這三個特定主題的行為模式提出自動偵測與辨識的解決方法，其實踐方式則規劃如以下的V~VIII等四個模組的功能。

V：搶劫事件偵測模組

首先，我們說明如何再監控畫面中，當有發生搶劫事件發生立刻提出警訊。在[圖-6]中，我們可以看到有一個帶著手提袋的女孩走在某一路上(穿著綠色衣服)，接著有一個穿黑色衣服的人從她的後方急速跑過來，搶走手提包後立刻跑走。當發生此種情形時，智慧型監控系統必須立刻提出警訊並且立刻告訴警察人員有此事搶劫事件發生。我們可以發現當有搶劫事件時，會有一個共通的特性，就是當有搶劫情形時，兩個人會有先靠近，進而有所接觸，再接下來則有離開的情形發生。因此，在此系統中，我們可以先針對每個物件(人物)做追蹤，尤其是對婦女做更進一步的注意。直覺來看，當某人身上的有物件消失不見時，我們可以很快的發現此人身上的

某些顏色會消失不見或者是減少了。因此，當我們發現有兩個人有“靠近-接觸-離開”的事件發生時，我們便可以利用此兩個物件顏色的 Histogram 來做第一步的分析。在這裡，我們舉了以下如[圖-7]所示的一個例子來加以說明。從[圖-7] (a)與(b)中，我們可以發現此人分別帶著背包與沒帶背包，因此，我們便對此兩張圖做 histogram 統計(這裡，為了講求運算速度，我們將 RGB 三種顏色從 2^{24} 降到 4096 色)，從 histogram 統計圖中可以發現，有某些顏色減少了，因此，為了突顯這個特性，我們便對此兩個 histogram 做相除的動作，正如預期，有某些 bin 特別的大，而這些 bin 就是可能消失的顏色。但由於兩個人交互的過程中，我們必須知道東西是由哪個人身上轉移到哪個人；為此，必須兩個人在位置交換前後的 histogram 都要計算並且比較；再依據此項比對結果，我們便可以找出哪個計算式會有較大的值出現；最後，我們在做一個對應回去的動作，也就是把特別大的幾個值所對應的顏色標出來。結果發現，背包的大部分區域被標出來了，其實例如[圖-7](d)所示。


(a)

(b)

(c)

[圖-6] 婦女被搶劫的過程： (a)一個穿著黑色衣服的人急速接近拿著背包的女生 (b)穿著黑色衣服的人搶走背包 (c)搶完後立刻逃逸


(a)

(b)

(c)

(d)

[圖-7] (a)受測人帶著背包； (b)受測人沒有帶背包；(c)將顏色投射回去的結果； (d)經過 GMM 辨認模型處理後所找出的背包。

VI：挾持行為偵測模組

在公共環境中，我們常聽到有婦女遭到挾持的事件（如[圖-8]所示），如果設置在公共空間中的監控系統能夠快速的將此行為樣模偵測出來，並立即主動告知警務/保全人員來處理，這樣更能有效的防止不必要的悲劇發生。在此模組中，我們仍利用性別偵測模組進行對女性的安全監控，當系統發現有女性出現時，便開始對其追蹤，當發現有不明人士快速接近並且沒有離開時，我們便可以開始對其分析。

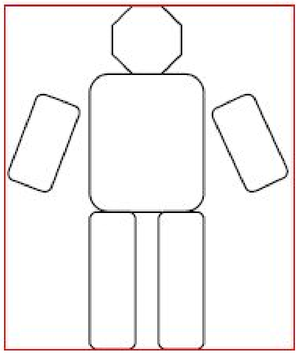
本模組執行偵測與辨認的過程中，系統首先會找出前景物，並對其作性別分析，當有發現女性時，便會開始建立 Pattern 及身上特徵(身上衣服顏色等等)；接下來，便會開始偵測是否有人接近她，如果有，便開始對這兩個人做影像分析。我們可以利用樣板比對的方法判斷兩人是否靠得非常的近，如果是，便開始分析細部動作。

由於靠得很近（也就是身體跟身體接觸）有可能是擁抱或者是挾持，這時候，我們可以利用兩人的相對關係找出他們的行為關係（例如面對面或者是一前一後…等等），此外，我們更可以利用影像切割的方法找出身體各部位，分析其肢體動作（例如手的擺放位置，姿勢等等）進而分析兩人行為。一旦我們可以找出兩人的相對關係及肢體位置時，我們還可以利用肢體姿勢對時間的關係做更進一步的輔助分析和判斷肢體追蹤與身體相對關係。接下來，我們便可以利用 Bayesian network 的方法去分析兩人相對或互動動作模式的機率關係式，以判斷出現行狀況最有可能的行為，一旦發現現行狀況可能是挾持事件發生時，便可以立刻提出警訊告知警務或保全人員密切注意並緊急處置。

[圖-8]　挾持行為示意圖

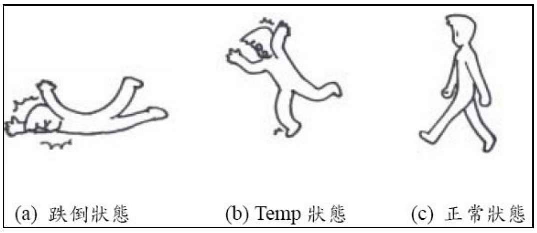
VII：跌倒偵測模組

當我們要偵測跌倒行為時，系統要能分辨目標物現在的狀態為何，是處於正常的狀態，還是處於跌倒的狀態，此兩種狀態有顯著不同的特徵。當對目標物進行偵測與追蹤時，我們有一最小邊界矩形，來表示前景物的範圍，如[圖-9]所示。人於站立狀態時，經由最小邊界矩形，我們可以得到前景物的長、寬、前景物面積等資訊。因為本系統要偵測跌倒行為，我們假設跌倒行為的發生是由人體於正常直立狀態時，若發生跌倒行為時，則經過若干時間，人體會因為跌倒而趴在地上。所以跌倒行為發生時，人會由正常狀態轉變成跌倒狀態。故人體於正常狀態時與發生跌倒時人體趴在地上的狀態，此兩種狀態有顯著的不同，而跌倒行為的判斷即是判斷前景物是否由正常狀態轉為跌倒狀態。並且考慮其他限制條件。



[圖-9]　前景物之最小邊界矩形

[圖-10]為人體於正常狀態與跌倒狀態的示意圖，由此示意圖我們可以發現此兩種狀態的特徵有很大的不同。故我們選擇前景物的最小矩形框的長、寬來作為狀態判別的特徵。因為上述兩種狀態的特徵於空間中有不同的分布，而相同狀態的特徵於特徵空間中有群聚的現象，故我們使用高斯混合模型來分別近似正常狀態與跌倒狀態。接下來我們也利用GMM模型進行跌倒行為的辨識，跌倒行為的辨識，即判斷前景物於正常狀態經若干時間後處於跌倒狀態並且要求符合若干預設條件，我們即知道發生跌倒行為。當前景物進入場景時，首先判斷前景物是否處於正常狀態，當前景物一直處於正常狀態時，則人體一切正常。一旦前景物發生跌倒行為時，則系統首先偵測到人體離開正常狀態，經過我們所設定的時間內，人體會因為跌倒而趴在地上，而處於跌倒狀態。當前景物處於跌倒狀態持續一段時間後，則系統確定人體發生跌倒行為。若人體維持跌倒的狀態而沒有明顯的狀態改變，當超過我們設定的一段時間後，則系統會自動發出警訊，告知其他人前景物人體發生危險，完成跌倒偵測。



[圖-10] 跌倒行為狀態圖

VIII：年齡偵測模組

我們在進行年齡偵測時，主要方法是偵測人臉影像中的皺紋與五官分佈，我們先對整張影像先做邊緣偵測，根據其結果區分老人跟一般的成年人，之後對 ROI 根據不同的門檻值做邊緣偵測，分析邊緣影像的分部密度來達到區分老人跟小孩的目的。[圖-11]即為定義的 ROI 和其中的皺紋。而在五官分佈的偵測中，我們首先找出人臉的輪廓，當找出輪廓後，由於有時候會因為人的臉部下巴部分會比較尖，因此，所以在計算人臉特徵分佈位置比例及人臉論擴對應時會產生錯誤，為修正此項缺失，我們必須找到下巴點，如果我們分別計算邊緣上每點的斜率，我們會發現到下巴部分剛好是正負斜率的中間點。因此，我們可以利用此方法找到下巴部分，當找到下巴點時，接下來我們必須找出兩耳的位置。這也就是橢圓人臉樣版的短軸部分，我們必須很正確的找出短軸部分，這樣我們才有辦法找到一個適當的橢圓來做樣板。從橢圓曲線來觀察，我們可以發現橢圓的短軸兩端點其實斜率幾乎接近垂直而這個部分經過觀察，我們可以發現其實這兩點也接近耳朵。因此，我們也可以利用此兩點來判斷耳朵的位置，接下來便開始要找出臉上各個器官所在地點，首先是眼睛部分，這裡我們先用 valley potential 的方法對臉部做運算，找出可能是窪地的部分，並且要成對，因此，我們可以找出眼睛的主要位置，接下來再用邊緣偵測的方法找出眼睛的輪廓慢慢修正，最後找出眼睛正確位置。

有了上述偵測老人與小孩的模組後，我們可以在第二階段的行為分析中加入偵測行為人是老人、婦女或是小孩的機制；而在擁有了行為人的進一步細分後，我們可以提高行為分析中的行為種類並且由於有了行為人的類別後，可以進一步提供細部行為分析的規則以提高行為分析的正確率，以使本計畫達成對婦女、幼童及老人安全照護之目標。

[圖-11] ROI 和皺紋（頭上皺紋、眼下皺紋）

五、計畫成果自評

本研究計畫以建構出一個對婦女、老年及幼兒的安全監控智慧型系統，此系統應能夠對整個開放空間進行完備之監控任務，並對特定目標物進行性別偵測、追蹤、行為辨識以及安全防護等工作，在實務上能夠對婦女、老年及幼兒提供一安全防護的預防措施，在實務上可以說是對弱勢一方的安全照護有了極大貢獻。在獲國科會「性別與科技計劃案」經費補助的本研究第一階段中，我們主要是想在一個公共環境中找出所有的人臉，並且在這些人臉中分出男性女性，由於在不同的監控環境中，我們該注意到的對象不同（例如監視器架在女性廁所外面或者是更衣室外面，那當有男性接近時，就必須適時的發出警告並告知警務人員）。因此，正確的判斷男性與女性便是非常重要的事情。如前述內容所示，現階段已完成的四個模組及其相關雛型系統已達成本研究的階段性目標。

對於參與本研究之研究及相關工作人員而言，參與本研究計畫使研究團隊成員們均獲得了學習並熟悉監控系統建置的機會，並熟悉類神經網路、影像處理、追蹤演算法、動態輪廓演算法等各種影像處理、圖形識別技術和工具以及它們的整合模型於監控系統中實際應用的經驗，也學

習到了對於建構智慧型監控系統的架構及標準程序等相關實作技術及經驗。

在研究成果的發表方面，本計畫除已將相關影像處理方法及模組之應用內容投稿於 IWAIT 2009 國際研討會，並獲得接受且已完成發表之外[17]；另外也有一篇相關研究成果的期刊論文已被 IEEE 之 Transactions on Circuits and System for Video Technique 接受，將在部份內容修改後正式刊登發表。未來亦準備將相關技術整合至 embedded systems 上，以增加本次研究成果的實用性，並使本研究的貢獻和實際應用性更具體可見。

整體而言，本原規劃為為期三年的計畫在計畫第一年期間，不論是在理論整合運用、實際系統開發或論文發表上的質與量進度表現，均已達成原設定之階段性目標。

六、參考文獻

[1] N. P. Costen, M. Brown, and S. Akamatsu, “Sparse Models for Gender classifier,” *Proceedings of the Sixth IEEE International Conference on Automatic Face and Gesture Recognition*, May 17-19, 2004, pp. 201-206.

[2] K. Ueki, H. Komatsu, S. Imaizumi, K. Kaneko, N. Sekine, J. Katto, and T. Kobayashi, “A Method of Gender Classification by Integrating Facial, Hairstyle, and Clothing Images,” *Proceedings of the 17th International Conference on Pattern Recognition*, Vol. 4, August 23-26, 2004, pp. 446-449.

[3] Z. Sun, X. Yuan, G. Bebis, and S. J. Louis, “Neural-Network-Based Gender Classification Using Genetic Search for Eigen-Feature Selection,” *Proceedings of IEEE International Joint Conference on Neural Networks*, May, 2002.

[4] I. Haritaoglu, D. Harwood, and L. S. Davis, “Ghost: A Human Body Part Labeling System using Silhouettes,” *Proceedings of the 14th International Conference on Pattern Recognition (ICPR ‘98)*, Vol. 1, 1998, pp. 77-82.

[5] S. Park and J. K. Aggarwal, “A Hierarchical Bayesian Network for Event Recognition of Human Actions and Interactions,” *Multimedia Systems*, 2004, pp. 164-179.

[6] S. Park and J. K. Aggarwal, “Recognition of Two-Person Interactions using a Hierarchical Bayesian Network,” *Proceedings of the ACM SIGMM International Workshop on Video Surveillance*, 2004, pp. 65-76.

[7] C. Stauffer and E. Grimson, “Learning Patterns of Activity using Real-Time Tracking,” *IEEE Transactions on Pattern Recognition and Machine Intelligence*, Vol. 22, No. 8, 2000, pp. 747-757.

[8] S. Park, J. K. Aggarwal, “Segmentation and Tracking of Interacting Human Body Parts under Occlusion and Shadowing,” *Proceedings of the IEEE Workshop on Motion and Video Computing*, Orlando, FL., 2002, pp.105-111.

[9] H. K. Young and N. L. da Vitoria, “Age Classification from Facial Images,” *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 1994.

[10] W.-B. Horng, C.-P. Lee, and C.-W. Chen, “Classification of Age Groups Based on Facial Features," *Tamkang Journal of Science and Engineering*, Vol. 4, No. 3, 2001, pp. 183-191.

[11] M. M. Skelly and H. J. Chizeck, “Real-time Gait Event Detection for Paraplegic FES Walking,” *IEEE Transactions on Neural Systems & Rehability Engineering*, Vol. 9, 2001, pp. 59-68.

[12] F. Bashir. A. Khokhar, D. Schonfeld, “Automatic object trajectory-based motion recognition using Gaussian mixture models ” , *IEEE conf. Multimedia and Expo*, 2005

[13] N. Johnson and D. Hogg, “Learning the

distribution of object trajectories for event recognition, *Image Vision. Computing*, 1996.

[14] N. Sumpter and A. Bulpitt, ”Learning spatio-temporal patterns for predicting object behavior,” *Image Vision. Computing*, 2000

[15] W. M. Hu, D. Xie, and T. N. Tan, “A hierarchical self-organizing approach for learning the patterns of motion trajectories, *IEEE Trans. on Neural Networks*, 2004

[16] J. Owsens and A. Huter, “Application of the self-organizing map to trajectory classification,” *Proc. IEEE Int. Workshop Visual Surveillance*, 2000.

[17] Y.-N. Chen, C.-T. Wang, C.-C. Lo, C.-C. Han, and. K.-C. Fan, “A Chinese spam filter using keyword and text-in-image features,” *Proceedings of The* 2009 International Workshop on Advanced Image Technology *(IWAIT 2009)*, Seoul, Korea, January 12-13, 2009.

行政院國家科學委員會補助國內專家學者出席國際學術會議報告

98 年 1 月 14 日

報告人姓名	陳 映 濃	服務機構及職稱	中央大學資工系博士研究生
會議 時間 地點	自 98 年 1 月 12 日至 98 年 1 月 13 日 韓國首爾 Korean Federation of Science and Technology.	本會核定補助文號	NSC96-2629-E431-001
會議名稱	International Workshop on Advanced Image Technology 2009		
發表論文題目	A Chinese Spam Filter Using Keyword and Text-in-Image Features.		

一、參加會議經過

本次會議於韓國首爾市 Korean Federation of Science and Technology 舉行為期兩天的研討會，研討會中吸引了許多世界各國的優秀學者投稿。本次研討會我們投稿的論文題目為：A Chinese Spam Filter Using Keyword and Text-in-Image Features.作者為陳映濃、王鄭慈、駱至中、韓欽銓與范國清，而由本人博士研究生陳映濃前往發表。本人於 1 月 11 日早上搭乘華航航空於中午時分抵達韓國首爾。並於 1 月 12 日早上搭乘地鐵前往會議中心向大會辦理報到手續，同時參加大會之 reception，隨後便與各國學者進行學術性交流，主要是討論各自發表的論文內容。此次國際會議發表了將近 90 篇的研究論文，其主題涵蓋 “Image Processing”, “Patern Recognition”, “Image/Video Compression”, “Multimedia Systems”, “Multimedia Applications”, “Virtual Reality”, ” Computer Vision”…等各種主題，主要與影像內容相關的任何應用，皆是本研討會討論之範疇，會議中有許多不錯的影像方面的工程應用。1 月 12 日本人除參與各個 session 的討論外並參與晚間的晚宴，於晚宴期間並與各國參與研討會的學術先進談論到本次投稿的論文內容，於討論過程中得到許多寶貴的建議。1 月 13 日，除了聽取每位演講者報告研究成果外，並參與各個 session 的討論，隨即於下午進行個人論文的發表，此次發表的論文為 poster，因此可以在過程中與各國學術先進直接面對面的討論，因此可以詳細說明我們的研究成果，而討論過程獲得與會學者的熱烈迴響，由於本論文是以中文字型的影像應用，因此許多外國學者特別對中文字影像處理有興趣，也逐一回答相關問題，收穫豐碩，於 16 日搭乘華航航空返台。

二、與會心得

此次研討會主題主要是與影像內容相關的應用，除了圖形識別之外，尚包括電腦視覺與影像處理兩大類主題，其中，電腦視覺是近來熱門的技術，可以應用在許多的自動化監控上，尤其愈來愈多的自動化行為辨識受到討論，911 攻擊事件之後，自動化安全機制愈來愈受到注意，個人身份的識別與行為辨識的應用上重要性與日俱增。尤其在機場安全控管上，更是重要，藉由每一個人身上獨有之生理或行為特徵，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，此次研討會共有 89 篇論文發表，由此可見，此一研討會受到各國學者重視。

三、考察參觀活動(無是項活動者省略)

無考察參觀活動

四、建議

本研討會屬於影像與圖形識別的研討會，此次國內參加的研究人員不多，但國外學者則是熱烈參與，此一議題有關於影像處理與圖形識別應用議題，雖然是一個小型的兩天研討會，但仍建議多多鼓勵國內研究單位參加，藉此彼此了解，尤其國內目前之電腦視覺相關產業蓬勃發展，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。

五、攜回資料名稱及內容

International Workshop on Advanced Image Technology 2009 會議電子檔之隨身碟，包括此次所有發表論文內容。

A Chinese Spam Filter Using Keyword and Text-in-Image Features*

Ying-Nong Chen[a], Cheng-Tzu Wang[b], Chih-Chung Lo[c], Chin-Chuan Han[d†], and Kuo-Chin Fan[a,c]

[a]Department of Computer Science and Information Engineering,
National Central University, Chungli, Taiwan
[b]Department of Computer Science,
National Taipei University of Education, Taipei, Taiwan
[c]Department of Informatics,
Fo Guang University, Ilan, Taiwan
[d]Department of Computer Science and Information Engineering,
National United University, Miaoli, Taiwan

Abstract

Recently, electronic mail(E-mail) is the most popular communication manner in our society. In such conventional environments, spam increasingly congested in Internet. In this paper, Chinese spam could be effectively detected using text and image features. Using text features, keywords and reference templates in Chinese mails are automatically selected using genetic algorithm(GA). In addition, spam containing a promotion image is also filtered out by detecting the text characters in images. Some experimental results are given to show the effectiveness of our proposed method.

Keywords: *spam, text/image features, genetic algorithm, evolution optimization, convolution neural network*

1 Introduction

Due to the wide use of Internet, E-mail is a conventional and effective communication among us in daily life. It is also an efficient promotion tool for companies. In such conventional environments, unwanted advertisement (i.e. spam) is congested in Internet. Lots of resources are wasted and users are disturbed during reading mails. Spam filter is an essential tool in filtering out those unwanted mails from mail servers.

Text classification is a popular research topic for information retrieval. Text keywords in documents are extracted and analyzed for classification. Many applications such as Web page classification, text-based searching agent, ..., etc, are widely developed using the classified results. Spam detection is an extension of text-based classification. Most of spam is filtered out using text features. However, a new type of spam is congested recently. An image mixed with text characters, like an advertisement DM, was attached in a mail. According to the reports of IronPort and CipherTrust Co. in 2006[1], the percentage of image-based spam was increased from 1% to 12%. This text-in-image spam will cheat the keyword-based spam-filter. In this paper, Chinese spam detection algorithms are proposed using the features of text keywords and image contents.

Soonthornphisaj *et al.*[2] proposed an anti-spam filtering system by using the centroid-based classification approach. They use the cosine function to measure the similarity of two mails. They also designed the Naive Bayes classifier and the k-nearest neighbor classifier to verify the testing samples are spam or not. The support vector machine-based(SVM-based) classifiers are designed to categorize the mails[3, 4]. All of them used the values of TF(term frequency) and IDF(inverse document frequency) to be the features in the classification process. In Chinese text classification, word segmentation is an essential step to extract the meaningful words. Lin[5] proposed an effective algorithm to extract the Chinese frequent strings without using a word dictionary. Chien[6] proposed the PAT-tree-based method to extract the keywords of documents for Chinese information retrieval. Chang[7] retrieved the information of web page by using the semi-structured patterns embedded in the pages. However, they are unsuitable and inefficient for verifying the mails in mail servers.

Instead of keyword-based approaches, Wu *et al.*[8] designed a behavior-based spam filter using enhanced

*The work was supported by National Science Council of Taiwan Under grant no. NSC 96-2629-E-431-001.

†To whom all correspondence should be addressed.

induction tree. The spamming behaviors include irrelevant subject to the content, the forged headers, the massive distribution, . . . , and so on. Using those behavior-based features, the decision tree was generated by using an ID3 algorithm. Lai [9] made an empirical performance comparison for the spam categorization on three classification algorithms, a naive Bayes, a k-nearest neighbor, and a support vector machine. They summarized their conclusions in five points.

In this paper, Chinese spam detection is proposed using text classification and text-in-image detection techniques. The architecture of keyword-based filter is composed of two phases as shown in Fig. 1. In the training phase, E-mails are grabbed from mail servers and segmented by an MIME-based parser. The text contents of mails are collected and analyzed to generate the frequently-used Chinese words. Next, the keywords are found to characterize the documents. Each document is represented as a vector form of keyword frequency appearing in the documents. The vectors are analyzed to find the discriminant features for the classification of spam mails. These feature vectors with higher discriminant power are trained to obtain a classifier. In the testing phase, a new mail is parsed and segmented by the MIME-based parser and the word cutter, respectively. Chinese words are separated from the sentences in mails. Keywords are also extracted to obtain a feature vector. This feature vector is verified by the trained classifier. If it is a spam, an alarm is made by the detection system.

This paper is organized as follows. The preprocessing step is to parse the mail contents and to segment the Chinese sentences are described in section 2. In section 3, a GA approach is designed to find the discriminant features and the better referred templates. Moreover, an NN-based text-in-image detector is constructed in section 4 for detecting the new type spam. Some experimental results are given in section 5 to show the effectiveness of proposed method. Finally, conclusions are made in section 6.

2 Pre-processing: Parsing and Word Segmentation

Recently, mails were all transmitted in MIMIE-based format. Thus, the mails should be first parsed by an MIME-based parser to retrieve the title, sender's address, mail content, attached files, etc, from the original mails. Lots of spam filters built the black lists for filtering when a large number of mails are sent in a short time. However, the lists must be frequently updated. Mail contents analysis is another effective approach for spam filtering.

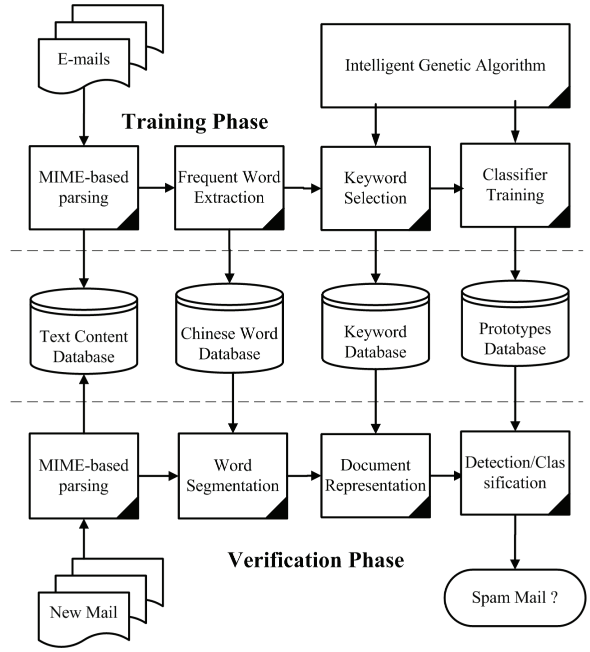


Figure 1: The architecture of text-based spam detection.

Word segmentation is the first step in analyzing Chinese mails. Some special symbols or space characters are frequently used to delimit the words in English sentences. However, there are no clear separators in Chinese sentences. It is a very time-consuming task to exactly cut the words for Chinese sentences. Long word priority rule, maximal matching rule[10, 11], and PAT tree-based rule[6] are the popular and efficient methods. In considering the efficiency of mail servers, the maximal matching approach was adopted by matching the pre-built word database. First, a Chinese frequent string(CFS) database was built from collected spam. In this study, the method of Lin and Yu's[5] was adopted to find the new words. The frequent words were extracted based on the statistical information among the words. In addition to the CFS database, two databases, an IIS[1] and a Tsai's[2], were included in our word database for word segmentation.

3 A Keyword-based Spam Filter

After the segmentation of Chinese sentences, lots of words are with less discriminant power for classification. Those lower discriminant words are of the

[1] A CFS database possessing 80,000 words was constructed by Institute of Information Science, Academia Sinica, ROC.

[2] A CFS database possesses 137,450 words, http://ftp.isu.edu.tw/pub/Windows/Chinese/phrase/wordlist.txt

frequently used words or the meaningless words in our life. They are widely spread in all class documents. Many researchers construct a *stop list* to exclude the frequent and meaningless words. However, the stop list was manually constructed and unsuitable for all applications. Therefore, high discriminant keywords were selected by a statistic-based criteria and a genetic algorithm(GA).

Keywords are selected to form feature vectors in the feature analysis module. Frequency computation is a statistical measurement to find out the importance of keywords in documents. TF and IDF are two most effective measurements in evaluating the importance. These two measurements are defined in the followings. Consider a set of documents $\mathcal{D} = \{d_1, d_2, \ldots\}$, and a set of keywords $\mathcal{W} = \{w_1, w_2, \ldots\}$, a document d_j in set $\mathcal{D}$ is represented in term of vector form $(d_j(w_1), d_j(w_2), \ldots)$. The TF is to compute the frequency of a specified keyword w_i appearing in document d_j as defined

$$TF_{d_j(w_i)} = \log\left(\frac{d_j(w_i)}{\sum_{w_k \in \mathcal{W}} d_j(w_k)}\right), \qquad (1)$$

where $d_j(w_i)$ denotes the number of keyword w_i appearing in document d_j. The IDF of keyword w_i is defined as

$$IDF_{w_i} = \log\left(\frac{|\mathcal{D}|}{|\mathcal{D}(w_i)|}\right), \qquad (2)$$

where, $\mathcal{D}(w_i)$ is the subset of set $\mathcal{D}$ containing the keyword w_i, and $|\cdot|$ represents the cardinality of set. The multiplication of values TF and IDF for keyword w_i is set to be an element of feature vectors.

Thousands of keywords are selected from the preceding section to represent the documents. The documents are represented as the feature vectors in terms of keyword numbers appearing in documents. Feature vectors with high dimensionality always complicate the design of classifiers. In addition to the keyword selection, the referred templates in the training samples are the key role in the matching process. In this study, both keywords and templates are selected by an evolution approach.

Different from the conventional IF-IDF weighting features, documents are represented by the TF features. In this section, nearest neighbor matching strategy is applied for determining the class of an input sample. In order to find the discriminant features and the better referred templates, a GA approach is designed. First, M features and N referred templates are encoded as a chromosome in term of binary vectors $[f_1, f_2, \ldots, f_M, R_1, R_2, \ldots, R_N]$. Two basic operations, crossover and mutation, are performed at each iteration. To increase the performance of multi-object evolution process, Chen *et al.* [12] designed an intelligent crossover operation. A multi-object GA based approach is proposed for a nearest neighbor classifier which maximizes classification accuracy and minimizes the template size and the feature number. More details could be referred in references[12]. Moreover, seven factors should be considered in a GA-based approach as summarized below.

1. **Initial population:** Initialize the population size P and randomize the values of the chromosomes to obtain the initial population.

2. **Fitness evolution:** The fitness function is designed as the mis-classified error.

3. **Elite set:** Store the better solutions and update the elite set S.

4. **Selection:** Select the chromosomes with the better fitness values from set S for the next generation.

5. **Crossover:** Generate the new chromosome by an intelligent crossover operation with a probability value ρ.

6. **Mutation:** Choose a single chromosome bit for the mutation with a probability η.

7. **Terminal condition:** The terminal conditions are designed as the accuracy rate is larger than a threshold or the generation iteration is larger than a number. The condition should be checked at iteration.

4 An NN-based Text-in-image Detector

In this section, a neural network-based detector is trained for detecting the text characters in images. This new-type spam could cheat and pass through the text-based spam filters. Different from the pictures we send to our friends, the advertisements mixed product pictures and promoted texts together. For promotion, artificial text characters in image-based spam are of higher contrast than the background texts in natural sense. Lots of POP characters were embedded into an image to highlight the functions of products. In this study, those text characters in images are identified by using an NN-based detector and a rule-based classifier. First, the NN-based detector was designed and trained to detect the patches of text characters. Next, the patches were clustered and classified by rules.

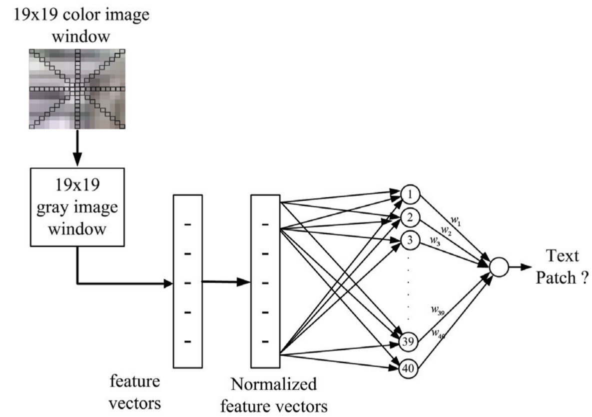
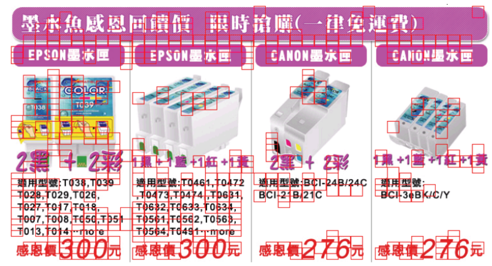


Figure 2: The architecture of NN-based text-in-image detector.

A window slid through an image from top to bottom and left to right. This window was verified by an NN-based classifier. Since Chinese characters are composed of lines, there exist clear edges and lines within a character. Unfortunately, the characters are too many and complex to design an effective detector that could detect the whole character within a window. Local and small patches with high contrast are detected by a trained NN. In order to efficiently detect the character patches, a feature vector with 73 gray values was extracted from a star pattern within a window of 19 by 19 pixels as shown in Fig. 2(a). This vector was inputted into the NN as shown in Fig. 2(b). The architecture of NN is a BPNN of 73 inputs, 40 hidden, and one output nodes. The weights were trained and a threshold was determined to determine the checked window was the text patch of a character or not. The text characters in a promoted spam image and the background characters in a conventional image are illustrated in Fig. 3(a) and Fig. 3(b), respectively. Lots of patches were detected and drawn in red rectangles in the spam image. On the other hand, only few patches were detected as shown in Fig. 3(b). In the training phase, 5000 text and 5000 non-text patches were collected for training the NN-based detector. In the verifying phase, the checked window was not slide through the whole image pixel by pixel. The main reason is that it is unnecessary to exactly identify the locations of text characters. After detecting the character patches, three classification steps are devised for identifying the text character.

1. Patch clustering: The detected patches were clustered and connected to obtain the larger regions.



(a)

(b)

Figure 3: The text-in-image detection results in a spam and a conventional picture.

2. Statistical data of a region: Made the statistical data for a clustered region. The mean and the standard derivation values were calculated.

3. Determination by threshold: The text regions contain the data with a high standard derivation. The threshold is determined from the training samples as follows. Calculate the standard derivation values of natural images and the text characters. The threshold is obtained from the average of two values.

5 Experimental Results

In this section, the experiments were conducted to show the validity of the proposed method. The system was developed and implemented on a personal computer with AMD Athlon 64 Dual Core CPU using the PHP language. The E-mails were parsed for testing. The samples were obtained from an internet web site CDSCE (CCERT data sets of Chinese Emails) for the performance evaluation. The ground truth of each sample was manually set by users. Three data sets were randomly selected for training the keyword-based filter. In each set, 100 spam and 100 non-spam samples were randomly chosen for training. Another 1000 samples, 500 spam and 500 non-spam, were collected for testing the trained filter.

Since the k-NN matching strategy is adopted in the keyword-based filter, is value k an essential role of classification? The first experiment was designed for evaluating value k. The parameters at the training phase were set as $P = 20$, $L_8(2^7)$, $|S| = 10$, $\rho = 0.6$, and $\eta = 0.05$. From the experimental results, the accuracy rates are achieved more than 94% after the second generation. It is unnecessary to choose a larger value k for more effectiveness. In the following experiments, value k is set to be 1 for efficiency. The comparisons of intelligent GA with the conventional GA are made in Fig. 4. Three data sets, I, II, and III, with 200 samples were trained and another 1000 samples were tested. The parameters for the intelligent GA are set to be $P = 20$, $L_8(2^7)$, $|S| = 10$, $\rho = 0.6$, and $\eta = 0.05$. The same scheme is performed in 30 times without loosing the generality. The performance of GA with IC outperform than the others.

In addition to the classification results, the simplification of keyword selection and template reduction is also achieved. Shown in Fig. 5, the curves of keyword selection are bounded in a range of [40%-65%] as drawn in a green line. The template numbers drawn in a red-dot line are reduced to a range of [35%-60%].

In the text-in-image filter, 100 images, 50 positive and 50 negative, were collected for testing the detection performance. Two sample images are shown in Fig. 3. The experiment was executed 30 times and the detection rates are in a range of 85.5% to 92.7%. In addition, the false accepted and false rejected rates are well reduced to the small values.

6 Conclusions

In this paper, a spam filtering system has been proposed based on text keywords and the text-in-image features. The designed scheme automatically finds the new keywords from Chinese mail corpus. Discriminant keywords and referred templates are selected by the evolutional approach. Finally, new mails were verified by the trained classifiers. Some experimental results are given to show the validity and effectiveness of the proposed system.

References

[1] "Spammers continue innovation: Ironport study shows image-based spam, hit & run, and increased volumes latest threat to your inbox," *http://www.ironport.com/company/ironport_ pr_ 2006-06-28.html*.

[2] N. Soonthornphisaj, K. Chaikulseriwat, and T. O. Piyanan, "Anti-spam filtering: a centroid-based classification approach," in *Proc. IEEE Internal Conference on Signal Processing*, vol. 2, Auguest 2002.

[3] K. L. Li and H. K. Huang, "An architecture of active learning SVMs for spam," in *Proc. IEEE Internal Conference on Signal Processing*, vol. 2, Auguest 2002.

[4] H. Drucker, D. H. Wu, and V. N. Vapnik, "Support vector machines for spam categorization," *IEEE Transactions on Neural Networks*, vol. 10, pp. 1048–1054, 1999.

[5] Y. J. Lin and M. S. Yu, "Extracting chinese frequent strings without dictionary from a chinese corpus and its applications," *Journal of Information Science and Engineering*, vol. 17, pp. 513–523, 2001.

[6] L. F. Chien, "Pat-tree-based keyword extraction for chinese information retrieval," in *Proceedings of the 20th Annual International ACM SIGIR Conference on Research and Development in Information Retrival*, pp. 50–58, 1997.

[7] K. Chang, K. W. Bowyer, S. Sarkar, and B. Victor, "Comparison and combination of ear and face images in appearance-based biometrics," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 25, no. 9, pp. 1160–1165, 2003.

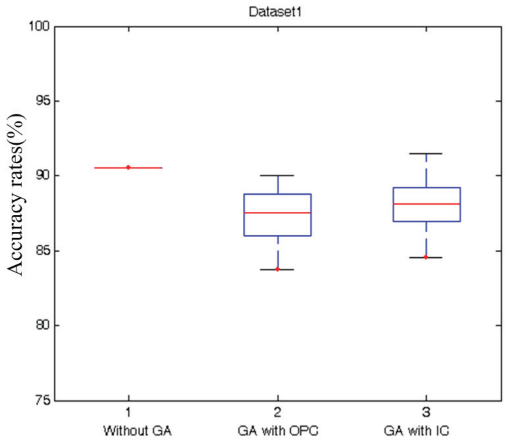
[8] Q. Wu, H. Zhang, W. Jia, X. He, J. Yang, and T. Hintz., "Car plate detection using cascaded tree-style learner based on hybrid object features," in *Proc. of 2006 IEEE International Conference on Video and Signal Based Surveillance*, pp. 15–15, 2006.

[9] C.-C. Lai, "An empirical study of three machine learning methods for spam filtering," *Knowledge-based Systems*, vol. 20, pp. 249–254, 2007.

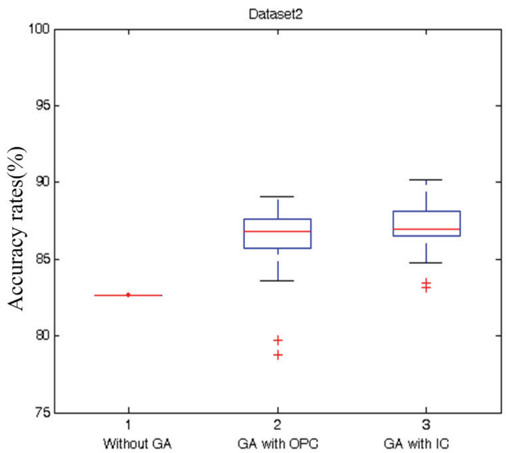
[10] K. J. Chen and S. H. Liu, "Word identification for mandarin chinese sentences," in *Proc. of 15th International Conference on Computational Linguistics*, 1992.

[11] K. J. Chen, "Lexical analysis for chinese-difficulties and possible solution," *Journal of Chinese Institute of Engineers*, vol. 22, pp. 561–571, 1999.

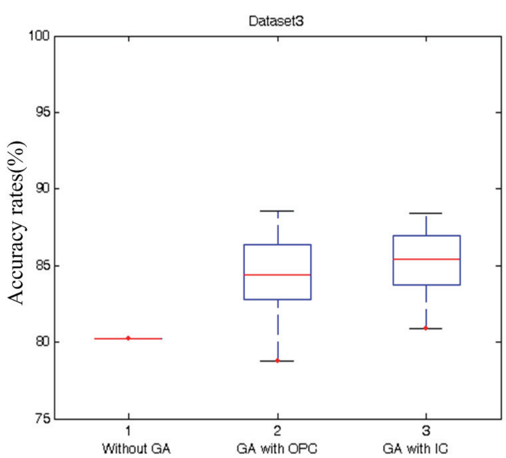
[12] J.-H. Chen, H.-M. Chen, and S.-Y. Ho, "Design of nearest neighbor classifier: Multi-objective approach," *International Journal of Approximate Reasoning*, vol. 40, pp. 3–22, 2005.



(a)

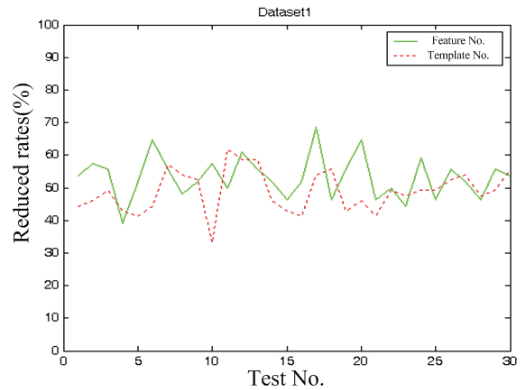


(b)

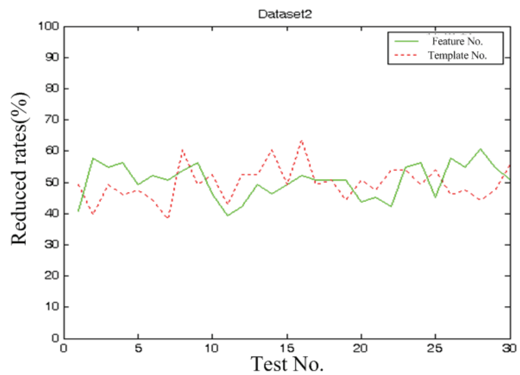


(c)

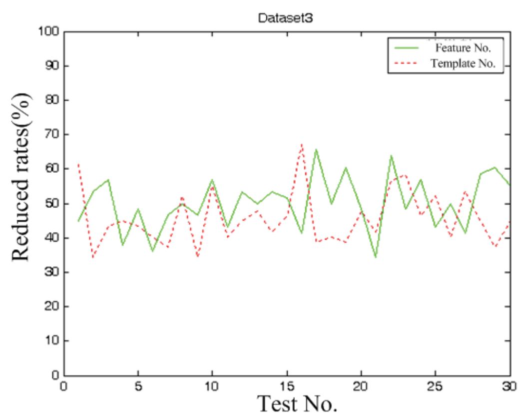
Figure 4: The comparisons for the non-GA, conventional GA and intelligent GA methods on three data sets.



(a)



(b)



(c)

Figure 5: The reduction of feature sizes and template numbers.