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本期論文審查通過率爲 26.09%

學報序

《清雲學報》第三十一卷第四期在近日即將出刊，感謝各位老師的踴躍賜稿，使得《清雲學報》相關編輯工作運作順利，尤其感謝諸位審查委員，針對專門領域，不厭其煩地複審、再審，以確保《學報》品質，在此致上最深的謝意。

本期通過審查的論文共六篇，其中電資類三篇、商管類一篇、人文社會類二篇，下則略述各篇研究大要：

電資類部分，電子系歐謙敏老師與研究生李宗晟發表〈一種高效能改良式基因演算法之向量量化器設計〉，提出一種以改良式基因(memetic algorithm, MA)演算法來設計向量量化器(vector quantizers, VQs)，本演算法在設計向量量化器上比其他改良式基因演算法在相同的基因族群個數下，擁有穩定效能且更能大幅降低CPU 計算時間。其次歐老師又與研究生邱人豪發表〈使用可重組式硬體電路實現歌曲檢索系統〉一文，提出一個可重組式的硬體電路模組，配合 Altera NIOS II 為處理器，以實現歌曲內容檢索系統。電子系李榮祥老師的〈一種由全金屬矽化鎳作為電極之先進MIM 電容之電流傳導機制 〉一文，審查委員以為「研究方法具有技術上的創新，且考慮變因恰當，研究成果具有產業的實用價值。」

商管類收錄行銷與流通管理系邱玉葉、方正璽兩位老師共同發表的〈受歡迎宣稱對廣告相信度及品牌態度的影響：廣告主信譽及懷疑度的干擾〉，本研究主要是引用社會影響理論來探討廣告中的受歡迎宣稱的勸服效果，是否會受到廣告主信譽及消費者廣告懷疑度的干擾為範疇，研究過程中發現使用受歡迎宣稱可能產生負面的廣告效果，本論文對廣告主提供實務的意涵。

人文社會類則收校外稿兩篇，分別為台南應用科技大學張忠良老師〈從《夷堅志》中看民眾的神像經驗〉，本論文的特色「乃論述《夷堅志》中所載之神像經驗，發前人之未發，具有研究視野與問題意識，值得嘉許」。另一篇為陸軍官校朱文章老師〈對孫子兵法「虛實」篇名現有英文翻譯之研究〉一文，則企圖以讀者眼光，檢查比較當前流行孫子兵法譯本中，對「虛實」二字之翻譯。

本期截至出刊前，投稿論文共二十三篇，其中校內稿十二篇，校外稿十一篇，通過率約為 26.09%，期待校內外各領域學者繼續支持《清雲學報》，歡迎賜稿，雖勉力完成相關編輯作業，恐有未全之處，尚祈方家不吝指正。

清雲學報編輯委員會　謹識

中華民國一百年十月

一種高效能改良式基因演算法之向量量化器設計

A High Efficient Memetic Algorithm for the Design of Vector Quantization

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摘　要

本文提出一種以改良式基因(memetic algorithm, MA)演算法來設計向量量化器(vector quantizers, VQs)，此演算法是先用穩態型基因演算法(Steady-State genetic Algorithm, SSGA)來做全域搜尋，並再以 C-Means 演算法做局部改善，相較於其他改良式基因演算法使用世代型基因演算法(generational GA)去做全域搜尋。本文所提出的改良式基因演算法能有效降低向量量化器碼簿訓練時間，除此之外，其結果也最接近全域最佳解，且對初始的碼字選擇較不敏感。模擬結果顯示，本演算法在設計向量量化器上比其他改良式基因演算法在相同的基因族群個數下，擁有穩定效能且更能大幅降低 CPU 計算時間。

關鍵詞：改良式基因演算法、向量量化器、穩態型基因演算法

Abstract

A novel memetic algorithm (MA) for the design of vector quantizers (VQs) is presented in this paper. The algorithm uses steady-state genetic algorithm (GA) for the global search and C-Means algorithm for the local improvement. As compared with the usual MA using the generational GA for global search, the proposed MA effectively reduces the computational time for VQ training. In addition, it attains near global optimal solution, and its performance is insensitive to the selection of initial codewords. Numerical results show that the proposed algorithm has significantly lower CPU time over other MA counterparts running on the same genetic population size for VQ design.

Keywords**:** Memetic Algorithm, Vector Quantizer, Steady-State Genetic Algorithm

壹、前言

現今許多研究學者都使用基因演算法(Eiben, & Smith, 2003; Ou, 2010; Ou, Chen, & Hwang, 2006; Ou, Hwang, Hu, & Lo, 2006; Srinivas, & Patnaik, 1994)，藉此來解決各種困難問題組合，並找出問題的最佳解。基因演算法是模擬生物演化程序所建立的計算模式，其物種族群是由一群基因序列所組成，藉由不斷淘汰其他適應性較差的基因序列，留下最好的基因序列進行再生、交配以及突變等流程，進一步將基因序列改善成比較優良的基因序列。

在世代型基因演算法(generational GA)中，結合再生、交配與突變，即稱爲一個世代，而基因序列會持續演化數代達到全域最佳解。雖然世代型基因演算法是有效，但是不能進行微調，而讓搜尋結果使其接近最佳解。爲解決這個缺點，本文提出一種結合世代型基因演算法(generational GA)以及局部搜尋的改良式基因演算法(memetic algorithm, MA)。在改良式基因演算法中，每個基因序列會經過再生、交配及突變等過程後，再藉由局部微調使結果更完善。在改良式基因演算法中，先使用世代型基因演算法做粗略搜尋，再利用細部的微調方式來對基因序列做局部改善，使其結果更接近全域最佳解。研究證明，改良式基因演算法卓越的性能比單純使用基因演算法效率來的高，並有多方面應用，例如:VLSI 設計(Coe, Areibi, & Moussa, 2007)，旅行推銷員問題(Radcliffe, & Surry, 1994)，及一元二次方程式的計算(Merz, & Freisleben, 1999)。

向量量化器(vector quantization, VQ) (Gersho, & Gray, 1992)已被證明能有效使用在資料壓縮、資料探勘以及辨識圖形等領域，向量量化器能消除原始資料中冗餘的部份，只保留有用資料。向量量化器最常見的設計方法是以C-Means演算法爲基礎(Kanungo, Mount, Netanyahu, Piatko, Silverman, & Wu, 2002)，當碼字與每個訓練集合以疊代方式，每次最佳化一個。因此C-Means演算法被視爲一種能局部最佳化向量量化器(Scheunders, 1997)的設計方法。

改良式基因演算法利用世代型基因演算法做全域搜尋，並使用C-Means演算法做局部改善以提高向量量化器的性能。不過使用基本型改良式基因演算法在計算上的時間複雜度非常高，因爲基本型改良式基因演算法在執行世代型基因演算法時，在每一個世代中，新的子代序列集合會取代親代集合，並對每個新的子代做C-Means演算法。因此，當基因序列越多時，所花費計算時間也隨之增長。本文提出一種新的改良式基因演算法來設計向量量化器，在此演算法中不是使用世代型基因演算法而是使用穩態型基因演算法(Steady-State genetic Algorithm, SSGA)(Ou, 2010; Goldberg, & Deb, 1991; Rasheed, & Davisson, 1999; Ou, & Zhang, 2009)來降低計算上的時間複雜度。穩態型基因演算法不採用世代型基因演算法的概念，而是在每一次基因運算過程只產生一個子代序列。經過交配及突變運算後，計算出合適值並對所有親代比較，如果新的子代合適值低於所有親代序列，親代序列不會被取代，否則新的子代將取代親代中最低合適值的序列。

本文所提出之改良式基因演算法稱爲穩態型改良式基因演算法(Steady-state MA)。爲了微調經過穩態型基因演算法(Steady-state GA)全域搜尋結果使其更佳，我們再執行 C-Means 演算法，對經過交配與突變運算後的子代序列進行局部改善。在穩態型改良式基因演算法(Steady-state MA)，由於一次只有產生一個子代序列，所以只要對一個新的子代序列進行 C-Means 演算法來做局部改善，之後產生新的子代序列將會與現存的親代序列比較。相較於基本型改良式基因演算法在執行 C-Means 演算法時，必須對所有產生

的基因序列進行運算。本文所提出的穩態型改良式基因演算法在設計向量量化器更能降低大量的計算時間。在同樣條件下所顯示的數據，當碼字 $N = 64$ 時穩態型改良式基因演算法明顯比基本型改良式基因演算法降低多達 66.3%的 CPU 計算時間，在碼字 $N = 32$ 時更能降低多達 74.7%的 CPU 計算時間，且能保持同等的效能。因此，本文提出演算法具有高效能及低計算時間，在向量量化器的應用上，更能有效的替代基本型改良式基因演算法。

貳、演算法

首先，我們使用 C-Means 演算法來設計向量量化器。考慮一個全域搜尋的向量量化有 N 個碼字 $\{\mathbf{y}_1,...,\mathbf{y}_N\}$，訓練向量集合爲 $T = \{\mathbf{x}_1,...,\mathbf{x}_N\}$，向量量化的平均誤差值 D 爲：

$$D = \frac{1}{wt}\sum_{j=1}^{t} d\left(\mathrm{x}_j, \mathrm{y}_{\alpha(x_j)}\right). \tag{1}$$

其中 w 是向量的維度，t 是訓練向量的個數，$\alpha(\ )$ 爲編碼器，以及 $d(\mathbf{u},\mathbf{v})$ 是 $\mathbf{u}$ 和 $\mathbf{v}$ 的距離平方。

在公式(1)中，C-Means 演算法是一種用疊代方法尋找在 $\{\mathbf{y}_1,...,\mathbf{y}_N\}$ 中，使平均誤差值 D 最小化。爲了設計出完善的向量量化器，在此演算法須滿足兩個必要的條件。

必要條件之一：

令 T_i 爲一個訓練向量藉由 $\alpha(\ )$ 編碼後分配給碼字 $\mathbf{y}_i$ 的集合，由於碼字 $\{\mathbf{y}_1,...,\mathbf{y}_N\}$，而產生 $T_1, T_2,..., T_N$ 最佳分群，所以在公式(1)中最小平均誤差值 D 應滿足：

$$T_i = \{\mathbf{x} : \mathbf{x} \in T, \alpha(\mathbf{x}) = i\}, \tag{2}$$

$$\alpha(\mathbf{x}) = \arg\min_{1\le j\le N} d(\mathbf{x}, \mathbf{y}_i). \tag{3}$$

必要條件之二：

進行分群後，將 T_i 訓練向量中所有碼字 $\mathbf{y}_i$ 利用公式(4)計算出理想的碼字 $\mathbf{y}_i$，且利用公式(1)計算最小平均誤差值 D 時應滿足:

$$\mathbf{y}_i = \frac{1}{Card(T_i)}\sum_{\mathbf{x}\in T_i}\mathbf{x}. \tag{4}$$

C-Means 演算法是藉由給定初始碼字，利用公式(3)計算得到理想的分群結果。再依照分群結果，利用公式(4)計算出新的碼字集合。重複兩個步驟並觀察向量量化器初始碼字的平均誤差值 D 值收斂後，並取出最後收斂時的 D 值及對應的碼字。

儘管 C-Means 演算法是有其效率，但是在向量量化器設計上幾乎只能尋找到局部最佳解。由於此演算法的性能高低完全依賴於初始碼字的選取結果，所以當初始碼字選取不當時，最後可能會落於最差的結果。因爲 C-Means 演算法在設計向量量化器有上述缺點，所以本文提出另外一種演算法。此演算法結合 C-Means 演算法與世代型基因演算法稱爲基本型改良式基因演算法。在基本型改良式基因演算法中，利用世代型基因演算法進行全域搜尋的優點，能有效解決 C-Means 演算法的缺點，另一方面使用 C-Means 進

行微調使其結果更接近全域的最佳解。

在基本型改良式基因演算法中，假設有 P 個基因序列來做基因運算，每一個序列 r 代表一組 N 個碼字 $\{\mathbf{y}_1,...,\mathbf{y}_N\}_r$。這些序列是由向量所組成，不是單一的數字。假設 $S(k)$ 與 $D(k)$ 各自代表著 P 個基因序列的集合與目前基本型改良式基因演算法經過 k 次演化後的最小失真值 D。而 s^* 是在基因演算過程中的當時最佳的序列。最初我們讓 $D(0)=\infty$，而初始 s^* 作爲 0。此外，我們可以從訓練向量中隨機選擇資料作爲 $S(0)$ 中的碼字序列。假設 $(k-1)$ 次已經完成，而第 k 次 $(k\geq 1)$ 即將結束，然後對 $S(k-1)$ 的序列做基因演算與局部的改善。

一、再生

由於每一個在 $S(k-1)$ 中用來做基因演算的基因序列，其實是向量量化的一個碼簿，可以透過公式(1)計算求出相對應的 D 值，而 D 值的倒數是作爲每一個序列的適應函數，再生過程中使用輪盤法技術。也就是說，我們模擬出一個旋轉輪盤，而輪盤根據各序列的適應函數值，有不同的大小區塊比例，再從中挑出再生序列。一旦有一個序列選取出來做再生，將複製此序列做爲再生序列，這再生序列將被用於進行交配與突變。在此演算法中，經過再生演算之後產生 P 個再生序列。

二、交配

在表示成 $\{\mathbf{y}_1,\mathbf{y}_2...,\mathbf{y}_N\}_r$ 的再生序列 r 中，其發生單點交配的機率爲 P_c。從全部的族群中，隨機選出另一個表示成 $\{\mathbf{z}_1,\mathbf{z}_2...,\mathbf{z}_N\}_{r'}$ 的序列 r'。然後再 1 到 N 中隨機產生一個整數值 n，兩個序列根據 n 的位置切割成兩部分，並且將 $\{\mathbf{y}_{n+1},...,\mathbf{y}_N\}$ 和 $\{\mathbf{z}_{n+1},...,\mathbf{z}_N\}$ 互相交換。

三、突變

突變步驟是根據一個極小機率 P_b 發生在每一個序列中的碼字。假設目前有一個即將進行突變的序列 $r=\{\mathbf{y}_1,\mathbf{y}_2,...,\mathbf{y}_N\}_r$，接下來隨機從 N 個碼字中選擇出一個 $\mathbf{y}$，而且在碼字 y 的 w 個數字中，隨機選取一個數字。接著產生一個隨機數，並加上這個隨機數或減掉這個隨機數也就是 $+b$ 或 $-b$ 來達成突變目的。

四、局部微調

我們對基因演算法中所有序列用 C-Means 做局部的改善，然後 P 個序列經過 C-Means 演算法設計後成爲 $S(k)$ 集合的序列，並計算出 $S(k)$ 中所有序列的平均誤差值 D。令 r^* 是 $S(k)$ 序列中有最小失值 D，且 D^* 是 r^* 的 D 值，然後比較 D^* 與 $D(k-1)$。假如 D^* 小於 $D(k-1)$，則 $D(k)\leftarrow D^*$ 且 $s^*\leftarrow r^*$。否則，$D(k)\leftarrow D(k-1)$，和保留目前相同的最佳化序列 s^*，這就完成執行第 k 次世代基本型改良式基因演算法。在基本型改良式基因演算法中，持續疊代上述計算直到 $D(k)$ 值收斂。實際上，觀察到連續 L 次相同的 $D(k)$ 值(即 $D(k)=D(k-1)=\cdots=D(k-L+1)$).我們便停止此演算法。然後選定基本型改良式基因演算法後的最佳序列 s^*，就是所求的最後結果。基本型改良式基因演算法的流程圖如圖 1 所示。

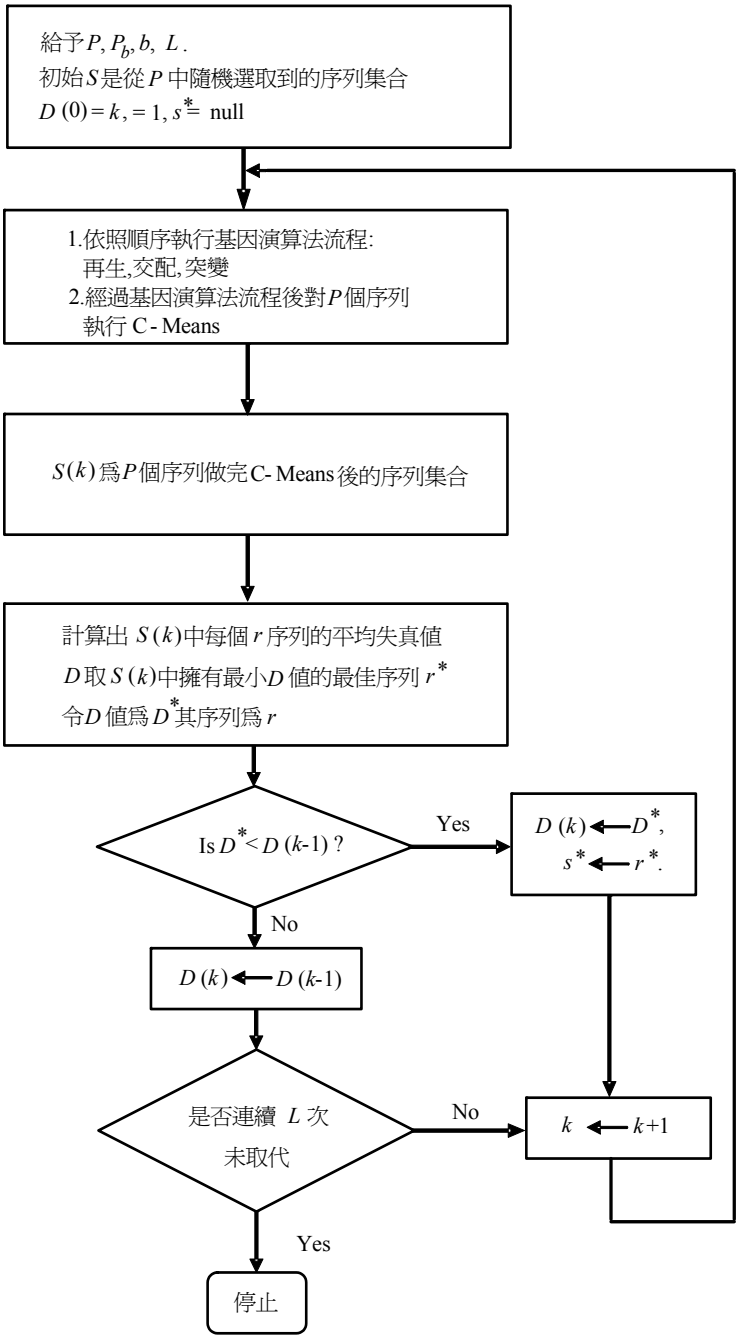

圖 1 基本型改良式基因演算法流程圖

基本型改良式基因演算法主要的缺點在於經過再生，突變與交配計算後的各個新族群的序列，都需要使用 C-Means 演算法做局部改善。從公式(3)中，C-Means 演算法對此程序採用全部-搜尋系統。因此，基本型改良式基因演算法在執行 C-Means 演算法的計算時間複雜度高。當族群 P 的數量多時，基本型改良式基因演算法就需要更長的 CPU 計算時間來尋找最佳解。

本文提出一種新的穩態型改良式基因演算法來設計向量量化器。此演算法能大幅降低 CPU 計算時間，在效能也能與基本型改良式基因演算法相同。在此改良式基因演算

法中，使用穩態型基因演算法取代基本型改良式演算法中的世代型基因演算法來做全域搜尋。但穩態型基因演算法並不使用世代型基因演算法的再生觀念來求得最佳解，因此不用每次讓子代序列完全取代親代序列。事實上，最多只有一個親代序列被子代序列取代。

首先從初始基因序列選擇兩個親代序列 r_1 和 r_2 進行交配運算。假設 $r_1 = \{\mathbf{y}_1, \mathbf{y}_2, ..., \mathbf{y}_N\}_{r_1}$ 和 $r_2 = \{\mathbf{z}_1, \mathbf{z}_2, ..., \mathbf{z}_N\}_{r_2}$ 經過交配運算後， r_1 和 r_2 序列變成：

$$\{\mathbf{y}_1, \mathbf{y}_2, ..., \mathbf{y}_N\}_{r_1} \rightarrow \{\mathbf{y}_1, \mathbf{y}_2, ..., \mathbf{y}_n, \mathbf{z}_{n+1}, ..., \mathbf{z}_N\}_{r_1}$$
$$\{\mathbf{z}_1, \mathbf{z}_2, ..., \mathbf{z}_N\}_{r_2} \rightarrow \{\mathbf{z}_1, \mathbf{z}_2, ..., \mathbf{z}_n, \mathbf{y}_{n+1}, ..., \mathbf{y}_N\}_{r_2}$$

假設 c 爲本演算法中產生的子代序列。在我們的設計中，首先從初始所有的基因序列中隨機選擇兩個基因序列進行交配，接著經過交配運算後將產生 r_1 和 r_2 等兩個新的基因序列，之後將 r_1 和 r_2 進行交配後產生的兩個新序列並隨機選一個做爲子代序列 c 。之後對子代序列 c 進行突變運算接著根據合適函數求出其合適值。如果子代序列的合適值比親代序列差，則親代序列全部都不會被淘汰。否則，合適值最低的親代，子代序列將會取代。

在穩態型改良式基因演算法中，對經過交配與突變運算後的子代基因序列 c 進行 C-Means 演算法做局部改善，接著根據 C-Means 演算法改善後評估產生新子代序列 c 的平均誤差值 D。假設 $\underline{r}$ 是目前 S 集合中擁有最低合適值的序列(亦即擁有最高平均誤差值 D)，此外假設 $\underline{D}$ 爲序列 $\underline{r}$ 的平均誤差值 D。如果子代序列 c 的平均誤差值 D 小於 $\underline{D}$，則進行取代。由於 $\underline{r}$ 被取代後，S 集合中的序列隨後被更新，接著依據各自的平均誤差值 D 大小做排序，擁有最大平均誤差值 D 的序列則成爲新的 $\underline{r}$ 。這個運算重覆執行，直到子代序列連續 L 次未取代親代才會停止。如果未達連續 L 次，則繼續重覆上述運算。最後在 S 集合中擁有最小失真值的親代序列作爲向量量化器的碼簿。
此演算法如下:

Step 0：
給予 $P, P_b, b, L.$
初始 S 是 P 中隨機選取到的序列集合
$\underline{r}$ 是 S 集合中擁有最低合適值序列
$\underline{D}$ 是 $\underline{r}$ 序列的平均誤差值 D 。
Step 1：
從 S 中隨機選取 r_1 和 r_2 兩個序列。
Step 2：
藉由 r_1 和 r_2 交配而產生子代序列 c
根據 P_b 和 b 突變序列 c 。
Step 3：
對子代序列 c 做 C-Means 演算法
計算經過 C-Means 演算法後序列 c
的平均誤差值 D 。
Step 4：

如果c的平均誤差值D小於D，則在S集合中序列c取代序列$\underline{r}$根據S中所有序列進行排序，找出S中新的序列$\underline{r}$，回到 Step 1。如果S中所有的親代序列連續L次未被取代，則選擇S中擁有最小失真值的基因序列，這就是預期的結果，結束演算法。

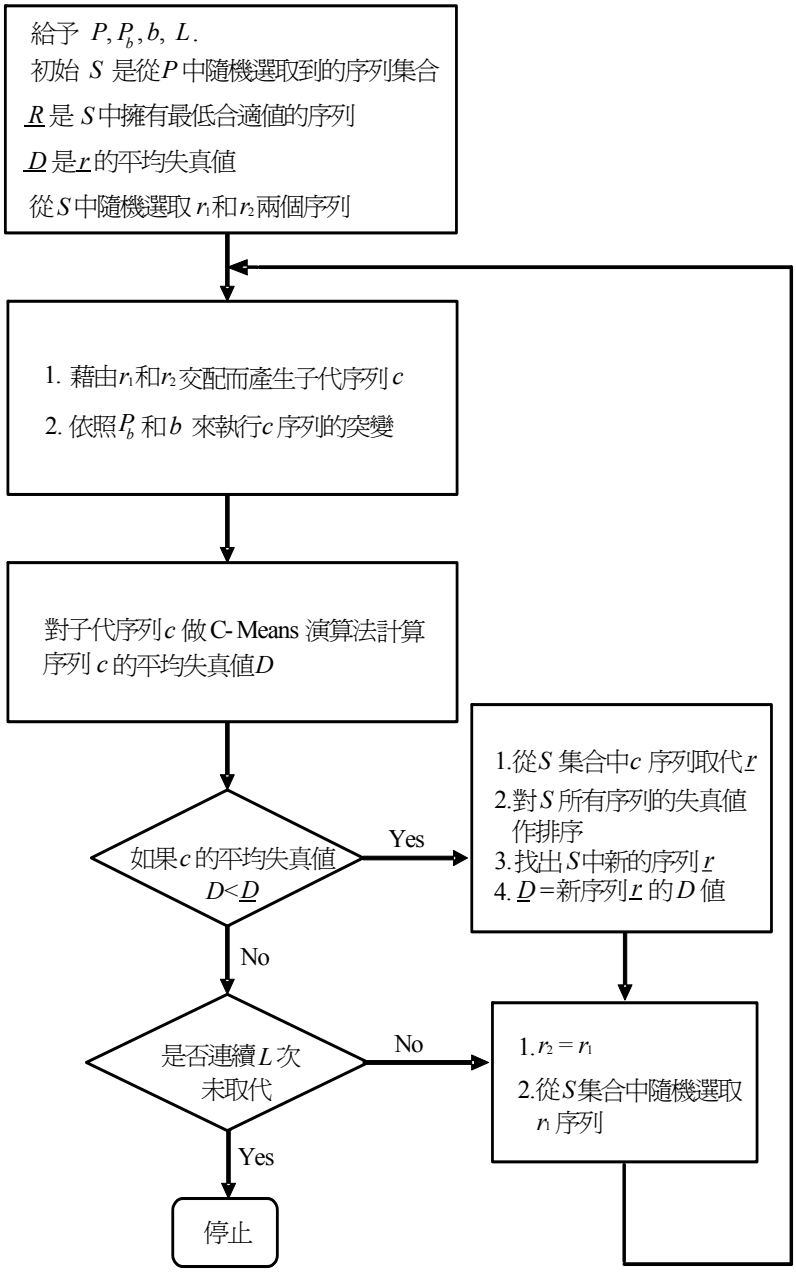

圖 2 穩態型改良式基因演算法流程圖

圖 2 爲穩態型改良式基因演算法的流程圖。由圖 2 可以得知，本文所提出穩態型改良式基因演算法中，並不需要對所有基因序列集合S執行 C-Means 演算法，因爲一次只產生一個子代序列c，所以每次只對一個子代序列c做 C-Means 演算法。相比之下，圖 1 之基本型改良式基因演算法，k次的再生都必須重覆對全部$S(k)$集合裡的所有序列做 C-Means 演算法，就此步驟而言，穩態型改良式基因演算法減少相當多的計算時間。因此，本文所提出演算法在局部的改善方面有較低的計算時間。此設計在大量的基因序列

個數 P 下，計算時間上會更明顯的改善。

參、實驗結果

本節將針對本文演算法提出實驗結果並討論，實驗之數據是由 Intel(R) Core(TM)2 Duo CPU 及 4GB 記憶體的電腦環境下所得。每一次訓練碼簿，使用兩張解析度 512×512 的訓練圖片“Lena” 與“Bridge”，並隨機選取不同基因序列集合。實驗條件中基因序列集合個數 $P=32$ ，每一個基因序列分別包含 $N=32$、64 個碼字，碼字的維度 $w=2\times 2$ ，突變機率 $P_b=0.01$ ， b 爲隨機數，連續收斂次數 L 爲 5 次。在圖 3 所示爲碼字 $N=32$ 時執行基本型改良式基因演算法與穩態型改良式基因演算法各 100 次(Times)後的平均誤差值 D 分佈圖。圖 4 是碼字 $N=64$ 時執行基本型改良式基因演算法與穩態型改良式基因演算法在相同 P,P_b,w 條件下執行各 100 次(Times)後的平均誤差值 D 分佈圖。圖 3 與圖 4 實線部分，分別是碼字執行穩態型改良式基因演算法平均誤差值 D 分佈圖，虛線部分是碼字 $N=32$、64 執行基本型改良式基因演算法平均誤差值 D 分佈圖。從圖 3 與圖 4 上可以看出在碼字 $N=32$、64 不同情況下穩態型改良式基因演算法與基本型改良式基因演算法的平均誤差值 D 分佈圖相當類似。當碼字 $N=64$ 時，穩態型改良式基因演算法與基本型改良式演算法的平均誤差值 D 分佈圖比碼字 $N=32$ 集中性較佳。觀察結果後會發現本演算法會隨碼字 N 增加時，效能更加穩定，然而穩態型改良式與基因演算法基本型改良式基因演算法的 CPU 執行時間也隨之增加，主要是因爲碼字 $N=64$ 時分佈比較密集，搜尋到最佳碼字時間上會較長，但是平均誤差值 D 會比碼字 $N=32$ 收斂集中。

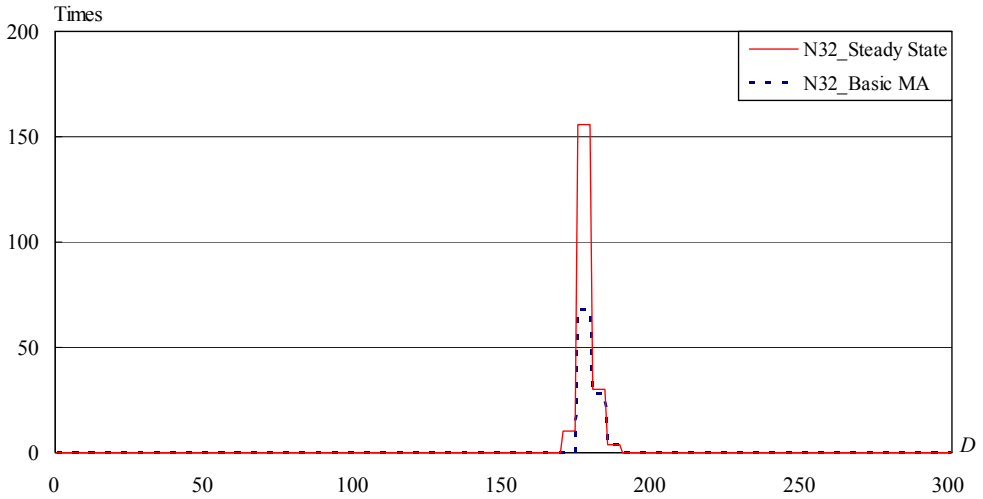

圖 3 碼字 $N=32$ 時，穩態型(實線)、基本型(虛線)改良式基因演算法平均誤差值 D 分佈圖

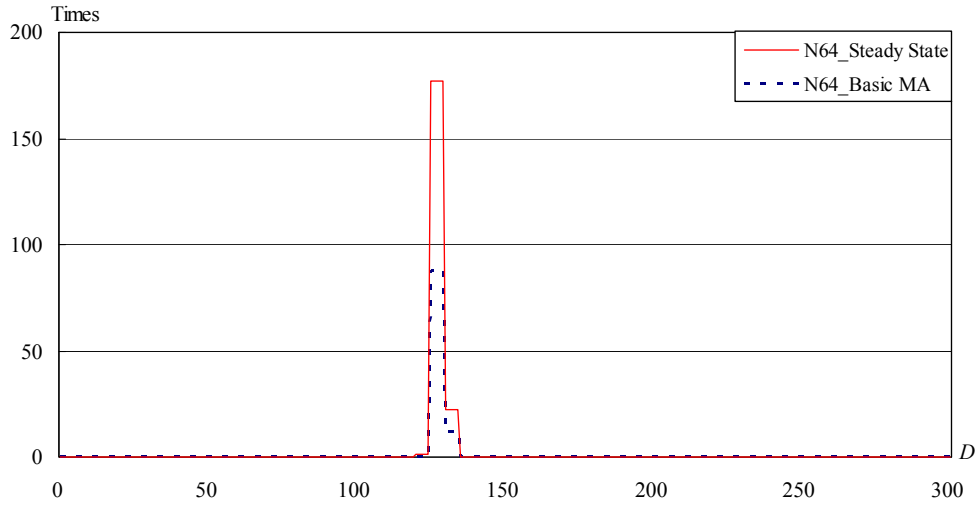

圖 4 碼字 $N=64$ 時，穩態型(實線)、基本型(虛線)改良式基因演算法平均誤差值 D 分佈圖

給定模擬數據條件下，每一個碼字個數 $N=32$、64，碼字的維度 $w=2\times 2$ ，突變機率爲 $P_b=0.01$，並仔細觀察表 1 發現碼字 $N=32$、64 且在不同基因序列 P 所產生的平均誤差值 D 與 CPU 平均執行時間，本文所提供的穩態型改良式基因演算法，當碼字 $N=32$ ， $P=32$ 平均執行一次 CPU 執行時間是 4.24 分。相比之下，基本型改良式基因演算法的 CPU 執行時間則需要 16.74 分，本演算法 CPU 執行時間大約爲基本型改良式基因演算法的 25.3%。當碼字 $N=64$，$P=32$ 時平均執行一次 CPU 執行時間是 13.6 分。相比之下，基本型改良式基因演算法的 CPU 執行時間則需要 40.3 分，本演算法 CPU 執行時間大約爲基本型改良式基因演算法的 33.7%。由此證明在 CPU 執行時間上穩態型改良式基因演算法優於基本型改良式基因演算法，當碼字 $N=64$ 時平均誤差值 D 會逐漸減小，CPU 執行時間上會明顯比碼字 $N=32$ 時花費更長。計算執行各 100 次，在不同基因序列個數 P 時，得到表 1 中的 CPU 平均執行時間與平均誤差值 D。從表 1 中看出當 P 增加時，基本型改良式基因演算法的 CPU 執行時間也隨之增加。而本演算法比基本型改良式基因演算法節省更多的 CPU 執行時間。此外，當相同的族群個數 P 之下，穩態型改良式基因演算法比基本型改良式基因演算法擁有較高的效能。

然後我們改變突變機率 P_b，並觀察突變機率 P_b 大小對於穩態型改良式基因演算法效能的影響。表 2 是本演算法在碼字個數 $N=32$、64 和維度 $w=2\times 2$ ，對各種 (P,P_b) 執行各 100 次而產生的平均誤差值 D ，從數值中顯示碼字 $N=64$ 時的平均誤差值 D 比碼字 $N=32$ 效能更加穩定。爲了讓數值能明顯比較出在碼字 $N=32$、64 的穩定效能，用圖 5 與圖 6 來呈現，圖 5 爲碼字 $N=32$ 時，穩態型改良式基因演算法在不同突變機率 P_b 下對平均誤差值 D 影響圖，圖 6 爲碼字 $N=64$ 時，穩態型改良式基因演算法在不同突變機率 P_b 下對平均誤差值 D 影響圖，仔細觀察圖 5 與圖 6，就算在碼字 $N=32$、64 時且不同參數的選擇之下，對於最後平均誤差值 D 的影響也不大，這些證明本演算法擁有穩定的效能。

表 1 碼字 $N = 32$、64 不同的基因序列時，兩種改良式基因演算法的 CPU 執行時間與平均誤差值 D

P	穩態型改良式基因演算法 CPU 計算時間(分)與平均誤差值 D				基本型改良式基因演算法 CPU 計算時間(分)與平均誤差值 D			
	$N = 32$		$N = 64$		$N = 32$		$N = 64$	
8	1.58	178.01	4.3	127.28	4.43	179.74	11.1	127.1
16	2.52	177.11	8.09	126.53	9.86	178.3	24.2	125.8
32	4.24	176.34	13.6	125.3	16.74	177.53	40.3	125.3
64	7.2	175.43	24.7	124.8	36.49	175.95	51.1	124.1
128	12.59	174.88	44.3	124.1	71.32	174.93	94.2	124.4

表 2 碼字 $N = 32$、64 時不同突變機率 P_b 對平均誤差值 D 影響

	$P_b = 0.01$		$P_b = 0.05$		$P_b = 0.1$		$P_b = 0.15$		$P_b = 0.2$	
	$N = 32$	$N = 64$	$N = 32$	$N = 64$	$N = 32$	$N = 64$	$N = 32$	$N = 64$	$N = 32$	$N = 64$
$P = 8$	178.01	127.28	178.7	127.25	178.06	127.11	178.66	127.98	178.76	127.43
$P = 16$	177.11	126.53	177.08	126.17	177.22	126.42	177.52	126.53	177.21	126.53
$P = 32$	176.34	126.3	176.47	126.41	176.45	126.26	176.37	125.8	176.62	126.37
$P = 64$	175.43	126.1	175.4	126.36	176.32	126.39	176.44	126.37	176.66	126.12

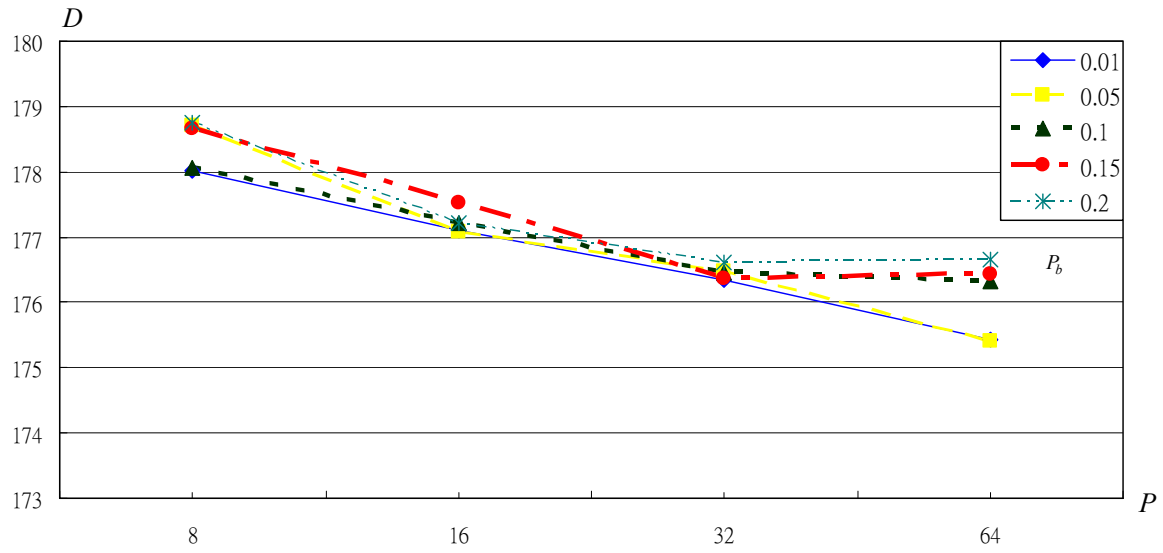

圖 5　碼字 $N = 32$ 時，穩態型改良式基因演算法在不同突變機率 P_b 下對平均誤差值 D 影響圖

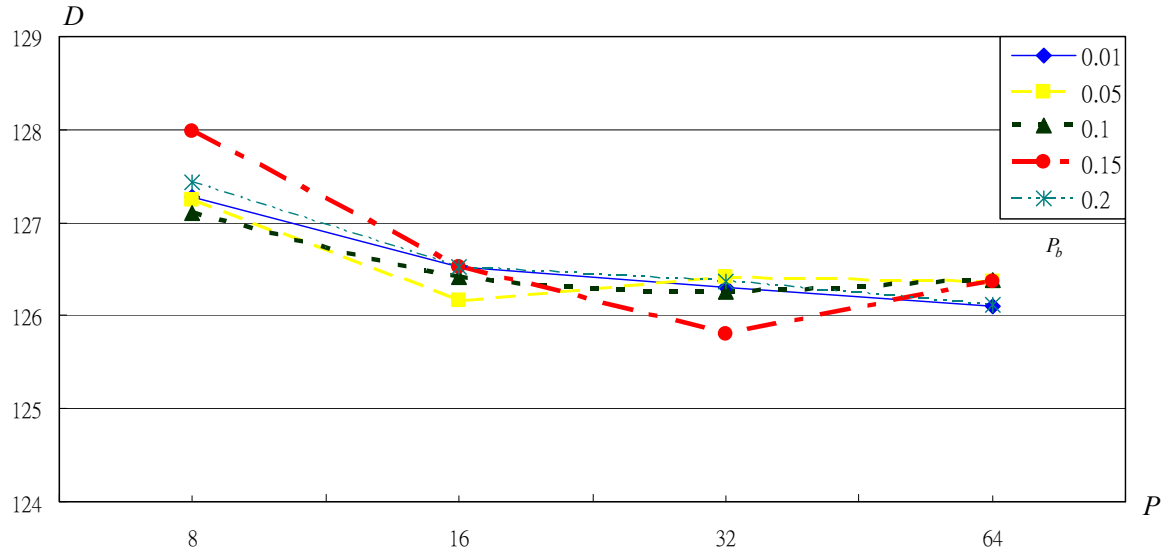

圖 6　碼字 $N = 64$ 時，穩態型改良式基因演算法在不同突變機率 P_b 下對平均誤差值 D 影響圖

肆、結論

實驗結果顯示出我們設計出來的穩態型改良式基因演算法設計出來的向量量化器，具有比較低的平均誤差值 D 與 CPU 執行時間。當碼字 $N = 64$ 時，穩態型改良式基因演算法與基本型改良式基因演算法相比之下，穩態型改良式基因演算法可降低多達 66.3%的 CPU 執行時間，在碼字 $N = 32$ 時，更能降低多達 74.7%的 CPU 執行時間。如圖 3 與圖 4 所示，在各自執行各 100 次後，穩態型改良式基因演算法與基本型改良式基因演算法兩者的平均誤差值 D 分佈圖相當類似，當碼字 $N = 64$ 時穩態型改良式基因演算法的平均誤差值 D 分佈圖也比碼字 $N = 32$ 時穩態型改良式基因演算法的平均誤差值 D

分佈圖來的收斂集中。從圖 5 與圖 6 也可以看出穩態型改良式基因演算法在不同突變機率 P_b 情況影響下且能維持穩定效能。由這些結果顯示出，穩態型改良式基因演算法在向量量化器設計上不僅具備與基本型改良式基因演算有相同的效果且不容易受初始碼字的影響。當碼字越大收斂效果更好且平均誤差值 D 越佳。因此，本演算法有助於改善向量量化器碼簿訓練時的 CPU 執行時間與平均誤差值 D 。

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使用可重組式硬體電路實現歌曲檢索系統

Implementation of the Music Retrieval System Using Reconfigurable Hardware Circuits

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摘　要

本文提出一個以可重組式硬體電路實現歌曲內容檢索系統，本系統採用一個近似字串比對硬體電路架構，藉由一個簡單的 shift-and-or 演算法則為基礎發展的硬體電路。此系統具有低面積、高效能及低功耗等優點。數據結果顯示本文所提出硬體架構在大量資料庫或允許錯誤增加之情況下，以硬體執行 shift-and-or 演算法的 CPU 運算時間遠比在 Pentium IV 以軟體執行低。系統硬體電路架構在 Altera 開發板上，量測本電路的功率損耗，在工作頻率增加時，功率損耗只有些微增加。經由 Altera Quartus PowerPlay Early Power Estimator 量測，當工作頻率從 10MHz 增加到 50MHz，功率損耗的變化從 1156.73mW 到 1192.32mW，代表本系統之功率損耗會因工作頻率不同而呈現線性之變化。

關鍵詞：可重組式硬體電路、近似字串比對、歌曲檢索

Abstract

This paper proposes a FPGA(field programmable gate array) design and implantation of music retrieval system. The system adopts a novel hardware architecture for approximate string matching. The architecture is based on a simple shift-and-or algorithm. It has the advantages of low area cost, high throughput. and low power. Numerical results show that the proposed architecture has significantly lower CPU time over its software counterpart running on Pentium IV for large database and/or edit distances. Data Result show that the proposed architecture has significantly lower CPU time over its software counterpart running on Pentium IV for large database and/or edit distances. The target FPGA device is Altera Development Board. The power of measurement electric circuit exhausts. As the operating frequency rises to increases from 10MHz to 50MHz, the power consumption only raises from 1156.73mW to 1192.32mW. Representing systematic power consumption will present the linear change because frequency is different.

Keywords : FPGA, approximate string matching, music retrieval

壹、前言

在過去，歌曲資料大都是儲存於 CD 或卡式錄音帶之中，一張 CD 中可以儲存數十首歌曲，在這少量的歌曲中搜尋曲目，對人們來說並不是很困難，只需要花點時間即可搜尋到想聽的旋律。但是近幾年來，大量的數位化資料包含音樂等，都已隨著網際網路快速傳播，使得歌曲資料儲存的範圍更加廣泛，儲存空間已不單單是 CD 或卡式錄音帶之中，現在人們幾乎隨身攜帶記憶卡或者外接式硬碟等儲存裝置，甚至還有自己的網路空間可以存放著大量的音樂資料，當人們在搜尋歌曲的過程中，其曲目已超過人們可以負擔的數量，對於想要選取歌曲的現在人而言，增加搜尋上的困難度，人們不再是花點時間就可以搜尋到歌曲，所以歌曲檢索在這幾年逐漸受到專家學者的重視，儼然成爲一個重要的研究議題。除了讓使用者以人性化的搜尋方式之外，如何在眾多歌曲之中快速又有效率，找到使用者所需要的歌曲，這就是歌曲檢索(Orio, 2006)的最終目的。

近年來，各家唱片公司的歌手如雨後春筍般不斷增加，歌曲的數量隨著時間的累積更是難以估計，尤其我們想在記憶卡、硬碟等，這種可存放大量音樂的空間中搜尋歌曲時，若以往傳統的音樂檢索方式，在大部分的系統中需使用者於系統中鍵入與該歌曲相關的文字資料，即所謂的外部資訊，如歌曲名稱、演奏家、作曲者或主題的分類等外部資訊，再藉由傳統文字比對方式搜尋出有關字詞找出相關歌曲資料，這類型的檢索方式有個缺點，在某些時候是無法滿足使用者的，歌曲資料有部分是無法利用文字型態去表達，也就無法利用關鍵字詞去搜尋歌曲。大多數的人從小到大幾乎都聽過無數的音樂旋律，有時候大家聽到某首歌曲時，使用者只記得音樂旋律或者是無意間聽到一段喜歡的音樂旋律，卻想不起歌曲名稱，若使用者知道這首歌的相關資料的話，就可以使用傳統文字比對搜尋。但在不知道其相關資訊的情況下，傳統檢索方式是無法直接檢索這類非文字型態的音樂資料，若以內涵式查詢(content-based retrieval)可以有效的解決此問題，所謂的內涵式查詢就是對所要搜尋的多媒體資料，做內容的分析並且擷取其特徵值，以作爲檢索查詢的依據，讓使用者能夠很容易地搜尋到其所想要的歌曲資料。

一首歌曲內容包含許多資訊，較常被擷取出用來描述歌曲特徵，例如旋律、節拍、和弦等，擷取這些歌曲特徵值，將這些資訊存入資料庫中，在查詢歌曲時，使用者輸入部分的歌曲特徵值於系統中與資料庫做比對，並回應給使用者最近似的歌曲資料，查詢過程中使用者不必輸入文字型態，而由歌曲資料的內容取代傳統文字做搜尋。目前現有的歌曲內容檢索技術，大部分都允許使用者輸入一個碎音(Tseng,1999)或提供一段不完整的歌曲片段做查詢，使用者可以經由鍵盤或哼唱的方式，而輸入的歌曲資料內容(Ou, Yeh, Su, Hwang, & Chen, 2008)可不需與資料庫中的歌曲完全相同。

字串比對技術已發展數十年了，應用在許多地方，查詢的字串要與被比對的字串達到完全相同，才可以算是符合檢索比對成功，這種稱爲完全比對(Exact Matching)。先前提到使用者不太能夠輸入與歌曲資料庫相同的片段，因此歌曲資料的比對不能以完全相同表示符合檢索條件，所以歌曲資料的比對以近似比對(approximate matching) 的技術較符合需求，包含允許字串的取代、插入和刪除(Lemstrom, 2000)等情況，作爲比對的方法，若近似字元串比對技術以軟體實現通常要很複雜的運算並需要花長時間，對於一個檢索系統是相當不合適地。

近似字串比對技術以硬體的方式，對於增加歌曲檢索的處理速度是相當有效率的方法。目前已有許多針對近似字串比對電路所提出的研究報告，但將這些電路套用在歌曲

檢索系統上是很困難的，例如有些近似字串比對電路是實現動態規劃(dynamic programming)的演算法(Yu, Kwong, & Leong, 2003; Bluthgen, & Noll, 2000; Dydel, & Bala, 2004)，要使用在不同長度的歌曲檢索片段缺乏彈性。雖然有別的電路架構(Park, & George, 1999)可能有更高的彈性，但此電路架構只支援字串中符號被取代的情況，而且實現此電路架構需要相當高的面積成本。

本文的目的是在近似字串比對爲基礎下，提出一個以歌曲內容爲基礎的檢索方式，本系統分爲系統端(server)及使用者端(client)，由網路進行資料的傳輸。系統端有別一般ASIC(Application Specific Integrated Circuit)(Smith, 2004)的技術是用可重組式電路(Bondalapati, & Prasanna, 2002; Brown, 1996)來實現，可重組式電路技術除了擁有與ASIC技術相當的運算速度，更重要的是修改電路僅需些許的時間，可隨時改變電路的特點。以硬體方式用在近似字串比對的 shift-and-or 演算法，此演算法簡單又具有彈性，系統運作之後接收使用者端的查詢(query)請求，執行高速 CBMR(Content-Based Music Retrieval)比對以後，系統端傳回的結果傳回使用者端，回傳的結果會依照相似度由高到低排序。本系統的架構利用硬體平行處理技術提升效能並量測比對核心 NIOS II CPU(Altera Corporation, 2007)在各種工作頻率上的功率損耗(Ou, 2011)。

貳、理論基礎

本文中我們用來判別歌曲資料的相似度是以歌曲內容爲查詢依據，而此歌曲內容就是指音符，將音符轉換成數位資料，再透過字串比對技術進行歌曲資料比對工作。字串比對分完全比對和近似比對，簡單說明二者的差異性，完全比對是必需與資料庫內容相同，不容許任何錯誤，而近似比對可以允許一些錯誤發生，包含字串的取代、插入和刪除等三種錯誤情況發生。

歌曲檢索不像一般資料比對只需要判斷比對結果是否完全相同，當使用者查詢歌曲時，可能無法記得正確的歌曲旋律、節拍等，過程中可能會有起音不準、曲調走音、多音或少音…等隨機錯誤的查詢狀況，導致輸入不完整的歌曲片段，而造成查詢失敗，利用近似字串比對的技術可以處理這些問題，相較於完全比對，而允許錯誤之近似字串比對難度更高，所需耗費的查詢時間更是倍數增加。所以歌曲檢索系統中“近似字串比對”顯得特別的重要，爲了允許使用者查詢的旋律字串與比對歌曲資料庫的差異，本系統採用一個近似字串比對方法爲 shift-and-or 演算法(Wu, & Manber, 1992)。

本節回顧 shift-and-or 演算法的原理，爲了解此演算法的運作規則，我們舉例說明，假設在一組大量目標字串 $T = t_1 t_2 ... t_n$ (target string) 中欲搜尋一組樣本字串 $P = p_1 p_2 ... p_m$ (pattern string)，若搜尋出完全一樣的字串，即爲完全比對，若不然，則爲近似比對。依據此原理以 shift-and-or 演算法發展成硬體電路，下面將詳細介紹 shift-and-or 演算法。

使用 shift-and-or 演算法須定義出一些條件：首先目標字串的長度遠大於樣本字串 $(n >> m)$；接著目標字串和樣本字串建立一組相同之集合(char set) $\Sigma = \{s_1, ..., s_{|\Sigma|}\}$；最後爲了紀錄比對過程，假設一個包含 $m+1$ 項元素的位元向量(bit vector) $R_j^d[i]$，d 表示允許錯誤，完全比對則以 $d = 0$ 代表。

接著介紹完全比對運算法則，$R_j^d[i] = 1$ 表示樣本字串 p 的前 i 項字元和目標字串 T 中

以 j 爲終點的前 i 項連續字元比對成功，即以 $p_1p_2...p_i = t_{j-i+1}t_{j-i+2}...t_j$ 表示。從 R_j 轉換到 R_{j+1}，若期待 $R^d_{j+1}[i]=1$，則需 $R^d_j[i-1]=1$ 且 $p_i = t_{j+1}$。表示若 R 之第 $j+1$ 項中的第 i 位置，結果等於 1，則 R 之第 j 項中的第 $i-1$ 位置，結果須爲 1 且 p_i 等於 t_{j+1}，方可成立。可歸納成公式(1)：

$$R^d_{j+1}[i] = \begin{cases} 1, \text{ if } R^d_j[i-1]=1 \text{ and } p_i = t_{j+1} \\ 0, \text{ otherwise.} \end{cases} \tag{1}$$

公式(1)欲成立，需要兩個初始條件，第一個初始條件是 $R^d_0[i]=0, i=1,...,m$，第二是 $R^d_j[0]=1, j=0,...,n$。爲了使公式(1)只使用 shift 及 AND 兩個運算子表示，定義一個包含 m 項元素的位元向量(bit vector) S_k，所有符號(symbol) s_k 屬於 Σ，S_k 的第 i 項元素可用公式(2)表示：

$$S_k[i] = \begin{cases} 1, \text{if } s_k = p_i \\ 0, \text{otherwise.} \end{cases} \tag{2}$$

假設 $t_{j+1} = s_c$，根據公式(2)，將公式(1)改寫爲公式(3)：

$$R^d_{j+1}[i] = R^d_j[i\text{-}1] \; AND \; S_c[i], i = 1, \ldots, m. \tag{3}$$

由公式(3)得知，完全比對只需 shift 及 AND 兩個運算子，即可實現。

Symbol S_k		$s_1=a$	$s_2=b$	$s_3=c$
Bit Vector S_k		$S_1[i]$	$S_2[i]$	$S_3[i]$
i	1	1	0	0
	2	0	0	1
	3	0	1	0

(a)

j		0		1			2			3			4			5	
		$R_j[i]$	$R_j[i\text{-}1]$	$S_c[i]$ $(s_c=a)$	$R_j[i]$	$R_j[i\text{-}1]$	$S_c[i]$ $(s_c=c)$	$R_j[i]$	$R_j[i\text{-}1]$	$S_c[i]$ $(s_c=a)$	$R_j[i]$	$R_j[i\text{-}1]$	$S_c[i]$ $(s_c=c)$	$R_j[i]$	$R_j[i\text{-}1]$	$S_c[i]$ $(s_c=b)$	$R_j[i]$
i	1	0	1	1	1	1	0	0	1	1	1	1	0	0	1	0	0
	2	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0
	3	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	①

((b)

j		0			1				2				3				4				5	
		$R^0_j[i\text{-}1]$	$R^1_j[i]$	$R^1_j[i\text{-}1]$	$S_c[i]$ $(s_c=a)$	$R^1_j[i]$	$R^0_j[i\text{-}1]$	$R^1_j[i\text{-}1]$	$S_c[i]$ $(s_c=c)$	$R^1_j[i]$	$R^0_j[i\text{-}1]$	$R^1_j[i\text{-}1]$	$S_c[i]$ $(s_c=a)$	$R^1_j[i]$	$R^0_j[i\text{-}1]$	$R^1_j[i\text{-}1]$	$S_c[i]$ $(s_c=c)$	$R^1_j[i]$	$R^0_j[i\text{-}1]$	$R^1_j[i\text{-}1]$	$S_c[i]$ $(s_c=b)$	$R^1_j[i]$
i	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	0	1
	2	0	0	0	0	0	1	1	1	1	0	1	0	0	1	1	1	1	0	1	0	0
	3	0	0	0	0	0	0	0	0	0	1	1	0	①	0	0	0	0	1	1	1	①

(c)

圖 1 (a)Σ 中所有符號 s_k 的位元向量 S_k、(b)完全比對過程、(c)允許一個取代發生的近似字串比對過程

圖 1 是說明允許一個錯誤發生 shift-and-or 演算法的例子。假設目標字串 T = bcbca，樣本字串 p = bca，將樣本字串依 char set $\Sigma = \{a, b, c\}$ 建立好對應的編碼。以完全比對來說，依公式(3)在 $i=3, j=5$ 的位置比對成功；以近似比對來說，依公式(7)在 $i=3, j=2, 4, 5$

時，發生刪除錯誤、$i=3, j=3,5$時發生取代錯誤、$i=3, j=5$時，發生插入錯誤。

近似字串比對可允許的錯誤種類分爲取代、插入和刪除，其錯誤發生的情況分爲兩種。它的比對流程可以視爲完全比對的延伸，此演算法只需 shift、AND 及 OR 三個運算子。近似比對可以允許一些錯誤發生，d 代表允許錯誤，其中包含取代、插入和刪除，爲了方便了解以下的公式範例，我們假設各情況皆允許一個錯誤發生，並$d=1$來代表。

以取代錯誤來說，$d=1$的情況，第一種情況是取代錯誤發生在最後一個位置，在T中以 j 位置的前i-1項字元爲完全比對，不論T中的第t_{j+1}位置是否等於 p_i，才視爲發生取代錯誤，即爲 $R^d_{j+1}[i]=R^{d-1}_j[i-1]$；第二種情況發生在第一種以外的其它位置，在目標字串T中的第 j 位置之前i-1項字元，有一個取代錯誤發生，那t_{j+1}須等於 p_i，亦視爲發生取代錯誤，即爲 $R^d_{j+1}[i]=R^d_j[i-1]\ AND\ S_c[i]$，綜合兩種情況可歸納成公式(4)：

$$R^d_{j+1}[i]=R^{d-1}_j[i-1]\ OR\ (R^d_j[i-1]\ AND\ S_c[i]), i=1,\ldots,m. \tag{4}$$

以插入錯誤來說，$d=1$的情況，第一種情況是插入錯誤發生在最後一個位置，樣本字串P的前i項字元與目標字串T以位置 j 爲終點的i項連續字元爲完全比對，當錯誤發生在第t_{j+1}位置，才可視爲發生插入錯誤，即爲 $R^d_{j+1}[i]=R^{d-1}_j[i]$；第二種情況發生在第一種以外的其它位置，在目標字串T中的第 j 位置之前i-1項字元，有一個插入錯誤發生，那t_{j+1}須等於 p_i，亦視爲發生插入錯誤，即爲 $R^d_{j+1}[i]=R^d_j[i-1]\ AND\ S_c[i]$，綜合兩種情況可歸納成公式(5)：

$$R^d_{j+1}[i]=\left(R^d_j[i-1]\ AND\ S_c[i]\right)OR\ R^{d-1}_j[i], i=1,...,m \tag{5}$$

以刪除錯誤來說，$d=1$的情況，第一種情況是刪除錯誤發生在最後一個位置，若P的第i位置字元 p_i 刪除，代表 $p_1p_2...p_{i-1}$與T以位置 $j+1$ 爲終點的$i-1$項連續字元爲完全比對，不論 p_i 是否等於t_{j+2}，都視爲發生刪除錯誤，即爲 $R^d_{j+1}[i]=R^{d-1}_{j+1}[i-1]$；第二種情況發生在第一種以外的其它位置，在目標字串T中的第 j 位置之前i-1項字元，有一個刪除錯誤發生，那t_{j+1}須等於 p_i，亦視爲發生刪除錯誤，即爲 $R^d_{j+1}[i]=R^d_j[i-1]\ AND\ S_c[i]$，綜合兩種情況可歸納成公式(6)：

$$R^d_{j+1}[i]=R^{d-1}_{j+1}[i-1]\ OR\ (R^d_j[i-1]\ AND\ S_c[i]), i=1,\ldots,m. \tag{6}$$

綜合前面所敘述，將取代錯誤、插入錯誤和刪除錯誤情況合併起來，把公式(4)、(5)及(6)整合起來，成爲可簡單的延伸成爲允許 d 個錯誤的公式(7)：

$$R^d_{j+1}[i]=R^{d-1}_j[i-1]\ OR\ R^{d-1}_j[i]\ OR\ R^{d-1}_{j+1}[i-1]\ OR\left(R^d_j[i-1]\ AND\ S_c[i]\right), d>0, i=1,...,m \tag{7}$$

由公式(7)得知此演算法僅需 shift、AND 及 OR 運算即可完成。

參、系統架構

本節介紹本文所提出系統架構與實作，圖 2 爲歌曲檢索系統架構外觀及流程圖，整個比對系統分爲使用者端(Client)與系統端(Server)，兩者之間是由網路作溝通。系統端是建立在可重組式硬體電路開發板上，主要負責進行檢索動作，使用者端是建立在個人電腦上執行，提供使用者輸入查詢(Query)內容，首先將系統端先開啓 TCP 連線等候使用者連接，使用者端連上比對端並將查詢資料傳送至系統端後，系統端將收到的查詢資料傳送到字串比對電路，同時讀出存放在 CF 卡中整個歌曲資料庫中的旋律字串，利用 DMA 的機制也傳送到字串比對電路，最後的比對結果將回傳至使用者端。

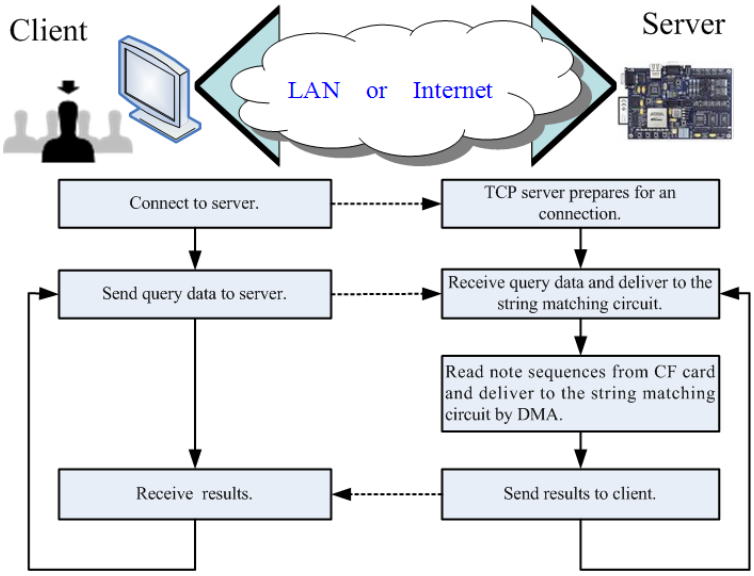


圖 2 歌曲檢索系統架構外觀及流程圖

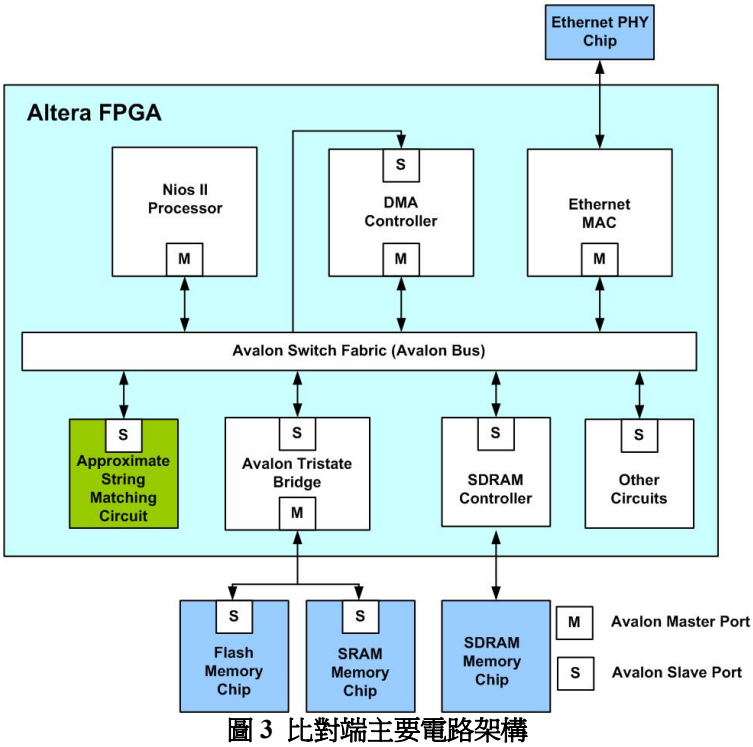


圖 3 比對端主要電路架構

系統端的電路架構如圖 3 所示，其主要週邊裝置含有 NIOS II 處理器、DMA Controller、Memory 及 Ethernet MAC 等，可以利用 Avalon Bus 來傳輸所有裝置的資料。

NIOS II 處理器主要負責協調系統上所有裝置，系統中近似字串比對不交由 NIOS II 處理器來運算，原因是 NIOS II 處理器的 throughput 有限，若以 NIOS II 處理器執行 shift-and-or 演算法，必定會消耗相當久的時間。爲了增加歌曲檢索的速度，本文設計一個電路來進行字串比對，本電路可視爲 NIOS II 處理器的一個 Custom User Logic，當 MAC Controller 獲得使用者端傳來的查詢資料後，NIOS II 處理器會將查詢資料傳送至字串比對電路。

接著，開始歌曲資料庫中的旋律字串傳送至字串比對電路，我們將歌曲資料庫放置於 CF 卡中，傳送過程可以分爲兩個階段，第一個階段，旋律字串由 CF 卡傳送至系統的主記憶體；第二階段，儲存在主記憶體的旋律字串經由 DMA(Direct Memory Access)，傳送至字串比對電路，利用 DMA 有利於降低資料的存取時間。

考慮到歌曲資料庫的容量有可能相當大，在 DMA 運作前，很難一次將資料庫中所有資料傳送至主記憶體，所以在主記憶體中使用兩個 Buffer，一個給 DMA 使用；另外一個在接收 CF 卡傳來的資料時使用，當 DMA 運作完成之後，兩個 Buffer 的角色就會對調。圖 4 爲讀取的機制，第一個 Buffer 將資料以 DMA 機制送至字串比對電路比對時，第二個 Buffer 在同一時間從 CF 卡抓取歌曲資料；然後換第二個 Buffer 將資料以 DMA 機制送至字串比對電路比對，第一個 Buffer 從 CF 卡抓取歌曲資料。利用 Buffer 和 DMA 機制共同運作之下，讀取 CF 卡資料和送資料至字串比對電路就可以同時進行。

圖 5 爲可重組式的硬體電路模組字串比對電路的架構圖，也就是實現 shift-and-or 演算法的硬體電路。其中包含三個部份：前處理單元(pre-matching unit)、比對核心(matching core)以及後處理單元(post-matching unit)。此電路接收 NIOS II 處理器傳來的樣本字串、以及 CF 卡/主記憶體傳來的旋律字串後，接著會傳回有比對到的歌曲索引值給 cpu。

爲了讓一首曲子可以以任何音高當作起音，而還是代表相同的旋律，也就是符合「音調無關」，我們將集合 Σ 中的符號由音符改爲鄰近兩音符之間的差值。當前處理單元中的 RAM 儲存完樣本字串的資訊後，硬體電路就準備好要執行近似字串比對。在透過 DMA 接收主記憶體傳來的資料後，比對流程便開始進行，一個時間點只會接收到一個符號，t_j 代表接收到的資料中第 j 個符號。爲了實現「音調無關」，t_j 爲旋律字串中的第 j 個音符與第 j -1 個音符之間的差值(difference)，我們的作法是先計算出 t_j，然後放置於資料庫中。

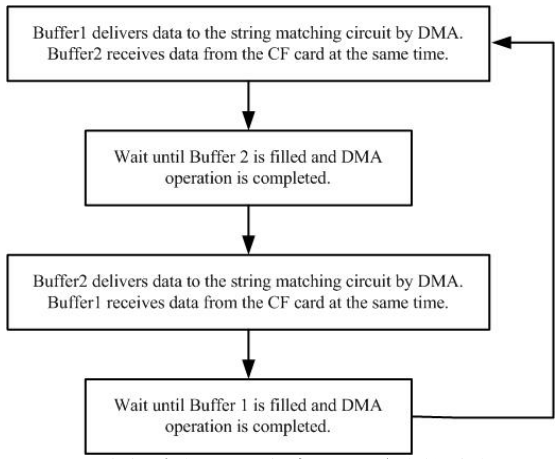


圖 4 資料庫傳送至字串比對電路的流程圖

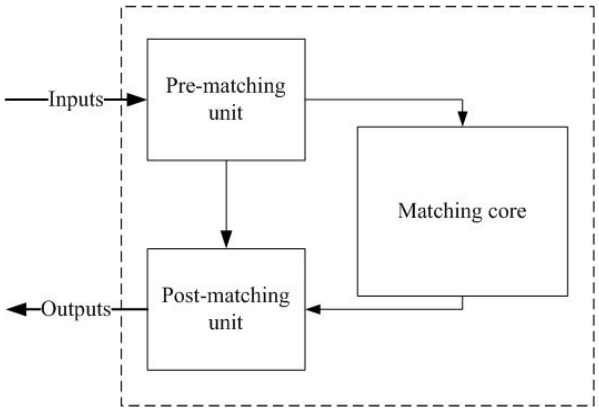


圖 5 字串比對電路架構圖

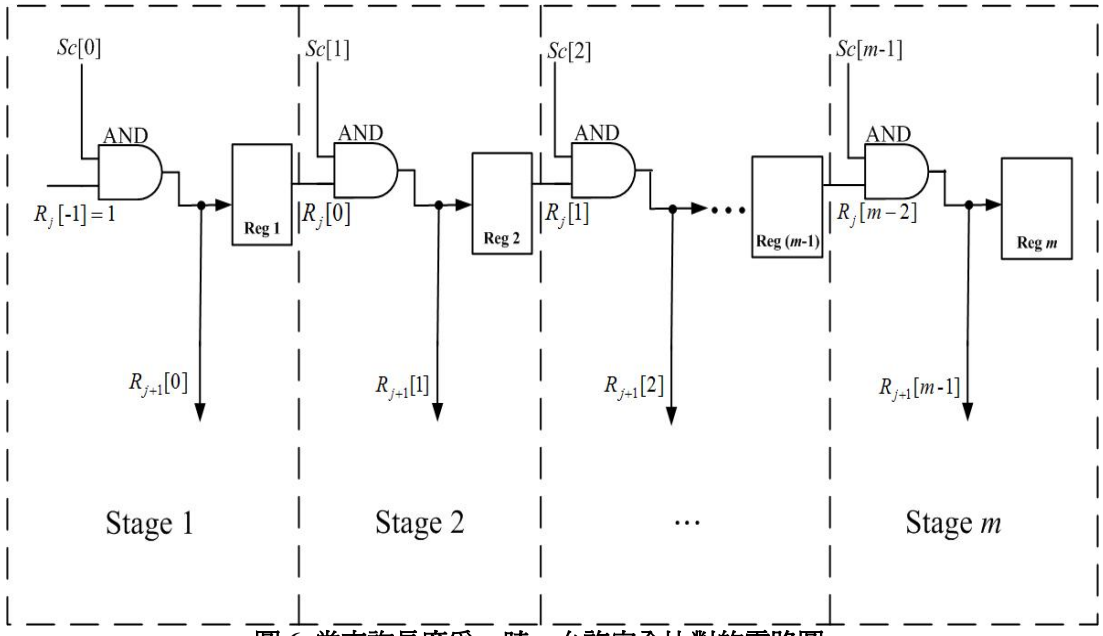


圖 6 當查詢長度爲 m 時，允許完全比對的電路圖

爲了簡單說明比對核心的電路架構，圖 6 之 S_c 爲樣本字串，先假設電路僅能執行完全比對，假設現在字串比對執行到 t_j 已比對完成，接著要執行 t_{j+1}，其電路架構如圖 6 所示，每個 *stage* 僅包含一個 1-bit 的暫存器及一個 AND 閘。

假設 $t_{j+1}=s_c$，輸入的字元 t_{j+1} 會先傳送到前處理單元，找出 S_c 後傳送到 AND 閘。每個 *stage* 中的 AND 閘擁有兩個輸入：一個是前處理單元中的 RAM 輸出的第 i 個位元(也就是 $S_c[i]$)；另外一個則是 stage$(i-1)$ 的暫存器輸出，即 $R_j^0[i\text{-}1]$。根據公式(3)，在 stage i 的 AND 閘後產生的 $R_{j+1}^0[i]$，會輸入到 stage i 的暫存器中，隨後運作到下一個 clock 時，$R_{j+1}^0[i]$ 也就變成 stage i 的暫存器的輸出。

當 $p_1p_2...p_i=t_{j-i}t_{j-i+1}...t_{j+1}$ 時，第 m 個 AND 閘產生的 $R_{j+1}^0[m]$ 會等於 1，也就指出歌曲查詢片段被辨別出有完全比對的情形發生，在圖 5 中的後處理單元便會紀錄這首歌曲的索引值。當所有歌曲資料庫的旋律字串都搜尋完之後，後處理單元便會將紀錄的索引值傳給 NIOS II 處理器進而回傳給使用者端。

比對核心可以延伸爲允許 d 個錯誤的近似字串比對，電路架構也是擁有 m 個 *stage* 的移位暫存器(shift register)，如圖 7 所示，每個 stage i 的暫存器包含 $d+1$ 個 bits，當字串比對執行到 t_j 比對完成，每個 stage i , $i=1,...,m$ 的暫存器會輸出 $R_j^k[i], k=0,1,...,d$，除了暫存器之外， stage i 也包含 $d+1$ 個 components，component k , $k=0,...,d$ 則是負責計算 $R_{j+1}^k[i]$。

由於 $R_{j+1}^0[i]$ 表示完全比對的結果，所以用來計算 $R_{j+1}^0[i]$ 的 component 0，等同於實現完全比對的硬體，此 component 也就只包含一個 AND 閘。根據公式(4)，負責計算 $R_{j+1}^k[i]$ 的 component k , $0<k\le d$，擁有 5 個輸入端：$R_j^{k\text{-}1}[i\text{-}1]$、$R_j^{k\text{-}1}[i]$、$R_{j+1}^{k\text{-}1}[i\text{-}1]$、$R_j^k[i\text{-}1]$ 及 $S_c[i]$。$R_j^{k\text{-}1}[i\text{-}1]$、$R_j^{k\text{-}1}[i]$、$R_{j+1}^{k\text{-}1}[i\text{-}1]$、$R_j^k[i\text{-}1]$ 可以由 stage i 及 stage i -1 的暫存器或 component 輸出獲得，$S_c[i]$ 則可由前處理單元的 RAM 中取得，依照公式(4)，component k , $k>0$ 是由 3

個 OR 閘及 1 個 AND 閘組成，所有 components 的運算會在同一個 clock 週期中完成。

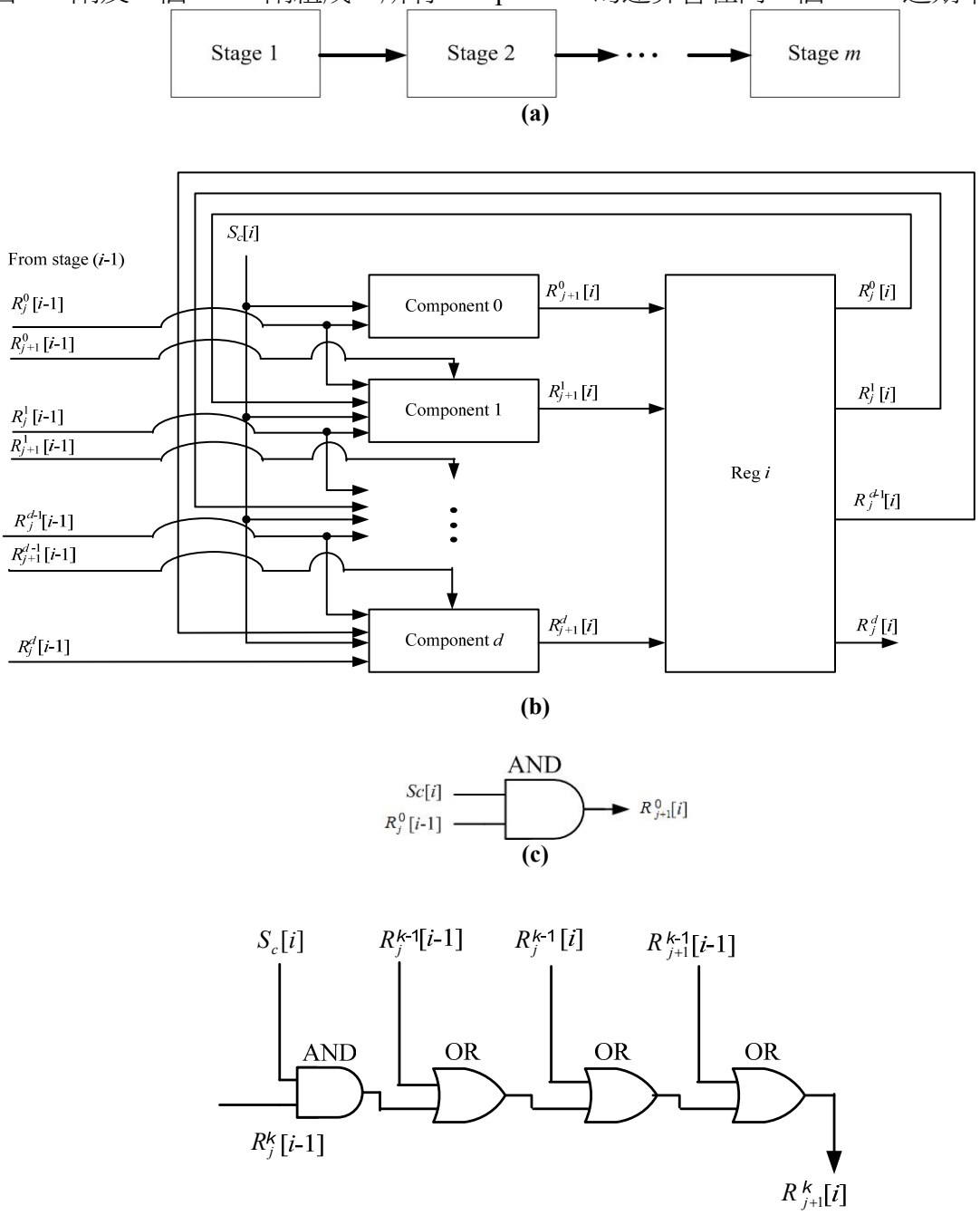


圖 7 比對核心架構圖：(a) 比對核心包含 m 個 stage，(b)比對核心中包含每個 stage i 的架構 (c) stage i 中 component 的電路圖，(d) stage i 中 component $k, k = 1,...,d$ 的電路圖

比對核心中的所有 *stages* 會同時平行運作，因此 clock 週期的運算時間與允許錯誤數目 d 及樣本字串的長度 m 無關，所以我們提出的電路架構，其時間複雜度即爲 $O(n)$ ，n 爲所有旋律字串的長度。

當比對核心可以允許錯誤時，針對每個比對到的歌曲，後處理單元要可以找出其錯誤數目。另外，給定一個旋律字串，當樣本字串與多個片段 match 時，後處理單元應該

要能紀錄最小的錯誤數目，此最小的錯誤數目用來當作相似度的評分依據。每個有比對到的歌曲，其索引值及分數會被傳回使用者端。

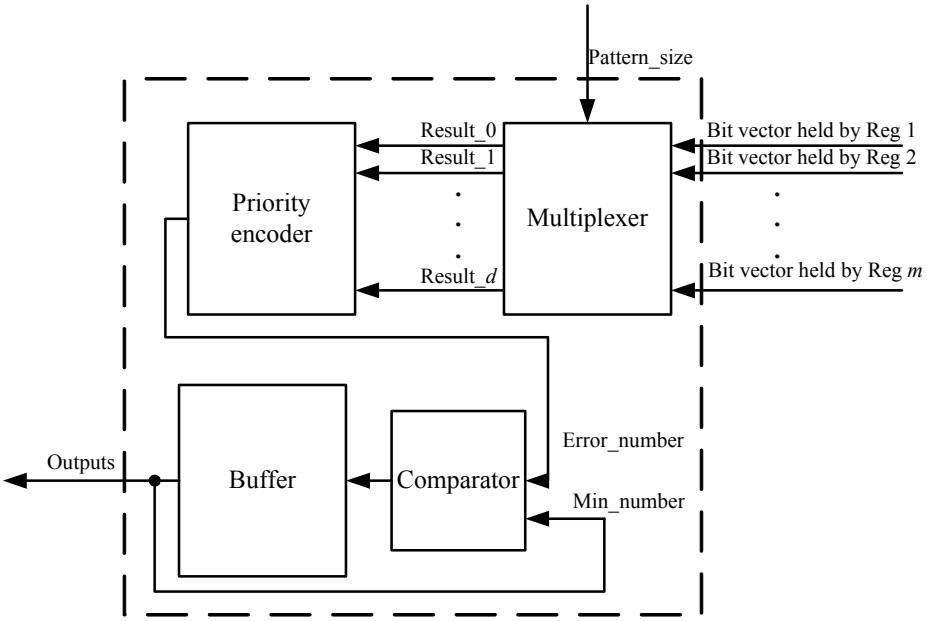


圖 8 後處理單元架構圖

圖 8 爲近似字串比對電路中的後處理單元，其輸入爲比對核心中每個 stage 的暫存器所持有的位元向量。如之前提到的，$R_j^k[i]=1$ 表示當比對至 t_j 時，樣本字串 $p_1,...,p_i$ 被發現有 match，而其錯誤數目爲 k。另外，當比對進行至 t_j 完成時，stage i 中的暫存器會擁有位元向量 $\left[R_j^0[i],...,R_j^d[i]\right]^T$。所以，雖然樣本字串的長度預設爲 m，但是當實際的查詢長度爲 i，$0<i\le m$ 時，stage i 中的暫存器所擁有的位元向量仍然可以偵測出有無 match。如圖 8 所示，在我們的設計中有一個多工器用來選擇位元向量，存放在前處理單元中的實際樣本長度是選擇的依據，在允許不同樣本長度的近似比對之下，這種設計方法提供更多的彈性。

從圖 8 可看出多工器的輸出會連接至一個具優先權編碼器(priority encoder)，它的目的是確定是否有 match 發生，如果有偵測到 match，編碼器會輸出此 match 的錯誤數目。因爲樣本字串有可能 match 旋律字串中的多個片段，我們不必將所有 match 的錯誤數目儲存起來，只需將最小的錯誤數目紀錄即可，爲了實現上述的作法，後處理單元也包含了一個比較器及一個 Buffer。Buffer 用來儲存目前最小的錯誤數目，當具優先權編碼器確定一個新的 match 時，其輸出的錯誤數目就會與目前 Buffer 中的最小錯誤數目做比較，當新的 match 有較小的錯誤數目時，就會取代原本在 Buffer 中的最小數目。

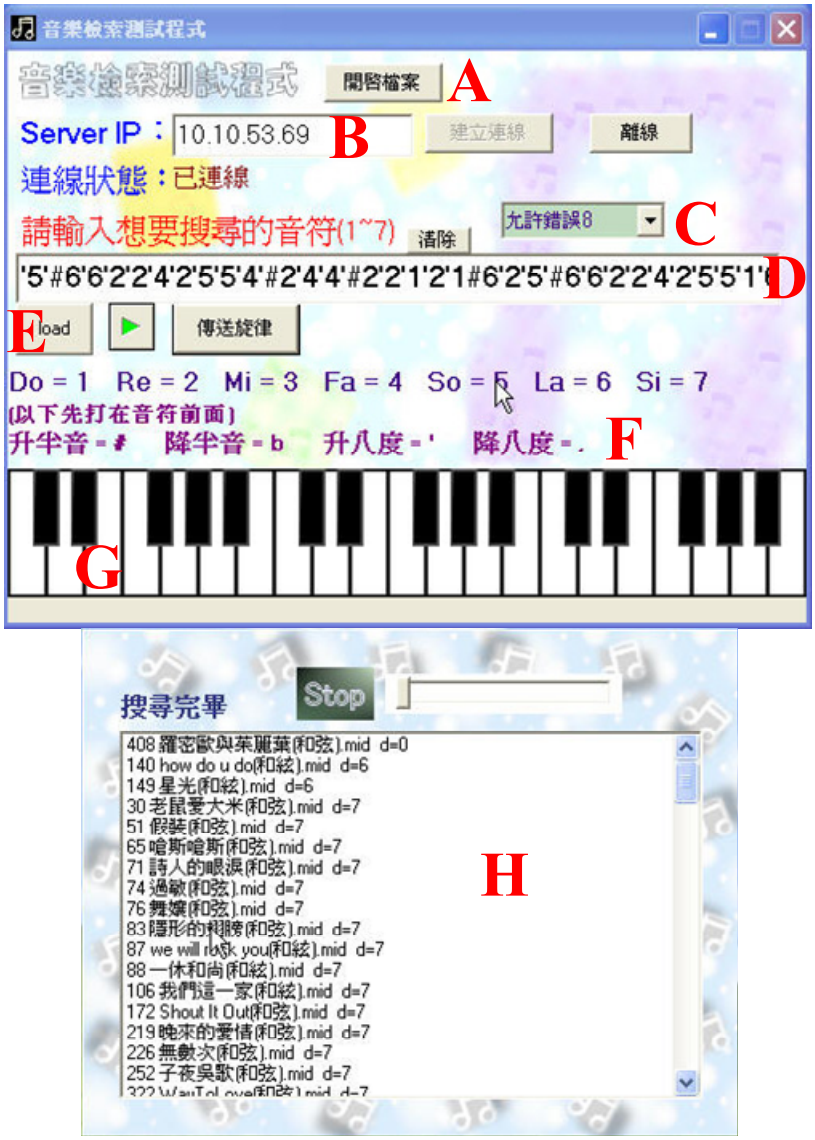


圖 9　Client 端的程式介面

圖 9 爲 Client 端提供使用者輸入查詢資料的介面，此介面是利用 Borland C++ Builder 撰寫出使用者輸入查詢資料，這是一套查詢資料的程式工具，圖中之各項標示 A-H，說明如下：

A. 選擇 midi 檔用來讀入欲檢索的歌曲片段。
B. 輸入 Server 端的 IP 位址，再點選“建立連線”後方可繼續檢索的動作。
C. 使用者依自己的需求選擇允許多個錯誤，最多可允許 8 個錯誤($d = 1 \sim 8$)。
D. 輸入欲搜尋的歌曲內容，最多可以輸入 32 個音符。
E. 載入輸入的音符後傳送旋律，也可供試聽歌曲。
F. 簡譜輸入說明。
G. 鋼琴介面可以輸入或彈奏歌曲片段。
H. 列出比對後的結果，依序錯誤數目由小至大遞增排列，列出的歌曲點擊左鍵二下方可播放試聽歌曲。

肆、實驗結果與結論

本節是提供有關歌曲檢索系統的數據資料，在可重組式電路的架構下，歌曲檢索系的實驗數據，表 1 爲比對核心單元，在不同的查詢長度 m 與編輯距離 d 下，其所需的消耗面積，LEs 數量是用來表示電路使用到多少面積大小。此系統使用的平台爲 Altera Stratix 1S40(Altera Corporation, 2006)，根據表 1 可以看出當查詢長度 $m=32$ 與 $d=10$ 時，只需 1082 個 LEs，由於圖 7 中的比對核心單元，會根據不同的查詢長度 m ，而有不一樣的 *stage* 數量，而每個 *stage* 中的暫存器大小皆爲 $d+1$ 個位元，所以當查詢長度 m 與編輯距離 d 增加時，LEs 的數量並不會急速增加。

本系統中的 NIOS II CPU 的工作頻率爲 50MHz 的標準類型(i.e., NIOS II/s)，表 2 爲歌曲內容檢索系統的硬體規格，另外圖 10 爲本系統之可重組式硬體電路在不同的工作頻率在 SOPC 上的功率損耗，可以觀察到我們所提出的電路，在工作頻率增加時，功率耗損只有些微增加。當工作頻率從 10MHz 增加到 50 MHz，功率損耗只有從 1156.73 mW 提升到 1192.32 mW.。雖然其它架構在 SOPC 系統上也能建立比對核心，但是相較於我們提出的架構，仍然有優越的效能。表 3 所示在不同的查詢長度 m 並固定 $d=2$ 時，我們提出的架構與 Park and George 的架構，所建立的核心比較兩者的消耗面積與最大工作頻率。由於 Park and George 提出的架構只支持取代，在這實驗中並不考慮刪除和插入這二種情況。

表 1 在不同的查詢長度 m 與編輯距離 d 下，比對核心單元的 LEs 數量

d	0	2	4	6	8	10
$m=16$	65	186	287	380	451	516
$m=24$	73	259	418	565	694	812
$m=32$	83	323	532	731	918	1082

表 2 歌曲內容檢索系統的硬體規格

項目	值
最大比對資料	32
最大允許錯誤數量	10
字串比對電路面積	3816 LEs
系統面積	8960 LEs

表 3 本架構與 Park and George 所提出架構下在固定 $d=2$ 、不同的 m 下，LEs 與系統頻率的差異

m		8	16	32	64	128	256
本文提出的架構	LEs	20	44	92	188	380	764
	系統頻率 (MHz)	422.12	422.12	422.12	422.12	422.12	422.12
Park and George	LEs	213	329	669	1257	2816	5846
	系統頻率 (MHz)	422.12	327.44	204.92	123.11	54.08	7.4

因爲提出的架構相當簡單，我們能從表 3 中可以觀察到此架構與 Park and George 的架構相比較下消耗相當低的 LEs 且在字串比對有著更高的工作速度。尤其是當查詢長度 m 增加時，提出的架構在 $m = 256$ ，工作在 422.12 MHz 時，消耗面積只佔 764LEs。相較之下，Park and George 的消耗面積是 5846，最大工作速度只有 7.4 MHz.。

圖 11 爲軟體(a)與硬體(b)方式分別執行 shift-and-or 演算法時的執行速度，CPU 的時間是指在資料庫上計算近似字串比對法則所耗的運算時間。(a)(b)兩者實驗參數皆爲查詢長度 $m = 16$ ，資料庫爲 2Mbytes，資料庫是指建立 CF 卡內的歌曲的總數量，在這個實驗過程中有考慮到 23 個不同大小的資料庫。圖 11(a)以 PC 軟體實現 shift-and-or 演算法時，所耗費的時間會依據使用者所編輯的距離 d 和資料庫 n 的大小增加而耗時；圖 11(b)以硬體方式實現 shift-and-or 演算法時，由圖中數據可知，硬體實現近似字串比對法則時，同樣會隨著資料庫大小 n 變化而呈線性成長，且不會受到編輯距離 d 的改變，而在所耗費的時間上而有所增減。

我們所設計的電路只需 2100 個 LEs，整個系統僅佔 Altera Stratix EP1S40 的可重組式硬體電路其 19.32%。當編輯距離 d 爲 10，資料庫爲 2Mbytes 時，數據結果顯示以硬體執行 shift-and-or 演算法的 CPU 運算時間遠比在 Pentium IV 以軟體執行低。實驗結果中可以可以觀察出，以可重組式硬體電路爲基礎的歌曲檢索系統具有低面積、低功耗。

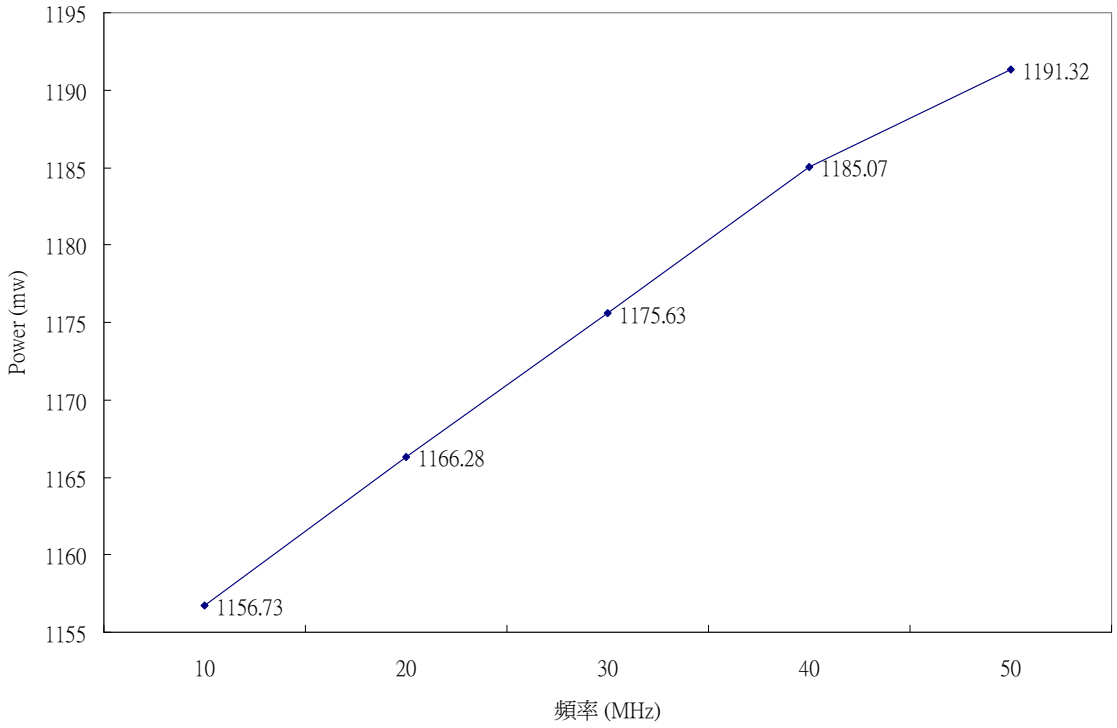
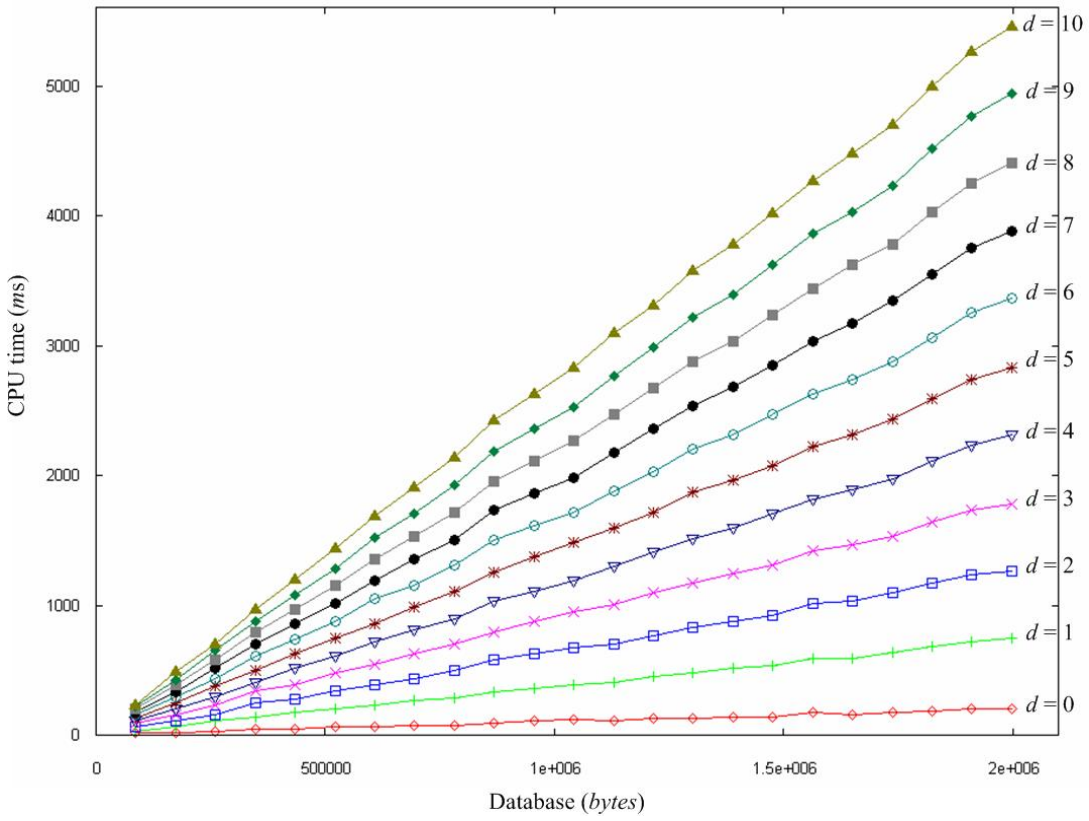
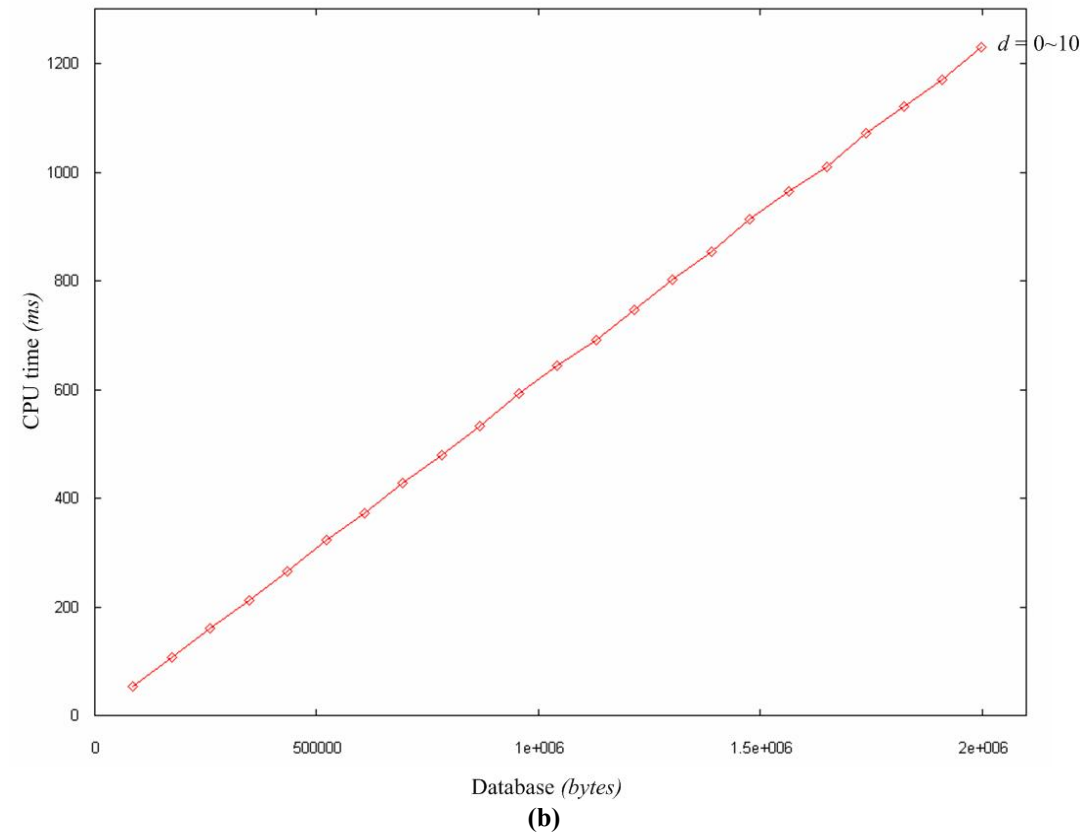


圖 10 本系統之可重組式硬體電路於不同工作頻率在 SOPC 上的功率損耗



(a)



(b)

圖 11 (a)在 Pentium IV 3 GHz CPU 以軟體方式執行系統之數據，(b)以硬體方式執行系統之數據

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一種由全金屬矽化鎳作為電極之先進 MIM 電容之電流傳導機制

Current Conduction Mechanisms in an Advanced Metal-Insulator-Metal Capacitor with Nickel Fully Silicided Polycrystalline Silicon Electrodes

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摘　要

一種使用全金屬矽化鎳電極和鈦酸鍶介電質且具低成本、高電容密度(25 fF/μm^2) 之 MIM 電容已被開發出來。無需貴重金屬材料，低電阻率之 Ni_3Si、Ni_2Si 和 NiSi 矽化鎳電極已實現並分別量測出電阻率約為 105、40 和 22 μΩ·cm。並展現出良好的漏電流密度為 2×10^{-8} A/cm^2 @ 1V。實驗顯示在高溫、低電場和上電極電子注入時肖特基發射為主要傳導機制。在 Ni_3Si/STO、Ni_2Si/STO 和 NiSi/STO 介面之肖特基勢壘高度(Φ_B)分別計算出為 0.98、0.91 和 0.78 eV。材料特性分析進一步顯示這種結構非常適合於先進 MIM 電容器。

關鍵詞：鈦酸鍶、高介電係數、全金屬矽化鎳、肖特基發射、傳導機制

Abstract

A low-cost metal-insulator-metal (MIM) capacitor with a high capacitance density of ~25 fF/μm^2 has been developed by using nickel fully silicided (Ni-FUSI) polycrystalline silicon electrodes and the $SrTiO_3$ (STO) dielectric. Without requiring noble metal materials, low resistivities of Ni_3Si, Ni_2Si and NiSi electrodes have been achieved and determined to be around 105, 40, and 22 μΩ·cm, respectively. It also displays a good leakage current density of 2×10^{-8} A/cm^2 at 1 V. Experiments demonstrated that Schottky emission is the dominant conduction mechanism at high temperatures and low fields under the top-electrode injection. The schottky barrier heights (Φ_B) at the Ni_3Si/STO, Ni_2Si/STO, and NiSi/STO interfaces were extracted firstly to be 0.98, 0.91, and 0.78 eV, respectively. Material Characterization further reveals that this structure is highly appropriate for advanced MIM capacitors.

Keywords**:** $SrTiO_3$, high-*k*, nickel fully silicided (Ni-FUSI), schottky emission, conduction mechanism

1 INTRODUCTION

Recently, metal-insulator-metal (MIM) capacitors have been used in many kinds of semiconductor applications and the high capacitance densities are required in the downscaling integrated circuits. The low electrode-resistivities resulting in a low equivalent-series-resistance (ESR) is crucial for radio-frequency (RF) applications [1]. Nitrogen (N)-incorporated refractory metal materials, such as TiN, TaN and TaTbN [2-4], possess higher resistivities than pure metals. Inexpensive copper (Cu) and nickel (Ni) develop complex processes to avoid metal oxidation [5-8]. Advanced ruthenium (Ru) and RuO_2 [9-11] are difficult to be integrated in a standard semiconductor process because of high costs, metal pollution, and difficulties in a reactive-ion-etching (RIE) process. Other noble metals are not practical due to high costs. Recently, a cost-effective nickel fully silicided (Ni-FUSI) gate technology with a low gate resistivity is getting important attention as a potential candidate for advanced CMOS applications [12-15]. Due to complete silicidation, it shows metallic behavior without polysilicon depletion for either high-*k* (dielectric constant) or SiO_2 gate dielectric applications. The low resistivities of Ni-FUSI can vary from 20 to 100 μΩ-cm by changing the crystalline phases of Ni silicides [16]. We previously proposed a new low-cost Ni-FUSI/ZrO_2/Ni-FUSI MIM capacitor with a high capacitance by using Ni-FUSI polycrystalline silicon as both top and bottom electrodes [17]. In this work, a Ni-FUSI/$SrTiO_3$(STO)/Ni-FUSI structure was developed similarly by using a very high-*k* STO dielectric, which has been widely adopted currently to provide both low leakage current densities and high capacitance densities [18-19]. To understand the obtained capacitor qualities, our studies focused on finding the electrical properties, carrier transport mechanisms, schottky barrier heights (Φ_B) at the Ni-FUSI/STO interfaces and material characteristics. Although there have been many literatures on the current conduction mechanisms of STO deposited by various techniques, most of them studied the samples with platinum (Pt), gold (Au), Ru, titanium (Ti), or TaN electrode [20-24]. There has been no report displaying the leakage current mechanisms involving the Ni-FUSI electrodes along with the STO dielectric. Besides, the electrode resistivities, secondary ion mass spectrometry (SIMS) profiles and X-ray diffraction (XRD) patterns were also obtained.

II. Experimental

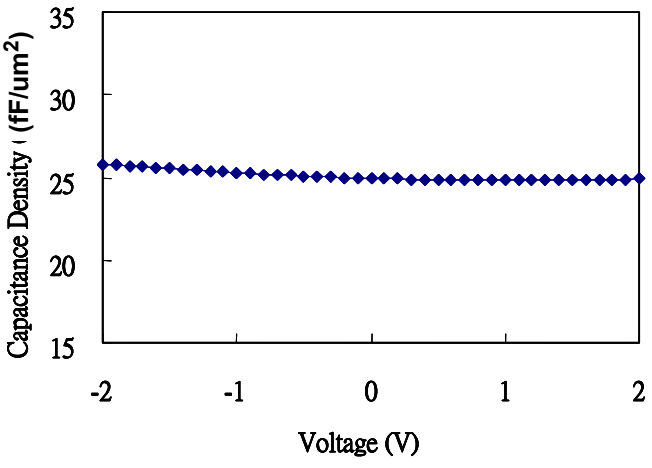
NixSi-FUSI/STO/NiSi-FUSI MIM capacitors including various Ni-silicide phases used for top electrodes were fabricated on a 4-μm SiO_2 that had been deposited on Si wafers. First, the 100-nm undoped polysilicon films were deposited on all of the samples by low-pressure chemical vapor deposition (LPCVD) at 600 °C. The 170-nm Ni was then deposited using a RF magnetron sputtering. Ni_3Si bottom-electrodes in all samples were formed by 600 °C rapid thermal anneal (RTP) in a N_2 ambient for 30 s. The unreacted nickel was removed by chemical etching. Next, 54-nm STO dielectric layers were deposited using ceramic targets in this sputter system, followed by a subsequent 600 °C anneal in a N_2 ambient for 60 s. The

100-nm undoped polysilicon films were deposited on the dielectrics by LPCVD at 600 ˚C. To investigate the effects of different Ni-FUSI phases developing the top electrodes on the capacitor properties, Ni_3Si, Ni_2Si and NiSi-FUSI were formed by the deposition of Ni with adjusted thicknesses of 170, 120, and 65nm along with subsequent one-step RTP (600 ˚C), one-step RTP (400 ˚C) and two-step RTP (400 ˚C +500 ˚C), respectively. The electrodes of all samples were deposited using 500-nm aluminum (Al) for good ohmic contacts. Finally, a sintering was carried out in a N_2/H_2 ambient at 420 ˚C for 30 min. The physical thicknesses of STO dielectrics were also measured by a profilometer (Tencor Alpha Step 500 Surface Profilometer) and further confirmed by an ellipsometer. Capacitance-voltage ($C-V$) measurements were performed at room temperature using a precision LCR meter (HP4284A). Current density-electric field ($J-E$) measurements were performed using a precision semiconductor parameter analyzer (HP4156C) from 300 to 400 ˚K. The resistivities of Ni_xSi-FUSI electrodes were determined from measured sheet resistances by four-point probe system and derived film thicknesses by this profilometer. The crystalline structures were analyzed by XRD. SIMS was used to analyze the atomic depth profiles of the films.

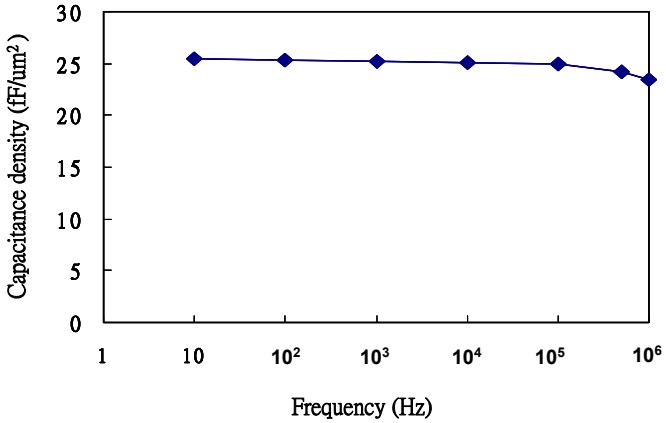
III. Results and Discussion

Figure 1(a) shows C-V characteristics of the Ni_3Si/STO/Ni_3Si MIM capacitor measured at 1MHz. A high capacitance density of ~25 fF/μm^2 has been achieved. The STO k value judging from capacitance data is around 152, which also confirms the perovskite-phase formation shown in Fig. 6. This extracted k value in our work is close to the previous reports [22-23]. C.J. Peng displayed that the sputtered-STO film annealed at 600 ˚C gave a k value of 151 [23]. K. C. Chiang showed that the sputtered-STO dielectric annealed at 450 ˚C developed k values of 147~169 [22].

Figure 1(b) displays the capacitances versus measurement frequencies for this capacitor biased at 1 V. The slight frequency dispersion (~8 % variations in capacitances) reveals that both the frequency dependence of the STO k value and the ESR resulting from electrode resistances are negligible.



(a)



(b)

Fig. 1. (a) *C-V* characteristics of the Ni_3Si/STO/Ni_3Si MIM capacitor measured at 1 MHz (b) Capacitances versus measurement frequencies biased at 1 V.

Figure 2 (a) demonstrates *J-E* characteristics of the Ni_3Si/STO/Ni_3Si MIM capacitors at various temperatures. To investigate the carrier transport, *J* was studied from 300 to 400 °K for top-electrode injection (negative voltage bias). To explain it briefly, the well-known Schottky emission mechanism can be expressed as [25]:

$$J = A^{*}T^{2}\exp\left[\frac{-q(\phi_B - \sqrt{qE/4\pi\varepsilon_r\varepsilon_0})}{kT}\right] \quad (1)$$

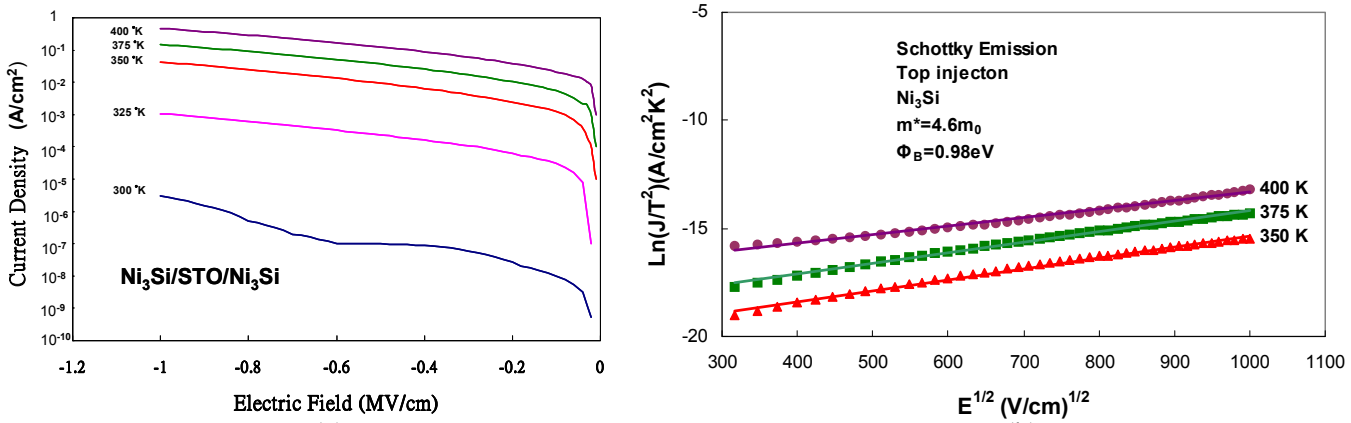
where A^* is the effective Richardson constant and $A^* = 4\pi q(m^*)k^2/h^3 = 120(m^*/m_0)$, T is the absolute temperature, h is the Planck's constant, k is the Boltzmann's constant, q is the electronic charge, ε_r is the dynamic dielectric constant, m_0 is the free electron mass, m* is the effective electronic mass in the STO dielectric, and $q\Phi_B$ is the Schottky barrier height.

A plot of $\ln(J/T^2)$ versus $E^{1/2}$ should be linear for the standard Schottky emission. Experimental data at high temperatures (350 - 400 °K) and low electric fields (<1 MV/cm) fit Schottky-emission theory very well under the top-electrode injection, as shown in Fig. 2(b). The intercept of the Schottky plot to the vertical axis can be expressed as (2) and is a function of the Φ_B at the Ni-FUSI/STO interface and the m* in the STO dielectric.

$$\text{Intercept} = \ln(A^{*}) - \frac{q\Phi_B}{kT}, \quad (2)$$

A high extracted Φ_B is desirable for improving the leakage current and device reliability.
The m* in the dielectrics and Φ_B at the Ni_3Si/STO interface were determined to be around $4.6m_0$ and 0.98 eV, respectively. The derived dynamic dielectric constants in our work are all around 4.1, which is the square of the refractive index $n_r = 2$. This derived n_r value in our work is close to the previous reports [23, 26-27]. Z. Wang displayed that the n_r value for STO

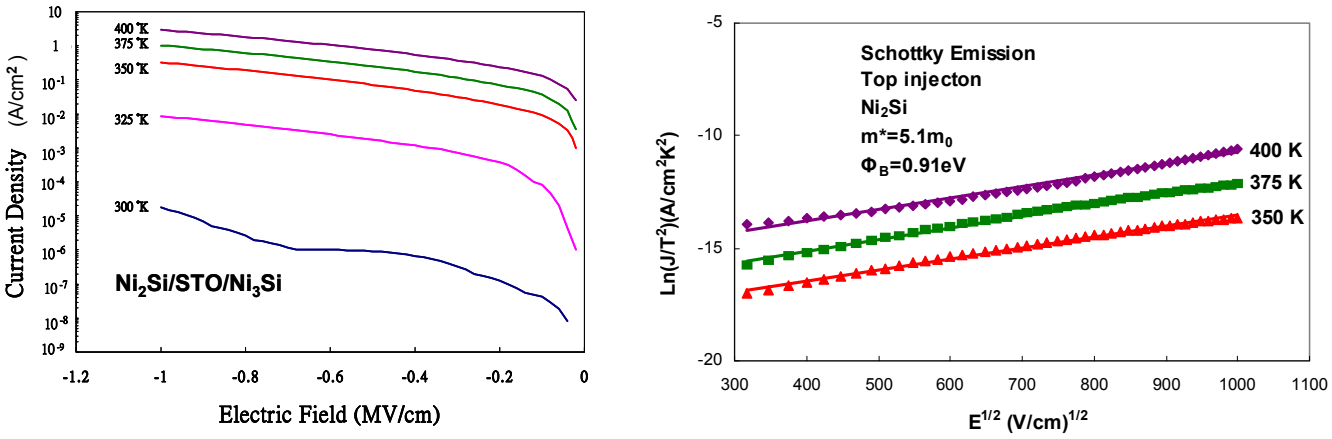
is in the range of 1.9 to 2.18 [26]. C.J. Peng mentioned that a refractive index of 2 is reasonable [23]. S. W. Lee displayed that the value as measured by an ellipsometry is 1.95 [27]. The deduced high m* is close to previous literatures [28-29]. W. Wunderlich demonstrated that the m* of the undoped STO with a perovskite phase is $4.8m_0$, as shown in Table 3 of this report [28]. He also showed that the m* of the undoped STO is $4.2m_0$ [29].



(a) (b)

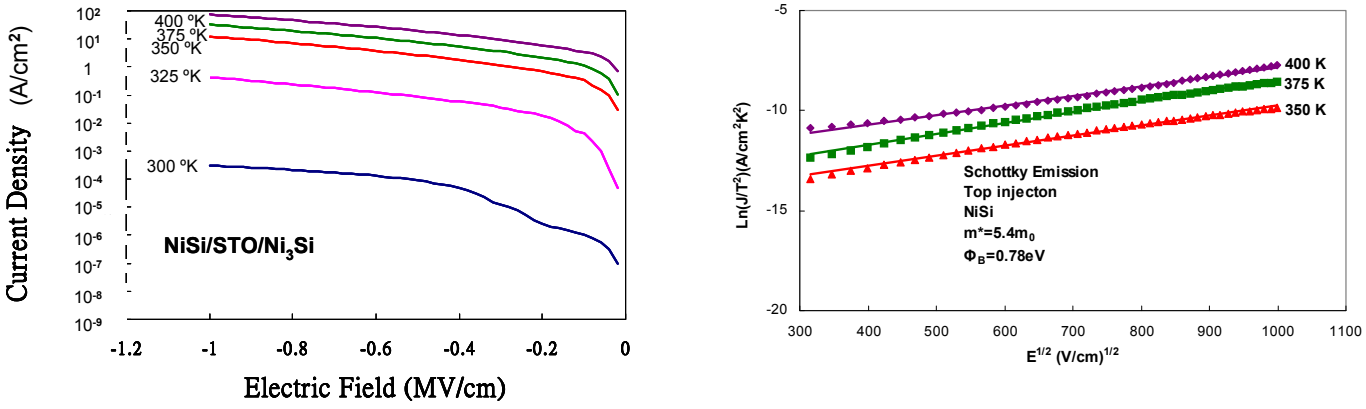
Fig. 2. (a) *J-E* characteristics of the $Ni_3Si/STO/Ni_3Si$ MIM capacitors at various temperatures. (b) Schottky emission constrained by $n_r = \varepsilon_r^{1/2}$ at high temperatures and low fields under the top-electrode injection. Φ_B is the Schottky barrier height.

Similarly, Fig. 3 and Fig. 4 demonstrate *J-E* characteristics for the $Ni_2Si/STO/Ni_3Si$ and $NiSi/STO/Ni_3Si$ structures at various temperatures, respectively. The obtained data at high temperatures (350-400 °K) and low fields (<1 MV/cm) also fit this theory very well for both two structures. Figure 3 displays that the m* in the dielectric and Φ_B at the Ni_2Si/STO interface were determined to be about $5.1m_0$ and 0.91eV, respectively. Figure 4 reveals that the m* in the dielectric and Φ_B at the NiSi/STO interface were also extracted to be around $5.4m_0$ and 0.78eV, respectively.



(a) (b)

Fig. 3. (a) *J-E* characteristics of the Ni_2Si/STO/Ni_3Si MIM capacitors at various temperatures. (b) Schottky emission constrained by $n_r = \varepsilon_r^{1/2}$ at high temperatures and low fields under the top-electrode injection. Φ_B is the Schottky barrier height.



(a) (b)

Fig. 4. (a) *J-E* characteristics of the NiSi/STO/Ni_3Si MIM capacitors at various temperatures. (b) Schottky emission constrained by $n_r = \varepsilon_r^{1/2}$ at high temperatures and low fields under the top-electrode injection. Φ_B is the Schottky barrier height.

The smallest derived Φ_B at the NiSi/STO interface may be attributed to the lowest NiSi work-function (Φ_m) reported previously [30-32]. Among the capacitors with different Ni-silicide phases forming top electrodes, the Ni_3Si/STO/Ni_3Si structure displays the lowest leakage currents at high temperatures and low fields due to the highest Φ_B at the Ni_3Si/STO. Schottky emission is thermionic in nature and is often observed at relatively high temperatures. The fitting of Schottky emission should be performed at high temperatures and low fields for removing other conduction mechanisms such as Fowler-Nordheim tunneling [33]. As the ultra-large scale integration (ULSI) continues, the thermal effect on IC becomes an important issue owing to the high integration density, increasing power density, and high chip temperature. Such leakage currents at elevated temperatures are crucial for advanced MIM capacitors [34-35]. Further improved leakage currents could be obtained by using the low-cost and high-Φ_m materials such as Ni (~5eV) or $Ni_{31}Si_{12}$ (~4.85 eV) [30] as top electrodes to increase the band offset for reducing the leakage current.

Figure 5(a), (b), and (c) show that the Ni_3Si, Ni_2Si, and NiSi crystal formations in top electrodes were confirmed by XRD patterns. The bottom electrode going through the subsequent high-temperature processes still remained the Ni_3Si crystal phase, as shown in Fig. 6(d). SIMS depth profiles for the Ni_3Si/STO/Ni_3Si MIM device further support the XRD results, as shown in Fig. 7. The profiles also suggest that the polysilicon was fully silicided and no significant Ni diffusion into the STO film.

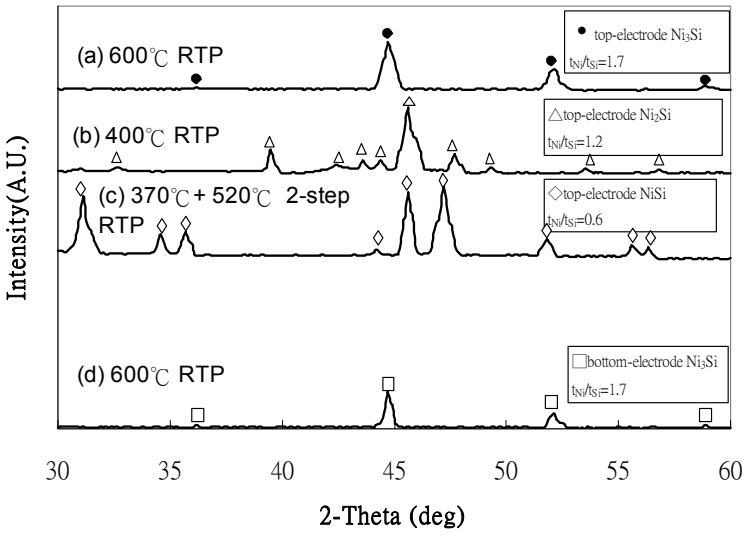


Fig. 5(a), (b), (c), and (d) XRD spectra showing the crystal formations of Ni_3Si, Ni_2Si, and NiSi used for the top electrodes, and Ni_3Si used for the bottom electrode, respectively

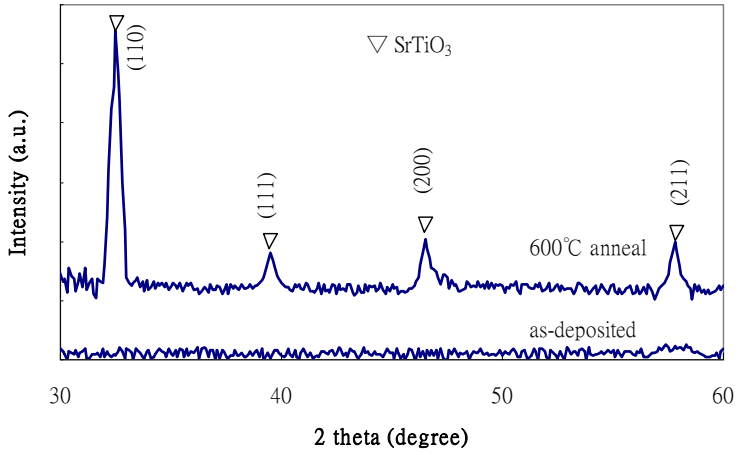


Fig. 6. XRD spectra of the as-deposited thin films and those annealed at 600 ˚C in a N_2 ambient for 60 s.

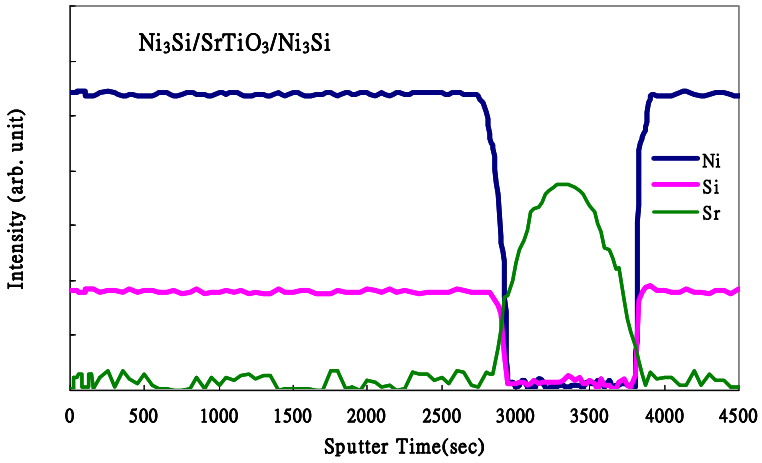


Fig. 7. SIMS spectra for Ni_3Si-FUSI phase formations. The ratios of Ni to Si are confirmed to be about 3 : 1 for both top and bottom electrodes.

From measured sheet resistances by the four-point probe system and derived film thicknesses by the profilometer on some selected samples, the low resistivities of Ni_3Si, Ni_2Si and NiSi electrodes were determined to be around 105, 40, and 22 μΩ·cm, respectively. The measurement results of XRD, SIMS, and electrode resistivity suggest no degradation on the Ni_3Si bottom electrode experiencing the subsequent high-temperature processes. Since a maximum allowable process temperature after the Ni salicide (self-aligned silicidation) process for CMOS technologies is around 700-750 ˚C [36], the subsequent process temperatures after the formation of Ni_3Si bottom electrodes should be lower than 700 ˚C. In our work, the total thermal budget after the fabrication of the bottom electrode is intentionally kept not to be higher than 600 °C without any possible damage on it.

IV. Conclusions

A cost-effective MIM capacitor with a high capacitance density of ~25 fF/μm^2 shows good device integrity by using Ni-FUSI polycrystalline silicon electrodes and the STO dielectric. Without requiring noble metal materials, low resistivities of Ni_3Si, Ni_2Si, and NiSi electrodes have been achieved and determined to be around 105, 40, and 22 μΩ·cm, respectively. It also displays a good leakage current density of 2×10^{-8} A/cm^2 at 1 V. The dominant conduction mechanism at high temperatures and low fields under the top-electrode injection is Schottky emission. The Φ_B at Ni_3Si/STO, Ni_2Si/STO, and NiSi/STO interfaces were found firstly to be 0.98, 0.91, and 0.78 eV, respectively. Combining the desirable electrical and material characteristics with the good process integration, it displays a potential candidate for an advanced MIM capacitor.

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受歡迎宣稱對廣告相信度及品牌態度的影響：廣告主信譽及懷疑度的干擾

Effects of Popularity Claim on Ad Believability and Brand Attitude: The Moderating Roles of Advertiser Reputation and Skepticism

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摘　要

本研究主要是引用社會影響理論來探討廣告中受歡迎宣稱的勸服效果，是否會受到廣告主信譽及消費者廣告懷疑度的干擾，根據本研究 2 個實驗的研究結果顯示，當廣告主信譽不佳或消費者對廣告懷疑度高時，廣告主在廣告中使用受歡迎宣稱，相較於沒有使用受歡迎宣稱，較可能產生較差的廣告相信度和品牌態度；然而當廣告主信譽佳或消費者對廣告懷疑度低時，廣告主在廣告中使用受歡迎宣稱，相較於沒有使用受歡迎宣稱，較可能產生較佳的廣告相信度和品牌態度。此外，本研究也提出受歡迎宣稱的主效果不顯著的解釋，其原因可能是由高廣告主信譽/低廣告懷疑度所引起的正面效果，和由低廣告主信譽/高廣告懷疑度所引起的負面效果，相互抵銷的結果。本研究發現使用受歡迎宣稱可能產生負面的廣告效果，對廣告主提供實務的意涵。

關鍵詞：受歡迎宣稱、廣告主信譽、廣告懷疑度、社會影響、廣告相信度、品牌態度

Abstract

This study specifically applies the notions of social influence perspective (i.e., focuses on informational social influence) to explores the persuasiveness of popularity claims embedded in advertising, as well as the moderating roles of advertiser reputation and consumers' ad skepticism. The results of two experiments suggest that when advertiser reputation is low or consumers' ad skepticism is high, advertisers using popularity claims likely produce lower advertising believability and less favorable brand attitudes in an ad-embedded popularity claim condition than in a no popularity claim condition. However, when advertiser reputation is high or consumers' ad skepticism is low, advertisers using popularity claims are likely to produce positive evaluations. In addition, our research provided an explanation of how the failed main effect of popularity claim could occur. It may be due to the cancel-out effect resulted from the positive effect caused by high advertiser reputation/ low ad skepticism and the negative effect caused by low advertiser reputation/ high ad skepticism. Our findings demonstrated that the use of popularity claim may create negative perceptions of the ad, which have significant implications for advertisers.

Keywords: Popularity claim, Advertiser reputation, Ad skepticism, Social influence, Advertising believability, Brand attitude

1. Introduction

Social influence research (i.e., normative and informational social influence) demonstrates that individual attitude and behavior are influenced by other people and groups (Anastasiadou & Vafeiadis, 2011; Burnkrant & Cousineau, 1975; Childers & Rao, 1992; Cohen & Golden, 1972; Hoye & Lievens, 2007; Kinard & Webster, 2010; Lascu, Bearden, & Rose, 1995; Lee, Cheung, Sia, & Lim, 2006; Raghunathan & Corfman, 2006; Wooten & Reed, 1998, 2004), especially if exerted by majorities. People conform to or accept the majority opinions, because many assume that the majority opinion reflects objective reality and implies correctness (Darke et al., 1998; Mackie, 1987), and because people desire to make correct judgments, they look to others' opinions to guide them, especially when they are unsure of the correct way to behave. Advertisers and marketers, aware of the power of social influence, often use this concept in their marketing tactics. They use popularity claim in product advertisements in an attempt to persuade consumers by asserting that a majority of consumers prefer, are satisfied by, or use the advertised product. For example, the Crest toothpaste ad asserted that "eight out of ten dentists recommend Crest", the Ford Motor Company asserted that "the best-selling truck in America" (Dean, 1999), and "Four out of five consumers prefer Ziploc storage bags" (Freling & Dacin, 2010). Although popularity claims are common in advertisements and are considered an effective advertising tactic, little is known how they work and very few empirical studies address their persuasiveness (Freling & Dacin, 2010). Furthermore, although some studies have demonstrated that the opinions of others about a product can influence an individual's brand attitude (Bailey, 2004; Moon, Sung, & Choi, 2009), consumption behavior (Kinard & Webster, 2010) and product evaluations (e.g., participants were shown a rating containing other participants' evaluations of the target product they were asked to evaluate) (Burnkrant & Cousineau, 1975; Cohen & Golden, 1972; Wooten & Reed, 1998) in the marketing area and in the advertising context (e.g., advertisers use endorser or spokespersons to influence consumers' attitude toward the ad)(Goldsmith, Lafferty, & Newell, 2000), it is rare for studies to apply the social influence perspective to popularity claim in an advertisement especially. It follows from the definition of social influence which is interpersonal influence, we suggest that apply social influence to explain why consumers adopt a majority of consumers' opinions in the product advertisement is very appropriate. Therefore, this study specifically applies the notions of social influence perspective to explain the effects of popularity claim embedded in advertising and focuses on informational social influence not the normative social influence.

Although Dean (1999) examined the effect of popularity claim on brand evaluations, the results revealed the failed main effect of popularity claim, that is, participants in the ad-embedded popularity claim condition did not have higher brand evaluations than in the no popularity claim condition. This study proposes that the main reason why a popularity claim does not approach significance may be due to the influence of situational factors, such as advertiser reputation (i.e., a perceptual representation of a company's past actions and future prospects), and individual difference factors, such as consumer skepticism toward advertising

(i.e., the tendency toward disbelief of advertising claims; ad skepticism). This study suggests that consumers' beliefs about popularity claims can influence whether the popularity claims can operate. For example, if consumers are skeptical about advertising claims, then they should have negative beliefs about popularity claims and negative evaluation toward the ad and brand. In addition, Goldsmith et al. (2000) also suggested that advertiser reputation plays an important role in consumers' reactions to ads and brands. Higher advertiser reputation may enhance consumers' beliefs about popularity claims. Furthermore, previous research notes that advertiser or corporate reputation moderates the effect of claim extremity (i.e., claims on the rank-order of the advertiser's brand among competing brands) on product evaluation and ad believability (Goldberg & Hartwick, 1990), the relationships among on website attitude, brand attitude, and purchase intention on the Internet (Kim & Jin, 2003), and the relationship between brand personality and purchase intention (Wang & Yang, 2011). Some studies also demonstrate that consumers' skepticism moderates the effect of advertised price claims on product evaluations (Hardesty, Carlson, & Bearden, 2002) and the effect of public information about celebrity endorsers on consumers' ad attitude (Bailey, 2007).

A critical determinant of the persuasiveness of popularity claim may be the perceived believability toward popularity claim. Therefore, according to these findings, namely that advertiser reputation and consumers' ad skepticism influence the believability of advertising claims and consumers' evaluations of the advertised product (Goldberg & Hartwick, 1990; Hardesty et al., 2002), this study investigates the effects of popularity claim on advertising believability and brand attitude and whether these effects are moderated by advertiser reputation and consumers' ad skepticism, using two experiments to assess these moderating roles.

According to studies of social influence, popularity claim that a majority of consumers prefer a particular product should influence consumers' product evaluations. Overall, advertisers seem to think that popularity claim effectively persuades consumers, but they might also provoke a negative reaction (i.e., popularity claim does not always elicit more favorable ad and brand attitude). This study demonstrates that popularity claim can sometimes produce negative effects on evaluations, if advertiser reputation is lower or consumers' ad skepticism is higher, which past researches have rarely addressed. Also, this study considers the advertiser reputation and consumers' ad skepticism as potentially important factors and possible explanations for the existing, failed main effect of popularity claim finding. The findings may constitute a useful contribution to the literature. The results of this study can help consumer researchers, advertisers, and marketing practitioners better manage the persuasiveness of advertisements containing popularity claim and provide a stronger understanding of popularity claim.

2. Theory and Hypotheses

How are an individual's attitude and behavior influenced by others? Research in social influence distinguishes two mechanisms of influence: normative social influence and

informational social influence (Deutsch & Gerard, 1955). Normative social influence is reflected in people conforming to the expectations of others in order to be liked and accepted by them. Informational social influence refers to accepting others' opinions as credible evidence about reality. Kelman (1961) identified three distinct processes of social influence, i.e., compliance, identification, and internalization. Burnkrant and Cousineau (1975) connected Kelman's processes to the normative and informational social influences, that is, the two types of social influence operated through distinct processes (Bearden, Netemeyer, & Teel, 1989; Burnkrant & Cousineau, 1975). A normative social influence operates through the process of compliance or identification. Compliance occurs when people adopt others' opinions and behaviors in order to achieve a desired response from them; people will conform to the expectations of others to obtain rewards or avoid punishments. This compliance most likely only occurs when the person's behavior is visible to others (Kelman, 1961). Identification occurs when people adopt others' opinions and behaviors in order to be associated with a satisfying self-defining relationship to the others. People desire to enhance self-image by a self-defining relationship (Kelman, 1961). Thus, normative social influence more likely leads to public compliance of the group's social norms or individual's performance meeting the others' expectations. In contrast, informational social influence operates through the process of internalization, which occurs when people accept the opinions and behaviors of others because these are congruent with their value system or because it is useful for the solution of people-confronting problems. Source credibility is an important factor in the internalization process (Kelman, 1961). Thus, informational social influence more likely operates if information from credible sources is perceived as enhancing individuals' knowledge or facilitating problem solving about their circumstance.

This study focuses on informational social influence, not the normative social influence. In the present study, the participants' task of judging an advertised product is in the anonymous condition, where the advertiser's popularity claim less likely results in participants' social pressure to conform to others' expectations. Contrarily, the popularity claim which reminds consumers about the majority of consumers' opinions, behaviors, and purchase likelihoods is more likely perceived as an instrument to the solution of the task of evaluating the advertised product, which in turn dictates that informational social influence should be the influence mechanism of the popularity claim on consumers' evaluations. The marketing literature demonstrated the effect of social influences on consumers' attitude and behavior and clearly distinguished between informational and normative social influence (Hoye & Lievens, 2007). For example, the word of mouth (from other consumers' opinions or recommendations) represents the type of informational social influence (Hoye & Lievens, 2007; Lee et al., 2006; Wooten & Reed, 1998). Popularity claim would be persuasive, with the assumption that because a majority of consumers prefer the brand, it must be a good brand, which heightens confidence in product judgments.

Advertisers commonly use popularity claim to persuade consumers, but only a limited number of studies have investigated their persuasive effectiveness. Freling and Dacin (2010) suggested that when the in-group members appeared in a popularity claim, consumers had

more favorable product evaluation. Haigood and Dacin (1999) examined the ways in which involvement (i.e., the degree of recipient's motivation to process a message) and argument type (i.e., a popularity claim containing central or irrelevant arguments) influenced the persuasiveness of popularity claim on ad and brand evaluations and suggested that high-involvement participants evaluated popularity claim containing central arguments more favorably than those containing irrelevant arguments. With high involvement and a central argument, evaluations of popularity claim were most favorable. However, low-involvement participants' evaluations remained indifferent between those containing central and irrelevant arguments. Furthermore, according to Petty and Cacioppo (1986), the quality of the message argument had a greater impact on the persuasion of high-involvement than low-involvement consumers. Thus, Haigood and Dacin's results may reflect the effects of argument type (i.e., central vs. irrelevant arguments) rather than the popularity claim on ad and brand attitude at different levels of involvement. In other words, it may not address the pure effect of popularity claim on ad and brand evaluations. In focusing explicitly on the persuasiveness of popularity claim for advertising believability and brand attitude, this study posits that the effects of the popularity claim on advertising believability and brand attitude are moderated by advertiser (or corporate) reputation and ad skepticism.

Fombrun (1996, p. 72) defined corporate reputation as "a perceptual representation of a company's past actions and future prospects that describes the firm's overall appeal to all of its key constituents when compared to other leading rivals." Fombrun (1996) and Keller (1998) proposed that corporate credibility was an important part of corporate reputation. The concept of corporate credibility is the perceived expertise and trustworthiness of a company (Goldsmith et al., 2000; Newell & Goldsmith, 2001). Therefore, the scope of corporate reputation is much broader than corporate credibility; it is not limited to the dimensions of expertise and trustworthiness (Goldsmith et al., 2000). Goldberg and Hartwick (1990) found that advertiser reputation moderated the effect of advertising claim extremity on product evaluation (i.e., the assessment of attitude change) and ad credibility (i.e., the truthfulness and believability of an ad). They highlighted the importance of advertiser reputation for advertising claims and indicated that high advertiser reputation seemed to lead consumers to believe the advertising claims and then gave more favorable product evaluations compared with low advertiser reputation. In particular, advertiser reputation had the greatest effect on product evaluations and ad credibility when the claim extremity was high (e.g., ranked best among 100 competitors) but no significant effect when the claim extremity was low (i.e., ranked 20th among 100 competitors). In other words, advertiser reputation became a critical determinant when participants viewed a high-extremity claim. On the basis of these findings, this study expects that when advertiser reputation is high, participants exposed to an advertisement with popularity claim will reveal higher advertising believability and more favorable brand attitude than will participants exposed to an advertisement without popularity claim, because participants likely believe the popularity claim of the highly reputable company and infer that the brand most consumers prefer is a good brand. However, when advertiser reputation is low, participants likely disbelieve the advertising claim and have an

unfavorable brand attitude, so an advertisement containing a popularity claim may strengthen their negative perception and unfavorable responses compared with an advertisement that does not feature a popularity claim. Thus, when advertiser reputation is low, participants exposed to popularity claim should have more negative evaluations than participants exposed to advertisements without popularity claim.

H1a: When advertiser reputation is high, participants' brand attitude is more favorable in the ad-embedded popularity claim condition than in the no popularity claim condition. When advertiser reputation is low, participants' brand attitude is less favorable in the ad-embedded popularity claim condition than in the no popularity claim condition.

H1b: When advertiser reputation is high, participants' perceived advertising believability is higher in the ad-embedded popularity claim condition than in the no popularity claim condition. When advertiser reputation is low, participants' perceived advertising believability is lower in the ad-embedded popularity claim condition than in the no popularity claim condition.

The other variable, consumers' ad skepticism, which Obermiller and Spangenberg (1998) defined as the tendency toward disbelief of advertising claims, represented a marketplace belief and an individual difference variable. They thought that the results of marketplace experience, interpersonal interactions, and advertisement commentary from the media could shape consumers' ad skepticism (Obermiller & Spangenberg, 1998). Friestad and Wright (1994) proposed the persuasion knowledge model (PKM) to argue that consumers develop knowledge about persuasion processes, which they use to help them interpret, evaluate, and respond to persuasion attempts from advertisers and salespeople. Persuasion knowledge refers to consumers' theories about persuasion process including beliefs about marketers' motives and tactics, effectiveness and appropriateness of marketers' tactics, marketers' persuasion goals, and consumers own coping tactics and coping goals (Friestad & Wright, 1994). Prior research demonstrates that consumers use persuasion knowledge to draw inferences about advertisers' or marketers' ulterior motives and manipulative intentions (Boush, Friestad, & Rose, 1994; Campbell & Kirmani, 2000). Moreover, ad skepticism constitutes an important part of consumer persuasion knowledge (Friestad & Wright, 1994). Highly skeptical consumers may be more likely to infer advertiser ulterior motives and manipulative intentions (Boush et al., 1994; Obermiller & Spangenberg, 1998), which influences the persuasiveness of the advertisement and leads skeptical consumers to reject the advertising claim and maintain less favorable ad and brand attitude compared with less skeptical consumers.

For example, Obermiller, Spangenberg, and MacLachlan (2005) found that skeptical consumers rated ads as less likable and less believable. Additionally, Hardesty et al. (2002) demonstrated that consumers' ad skepticism moderated the effects of advertised invoice price claims (i.e., the external reference price about manufacturer's cost) on product evaluations (e.g. the perceived fairness, acquisition value, and purchase intentions). When an advertised sales price paired with high manufacturer's cost (i.e., high invoice price), respondents perceived it as more fair than a situation that paired the sales price with low manufacturer's cost (i.e., low invoice price). Thus, less skeptical consumers were more likely to believe the

advertised invoice price claims and utilized this price information for a less familiar brand, and their evaluations were enhanced by a high invoice price (compared with a low invoice price). In contrast, more skeptical consumers tended to disbelieve advertised price claims for less familiar brands, especially when the invoice price was high, they disregarded the advertised price information and their evaluations were indifferent between high and low invoice price claims. This study extends these findings to argue that consumers' ad skepticism likely influences the perception of advertising claims and thus their evaluations of advertisements. The hypotheses suggest that when participants' ad skepticism is high, they infer that the popularity claim represents a persuasion tactic and, compared with a situation with no popularity claim, react negatively to its use, which then transforms into low advertising believability and poor brand attitude. However, when participants' ad skepticism is low, they probably do not infer that the popularity claim is a persuasion tactic or develop negative perceptions, so they likely believe the popularity claim, infer that the brand is a good brand, and have more favorable brand attitude.

H2a: When participants' ad skepticism is low, their brand attitude is more favorable in the ad-embedded popularity claim condition than in the no popularity claim condition. When participants' ad skepticism is high, their brand attitude is less favorable in the ad-embedded popularity claim condition than in the no popularity claim condition.

H2b: When participants' ad skepticism is low, their advertising believability is higher in the ad-embedded popularity claim condition than in the no popularity claim condition. When participants' ad skepticism is high, their perceived advertising believability is lower in the ad-embedded popularity claim condition than in the no popularity claim condition.

3. Experiment 1

3.1 Participants and Design

This study used a 2 (popularity claim: with vs. without) × 2 (advertiser reputation: high vs. low) between-subjects factorial design to test Hypothesis 1. To fulfill a course requirement, one hundred and twenty-seven business college students were recruited and randomly assigned to one of the four cells.

3.2 Procedure

Four booklet designs contained the different manipulations of advertising claims and advertiser reputation. The front page of each booklet provided the cover story and general instructions. Participants were told that the study was intended to investigate their evaluations of an advertisement for VexCom (a fictitious company that manufactured office furniture) and were instructed to read the company description of VexCom before reading the ad. The second page of the booklet included the company description and the manipulations for advertiser reputation, which adapted from Goldberg and Hartwick (1990). Two descriptions, approximately equal in length, presented a high advertiser- and a low advertiser-reputation, based on the length of time the company had been in business, its business volume, the number of plants, number of employees, and whether it exported to Europe, which indicated

company expertise. In addition, the manipulation of high advertiser reputation contained information about the company's contributions to the community and society and its honor record; the manipulation of low advertiser reputation described strike threats and alleged forged account events under investigation by the Tax Administration. Our manipulation of advertiser or corporate reputation is consistent with Fombrun's (1996) definition of corporate reputation. Moreover, Purohit and Srivastava (2001) also manipulated manufacturer reputation by past products manufactured by the company compared to other competitors' offerings and retailer reputation by dimensions such as store number, customer satisfaction, and product assortment.

The next page showed the ad for a VexCom computer/desk chair, containing either a popularity claim or no popularity claim. In the advertisement with the popularity claim, participants viewed an ad claiming that "9 out of 10 trial users are satisfied with our product," in bold, large type (i.e., using a subtitle). In the no popularity claim condition, participants did not see such a claim. The layout of each ad, the picture of the product, the headline, and advertising copy were identical in both ads. The final two pages asked the participants to complete dependent measures containing the manipulation checks. After finishing an open-ended suspicion probe (i.e., an open-ended question was used to detect whether participants had awareness of the study's true purpose), participants were thanked and debriefed. Based on participants' responses, no one guessed the true purpose or hypotheses of the study.

3.3 Measures

Brand Attitude. Participants' brand attitude toward the advertised product was assessed by using four seven-point semantic differential scales anchored at dislike/like, negative/positive, bad/good, and unfavorable/favorable. We adopted this brand attitude scale from Holbrook and Batra (1987). Next, the responses to these items were averaged to form an attitude index (Cronbach's $\alpha = .90$).

Advertising Believability. Participants' advertising believability toward the target ad were assessed by four seven-point semantic differential items from Beltramini's (1982, 1988) advertising believability scale: unbelievable/believable, not convincing/convincing, not reasonable/reasonable, and untrustworthy/trustworthy. These responses were averaged to form an advertising believability index (Cronbach's $\alpha = .90$).

3.4 Manipulation Checks

To assess the effectiveness of our reputation manipulation, participants were asked to rate the reputation of the company on four seven-point semantic differential scales anchored at unreliable/reliable, untrustworthy/trustworthy, inexperienced/experienced, and unskilled/skilled. These responses were averaged to form an advertiser reputation index (Cronbach's $\alpha = .93$). In addition, participants were asked to recall how many consumers were satisfied with the product, according to the VexCom ad, to assess the effectiveness of the popularity claim manipulation.

3.5 Results and Discussion

Manipulation Checks. The 2 × 2 ANOVA of the four-item reputation index yielded only the expected main effect of reputation. Participants in the high advertiser-reputation condition expressed higher scores than those in the low advertiser-reputation condition (M_{High} = 5.24 vs. M_{Low} = 3.80; F (1, 123) = 75.69, p < .001). No other significant treatment effects emerged from the reputation index; therefore, the manipulation of advertiser reputation was successful. In addition, the participants accurately recalled the number of consumers the ad claimed were satisfied with the product (90% correct).

Brand Attitude. A 2 × 2 ANOVA performed on the attitude index revealed a significant main effect of advertiser reputation (F (1, 123) = 27.10, p < .001). The high advertiser reputation condition (M_{High} = 5.17) elicited more favorable attitude than the low advertiser reputation condition (M_{Low} = 4.40). The cell means for all conditions are depicted in Table 1. Of greatest interest for our research, this main effect was qualified by a significant popularity claim × advertiser reputation interaction (F (1, 123) = 14.45, p < .001). Simple effects tests revealed that participants' brand attitude was less favorable in the ad-embedded popularity claim condition than in the no popularity claim condition when advertiser reputation was low (M_{with} = 4.02 vs. $M_{without}$ = 4.73, F (1, 123) = 9.76, p < .003), but when advertiser reputation was high, participants' brand attitude was more favorable if the ad featured a popularity claim than if it did not (M_{with} = 5.40 vs. $M_{without}$ = 4.94, F (1, 123) = 4.91, p < 0.03). Thus, Hypothesis 1a is supported.

Ad Believability. A 2 × 2 ANOVA on the ad believability index yielded a main effect of advertiser reputation (F (1, 123) = 12.53, p < .002). A higher advertiser reputation (M_{High} = 4.88) elicited greater believability than a lower advertiser reputation (M_{Low} = 4.33), and the significant popularity claim × advertiser reputation interaction (F (1, 123) = 8.04, p < .006) revealed that when advertiser reputation was low, advertising believability decreased in the ad-embedded popularity claim condition compared with the no popularity claim condition (M_{with} = 4.07 vs. $M_{without}$ = 4.56, F (1, 123) = 4.33, p < .05). However, when advertiser reputation was high, advertising believability increased for the ad-embedded popularity claim condition compared with the no popularity claim condition (M_{with} = 5.09 vs. $M_{without}$ = 4.67, F (1, 123) = 3.71, p < .06). Thus, Hypothesis 1b is supported.

Table 1 Means and Standard Deviations for Experiment 1 Treatment

	High advertiser reputation			Low advertiser reputation		
	With popularity claim	Without popularity claim	F-value	With popularity claim	Without popularity claim	F-value
Brand attitude	5.40 (0.85)	4.94 (0.90)	4.91*	4.02 (0.59)	4.73 (1.01)	9.76**
Advertising believability	5.09 (0.97)	4.67 (0.87)	3.71	4.07 (0.82)	4.56 (0.91)	4.33*
Sample size	35	34		27	31	

SD shown in parentheses.

In summary, the results of Experiment 1 indicated that participants tended to hold more negative brand attitude and advertising believability in conditions containing a popularity claim than in the no popularity claim condition when advertiser reputation was low. When advertiser reputation was high, participants revealed more positive brand attitude and advertising believability in the popularity claim condition than in the no popularity claim condition.

4. Experiment 2

4.1 Participants and Design

A 2 (popularity claim: with vs. without) × 2 (ad skepticism: high vs. low) between-subjects design was used to test Hypothesis 2. To fulfill a course requirement, one hundred and two college students joined this experiment (different from experiment one). In addition, to measure ad skepticism, this study adopted Obermiller and Spangenberg's (1998) ad skepticism scale (i.e., SKEP scale) and median split the participants into low and high ad skepticism groups (Hardesty et al., 2002). The SKEP scale contained nine items with five-point Likert scales (from "1" strongly agree to "5" strongly disagree), higher numbers indicating greater skepticism. The ad skepticism was dichotomized based on a median split in order to test our hypothesis 2, we hypothesized that high and low level of the ad skepticism could induce different effects on ad believability and brand attitude. Simple main effects tests for popularity claim within high and low level of the ad skepticism were conducted to specifically test the hypotheses. In Hardesty et al. (2002) study, they also dichotomized ad skepticism as high and low levels based on a median split.

4.2 Procedure

The two booklets contained two versions of the target ad. Again, the front page of each

provided general instructions and the cover story, namely, that the study was intended to investigate college students' attitude toward some advertisements extracted from a magazine. The second page of the booklet featured the target ad for a hypothetical brand of juice drinks. In the advertisement with the popularity claim condition, participants viewed the following ad claim: "90% of consumers love Hi-Q juice drinks." The no popularity claim condition did not contain any such claim. Except for the popularity claim, the layout, picture, headline, and copy of both ads were identical. The third page of the booklet asked participants to rate the target ad in terms of its advertising believability and provide their brand attitude. The final three pages contained instructions for participants to read and rate the filler ad and complete the ad skepticism scale. After finishing an open-ended suspicion probe, participants were thanked and debriefed. Based on participants' responses, no one guessed the study's true purpose.

4.3 Measures

The dependent measures of brand attitude and advertising believability were the same as in Experiment 1. The responses to the items were also averaged to form an attitude index (Cronbach's α = .87) and an advertising believability index (Cronbach's α = .89). Participants recalled how many consumers loved Hi-Q juice drinks, which indicated the effectiveness of the popularity claim manipulation; they were accurate in recalling the correct number (86% correct).

4.4 Results and Discussion

Brand Attitude. The 2 × 2 ANOVA for the attitude index revealed a significant main effect of ad skepticism (F (1, 98) = 9.15, $p < .004$). Table 2 reveals the cell means for all experimental conditions. Participants low in ad skepticism (M_{Low} = 4.35) indicated more favorable brand attitude than participants high in ad skepticism (M_{High}= 3.84). This main effect was qualified by a significant popularity claim × ad skepticism interaction (F (1, 98) = 4.04, $p < .05$). Simple effects tests showed that the popularity claim exerted a significant effect on brand attitude only when participants' ad skepticism was low (M_{with} = 4.61 vs. $M_{without}$ = 4.10, F (1, 98) = 4.53, $p < .04$); thus, the ad featuring a popularity claim elicited more favorable attitude than the ad without any such claim when participants' ad skepticism was low. However, when participants' ad skepticism was high, their brand attitude was less favorable in the ad-embedded popularity claim condition than in the no popularity claim condition (M_{with} = 3.75 vs. $M_{without}$ = 3.92, F (1, 98) = .51, p = .48), though this effect did not approach significance. Thus, Hypothesis 2a is partially supported.

Ad Believability. A 2 × 2 ANOVA of the ad believability index yielded a main effect of ad skepticism (F (1, 98) = 18.25, $p < .001$). Consistent with the expected effects of ad skepticism, skeptics (M_{High} = 3.49) displayed lower advertising believability than less skeptical participants (M_{Low} = 4.23). The significant popularity claim × ad skepticism interaction (F (1, 98) = 10.81, $p < .002$) indicated that when participants' ad skepticism was low, their perceived advertising believability was higher in the ad-embedded popularity claim condition than in the no popularity claim condition (M_{with} = 4.45 vs. $M_{without}$ = 4.01, F (1, 98)

= 3.13, p = .08). However, when participants' ad skepticism was high, their perceived advertising believability declined in the ad-embedded popularity claim condition compared with the no popularity claim condition (M_{with} = 3.12 vs. $M_{without}$ = 3.84, F (1, 98) = 8.29, p < .006). Thus, Hypothesis 2b is supported.

Table 2 Means and Standard Deviations for Experiment 2 Treatment

	High ad skepticism			Low ad skepticism		
	With popularity claim	Without popularity claim	F-value	With popularity claim	Without popularity claim	F-value
Brand attitude	3.75 (0.95)	3.92 (0.98)	.51	4.61 (0.70)	4.10 (0.79)	4.53*
Advertising believability	3.12 (0.85)	3.84 (0.85)	8.29**	4.45 (0.99)	4.01 (0.86)	3.13
Sample size	25	26		25	26	

SD shown in parentheses.

In summary, the results of Experiment 2 demonstrated that participants tended to reveal more positive advertising believability and brand attitude in the popularity claim condition compared with the no popularity claim condition when their ad skepticism was low; however, when their ad skepticism was high, they tended to assert less advertising believability in the popularity claim condition than in the no popularity claim condition, though their brand attitude did not differ significantly. Two possible reasons may account for this result. First, more skeptical participants might be more likely to carefully process the persuasive arguments contained in the ad, and did not process the peripheral cues which they perceived as irrelevant or incredible (e.g., popularity claim) when making product judgments. Since the persuasive arguments were identical between the popularity claim condition and the no popularity claim condition, it was likely that brand attitude was indifferent between these two conditions. Second, it might be the hierarchy of effects whereby ad believability precedes brand attitude. Consumers form ad attitude base on ad believability and ad cognitions. Previous studies also found that a strong positive relationship between ad attitude and brand attitude (Teng, Laroche, & Huihuang, 2007; Yoo & McInnis, 2005), however, the direct influence of ad attitude on brand attitude may be weakened by some intervening variables (Brown & Stayman, 1992). Consumers' brand cognitions may directly influence their brand attitude without through ad attitude (ad believability).

5. General Discussion

This study used social influence theory to explain the mechanisms by which advertisements containing popularity claim work. This research examined the relation

between popularity claim and advertising believability and brand attitude and whether advertiser reputation and a consumer's ad skepticism moderated these relationships. The main effect of popularity claim did not approach significance, and this result is consistent with Dean's (1999) findings. However, our results revealed the moderating effects of advertiser reputation and consumers' ad skepticism on advertising believability and brand attitude and indicated that when advertiser reputation is low or consumer' ad skepticism is high, advertisers using popularity claim may generate lower advertising believability and less favorable brand attitude. On the other hand, when advertiser reputation is high or consumer' ad skepticism is low, advertisers may benefit from using popularity claim, which are less likely to produce negative evaluations and more likely to produce positive evaluations. In addition, our research provided an explanation of how the failed main effect of popularity claim (e.g., Dean (1999) found that the ad-embedded popularity claim did not produce higher brand evaluations) could occur. It may be due to the cancel-out effect resulted from the positive effect caused by high advertiser reputation/ low ad skepticism and the negative effect caused by low advertiser reputation/ high ad skepticism.

Although little empirical research has assessed the persuasiveness of popularity claim, some studies have suggested its effectiveness (Dean, 1999; Freling & Dacin, 2010; Haigood & Dacin, 1999). Our findings demonstrated that the use of popularity claim may create negative perceptions of the ad, which have significant implications for advertisers. That is, because the popularity claim is not always effective persuasive tactics, advertisers must take care in their use of the popularity claim, especially when the advertiser's reputation is low. Additionally, advertisers need to identify the demographic factors associated with high and low ad skepticism (e.g., gender, age, education, consumers' expertise and experience) (Obermiler & Spangenberg, 1998), in turn, develop strategies, tactics or advertising copies for high and low skeptics. To minimize consumers' suspicions, advertisers should enhance the source credibility of their popularity claim (e.g., opinions from expert or consumer reports). When a popularity claim appears reliable, consumers are more likely to have a favorable evaluation of the advertised product.

This research draws on the social influence perspective to explain the effects of popularity claim on ad believability and brand attitude, and further proposes such effects can be moderated by two factors: advertiser reputation and ad skepticism. By imposing the notions of social influence in an advertising context (i.e., popularity claim), this study extended the applicability of this important theory. Although less attention has been paid to the moderating role of advertiser credibility or consumers' ad skepticism in the marketing literature, there is reason to believe that these variables may moderate the effect of popularity claim on product evaluations. This demonstrated that the persuasiveness of popularity claim depended on the moderating roles of advertiser reputation and consumers' ad skepticism and found that negative sources of popularity claim (low advertiser reputation or highly skeptical consumers) were not persuasive and could in fact lead to a backlash effect which little previous research has examined.

Because this study used business college students as respondents, who may be more

intelligent and have more knowledge about advertising, these respondents may be more skeptical or suspicious about advertising claims, which would reduce the persuasiveness of popularity claim in general. For example, Obermiller and Spangenberg (1998) found that MBA students (M=29.4) were more skeptical than the undergraduate students (M=27.9) and high school students (M=27.7). Our sample mean (undergraduate students M=27.8) is below MBA students but above high school students. MBA students have more business-related knowledge and experiences than undergraduate and high school students, which leads to a higher level of ad skepticism for MBA students. Boush et al. (1994) also demonstrated that skepticism toward TV advertising was positively related to knowledge about advertising tactics. Therefore, further research should improve the generalizability of our results by testing other populations and consider other factors may affect the persuasiveness of popularity claim, such as individual difference variables (e.g., age, education, experience, product familiarity/knowledge). More experienced or more knowledgeable consumers may be more skeptical or suspicious about advertising claims, which would reduce the persuasive effects of popularity claim.

The types of products could also influence the effect of popularity claim. When consumers perceive high financial or performance risk (e.g., a high-involvement versus a low-involvement product) or can evaluate the product only after purchase (e.g., experience versus search goods), they likely require others' opinions as evidence of the reality to reduce their perceived risk. Thus, popularity claim may be more persuasive in such situations. Additional research should address the effect of the persuasiveness of popularity claim according to product type.

Additionally, the popularity claim this study used (e.g., "9 out of 10 consumers" or "90% of consumers") did not address variations in the ostensible sampling size of the claim itself (e.g., "900 out of 1000 consumers" versus "9 out of 10 consumers") (Darke et al., 1998). The sampling size may influence the perceived reliability of the popularity claim and thus yield different persuasive effects, as further research might investigate. Finally, further research might examine the interaction effect among advertiser reputation, ad skepticism, and popularity claim. Popularity claim may elicit the most favorable ad and brand attitude when the advertiser reputation is high and consumers' ad skepticism is low.

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從《夷堅志》中看民眾的神像經驗

The Experience of the Deity Images in Yi-Jian-Zhi

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摘　要

本文探討南宋洪邁《夷堅志》中有關民眾和神像間的關係，其中討論的議題有神像的類型及成像、設置神像的目的、人與神像間的互動，以及民眾對神像的理解和認知等，藉以探究庶民生活中所反映的宗教意識和祭祀心理。

總結資料所示，民眾設置神像的目的，最常見的是祈福求願，這是庶民信仰生活中最重要的意涵。其次，在人與神像間的互動現象上，常見的情況包括神像具有與人相同的身體經驗，且能透過託夢、杯珓、圓光、現身等方式和人進行溝通；再者，對造像的尊重保護與否，則可能遭致意想不到的福報與咎責，而少數神明卻會因為有所不足而乞求於人。在民眾對神像的認知和理解上，筆者歸納出具有靈力、人神交感及反射人性三點，發現人與神之間的互動和彼此觀照，其實正是人間社會種種關係和意義的投射。

關鍵詞：夷堅志、神像、祠神信仰

Abstract

In this study, the relationship between people and the image of deities in Yi-Jian-Zhi, written by Hong Mie in the South Sung Dynasty, was observed through aspects of religious function and experience. To explore the worship patterns and the religious consciousness reflected in folk people's everyday life, the following issues were discussed: typology of deity images, purposes of setting up statues of deities, people's interaction with the deity images they create as well as people's comprehension and recognition of deities.

The results show that: 1. The most common purpose of setting up statue of deities is to pray for fortune and making wishes, which has greatest significance in folk religion. 2. As regards the interaction between people and deity images, we see that the latter was endowed with same bodily experiences as human being. deities communicate with people by dreams, jiaobei blocks, light and their apparition. Protection and respect toward deity images may be considered to cause unexpected fortune, otherwise punishment. However, some deities may appeal to people out of their own deficiencies, which reveals the potential contradictory characters projected by worshiper's mentality toward their deity images 3. On people's comprehension and recognition of deity images , three point are noticed, i.e. the supernatural power, communicability with people and their “human nature”. The interaction between worshipers and their deity images is rather a reflecting process of human social relationships, interwove with both sacred and secular complex.

Keyword: Yi-Jian-Zhi , Deity Images, Popular cults

一、前 言

神像是神靈物質化和具體化後的產物，它具有主客體兩面不同的意義和功能。就信仰的客體而言，神像具有標示宗教理念和情感的作用，透過有形的各種成像，使信徒感覺神明無所不在，誘發民眾的信仰力量，甚或有時也成爲傳達某些特殊神秘訊息的載體。再就信仰的主體而言，它是信仰心理的落實和完成。信眾從「祭神如神在」到「祭神神已在」，透過視覺的接觸、身體的膜拜，建立起和祭拜對象間的關係，以此培養信賴感和歸屬感，最後成爲表達生活願望和心裡訴求的對象。

隨諸宗教信仰內涵的差異，神像所顯發的性格和功能也不盡相同。在比較定型和制度化的宗教體系裡，神像具有超然及不可替代性，很明顯的是做爲精神象徵，供信徒靜觀冥想，以及標示活動場域和配合儀式進行之用；而屬於擴散型的民間信仰體系的神像，則由於其社會性、功利性及神祕性等特殊內涵，變得更富世俗色彩，也就因爲如此，它和群眾間才有更多更複雜的互動空間。換言之，吾人也可以同時根據群眾對神像的反應，觀察一般庶民信仰的特質。

中國傳統社會泛靈信仰非常普遍，早在殷商時期，便有帝乙將天神人格化並立爲偶像的記載，[1]這樣的情形自從佛教傳入中土後更形普遍。而在隋唐以後的國家祀典中，爲受奉祀者（包括嶽瀆神）造像，或坐或立，並受官方明令保護，也成爲常例。[2]在此同時，朝廷基於傳統禮制及儒家教化思想，也經常出現透過國家力量，試圖消弭地方泛濫的「淫祀」，禁制巫術信仰，打擊偶像崇拜，唐代狄仁傑、李德裕的禁毀淫祠，就是歷史上最具代表性的例子；然而在民間，這種神偶信仰非但沒有減少，反而隨諸地方「祠神信仰」[3]的普遍而日益擴張蔓延。

過去有關宋代民間祠神信仰的研究，頗有一些重要的著作，例如韓森（Valerie Hansen）的《變遷之神：南宋時期的民間信仰》[4]、賈二強的《唐宋民間信仰》[5]、皮慶生的《宋代民眾祠神信仰研究》[6]、韓明士（Robert Hymes）的《道與庶道：宋代以來的道教、民間信仰和神靈模式》[7]、王章偉：《在國家與社會之間－宋代巫覡信仰研究》等。這些著作對於祠神信仰的宗教面、歷史面、區域面和社會面都有深入的探討；但特別針對民眾和神像間的互動研究卻極爲罕見，除韓森書中有一小部份的討論外，並沒有其他相關之作，因此筆者希望以「神像經驗」爲題，檢視南宋洪邁（1123－1202）《夷堅志》

[1]《史記 • 殷本紀》（台北：粹文堂，1975）第三：「帝武乙無道，爲偶人，謂之天神，與之博，令人爲行，天神不勝乃僇辱之。」頁 104。

[2]如唐代祭祀孔子、先哲和武成王、歷代良將等，皆有造像。見《唐書》（台北：鼎文，1980）卷十五、志第五、禮樂五：「明年，司業李元瓘奏：先聖廟爲十哲像，以先師顏子配，則配像當坐，今乃立侍，餘弟子列像廟堂不豫享。」又「上元元年，尊太公爲武成王，祭典與文宣王比，以歷代良將爲十哲象坐侍。」

[3]所謂祠神信仰，其對象是指地方祠廟或神祠所供奉的神祇，信眾涵蓋包括士人群體，並融入儒釋道的一些重要觀念，在過去曾是民間信仰的核心。而祠神信仰盛行除了有民眾崇祀的心理因素外，更和朝廷封號賜額、商業發達、經濟利益、釋道互動等有密切的關聯。見皮慶生：《宋代民眾祠神信仰研究》（上海：上海古籍，2008）頁 2-30。

[4]韓森（1999），杭州：浙江人民。

[5]賈二強（2002），福州：福建人民。

[6]皮慶生（2008），上海：上海古籍。

[7]韓明士（2007），南京：江蘇人民。

[8]中有關神像設置的目的、成像經過、人與神像間的互動等問題，藉以瞭解民眾對神像的認知，和其中所反映出來的宗教意識和崇祀心理。所謂神像經驗，筆者定義爲民眾和神像間，透過包括祭祀作爲或非祭祀作爲而產生的互動，且經由感官接觸，獲得各種具體或想像的印象，而這些神像所在的位置則包括住家、祠廟，和一些不特定的空間。

歷來典籍中載錄神像的異聞傳說彼彼皆是，筆者之所以選擇《夷堅志》做爲觀察的素材，原因有二：一是基於南宋特殊的宗教發展趨勢，二是此書的特性。就前者而言，中國自古以來便巫風不斷，吳楚之地尤盛，宋室南遷後，此一強烈的鬼神觀念，成爲其宗教發展上的一大特色。宋人對南方巫覡信仰和民間淫祠的記載極多，在此僅以張邦基（約 1096-1150）所述爲例，以窺其全豹：

> 予每憤南方淫祠之多，所至有之。陸龜蒙所謂有雄而毅黝而碩者，則曰將軍；有溫而願哲而少者，則曰某郎；有媼而尊嚴者則曰姥；有婦而容者則曰姑；而三吳尤甚。所主之神不一，或曰太尉、或曰相公、或曰夫人、或曰娘子。村民家有疾病，不服藥劑，惟神是恃。事必先禱之，謂之問神。苟許其請，雖冒險以觸憲綱，必為之。儻不諾其請，卒不敢違也。凡禱必許以牲牢祀謝封物命，所費不貲。禱而不驗，病者已殂，猶償所許之祭，曰：弗償其禍必甚。無知之俗，以神之禦災捍患為可，惴惴然不敢少解也，豈獨若是乎？近時士大夫家亦漸習此風。士大夫稍有識者，心知其非，而見女子之易惑，故牽於閨幃之愛，亦遂狥俗，殊可駭嘆。[9]

文中對於民間神明之多、信神之切，以及知識份子助長此風，頗多描述。而《夷堅志》正是此一時代下的產物，其所記載有關神像的諸多傳聞，應可視爲反映南宋前期地方宗教信仰特殊發展的直接材料。

就後者而言，《夷堅志》是宋人非常重要且篇幅浩瀚的筆記文獻。其中所載神仙鬼怪、因果事蹟和種種民俗風尚等，經常載明主人翁的姓氏、籍貫、仕宦歷程、事件發生的時地背景，以及傳聞出處等，具有一定的可信度。正如洪氏評價歷來志怪之書有言：

> 夫齊諧之志怪、莊周之談天，虛無幻茫，不可致詰。逮干寶之《搜神》、奇章公之《玄怪》、谷神子之《博異》、《河東》之記、《宣室》之志、《稽神》之錄，皆不能無寓言於其間。若予是書，遠不過一甲子，耳目相接，皆表表有據依者。[10]

正因洪邁所載，多爲生平所聞之事，且又有真憑實據，使本書得以成爲探討南宋前半期民眾生活非常珍貴的參考資料。據筆者統計，《夷堅志》中載錄與神像經驗有關的內容，大約有 190 則左右，[11]其中牽涉的人物身份，上至宗室、丞相、官員、太守縣令，下至士人、士兵、住持、道人、鄉民、倡女等，範圍非常廣泛。傳聞發生的時間，自都集中在洪邁所處的年代裡，故語多建炎、紹興、乾道、淳熙、紹熙等，而來源地點除少數在北方外，大致仍以江南爲主，如饒州、臨安、湖州、崑山、溫州等，並擴及峴、蜀、湘、桂各地。基於上述兩點理由，筆者選擇《夷堅志》而不選擇類似《太平廣記》這種匯集前代大量文獻資料的大部類書做爲探討的原始素材，以期能夠掌握研究事象發生的明確時空，以及採樣的合理性。

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[8]本研究採用台灣明文書局 1982 年刊行的版本，該書乃根據涵芬樓編印之《新校輯補夷堅志》爲底本，並從《永樂大典》等書中輯錄佚文 28 則而成。

[9]《墨莊漫錄》（北京：中華，1985）卷八，頁 91。

[10]〈夷堅乙志序〉，《夷堅志》第一冊，頁 185。

[11]有關神像經驗的書寫，包括有描述細節、鋪陳完整者，以及僅在敘述上帶過而已兩大類。

二、神像的類型及成像經過

（一）神像的類型

唐宋以後，中國各地出現許多非列於祀典的祠廟，而平民類型的神祇也大量增加，本文神像所含蓋的範圍，是泛指民眾相信具有靈力能夠施法，並加以奉祀祝禱的對象，因此除了傳統有功於民的聖賢先哲，和佛、道既有受人尊崇的神明外，也包括更多地方上的神祇，甚或動物神。韓森爲整理民間神祇體系變化的特徵，把江南地區的神祇分爲八大類，包括傳統的、平民的、儒教的、佛教的、道教的、一般的、區域性的、動物與自然的。[12]《夷堅志》中出現的神明，種類繁多，傳統歷史人物有大禹、孔子、樊噲、霍將軍、關帝、裴度等；宗教的仙佛有觀音、地藏菩薩、僧伽大聖、許真君、呂洞賓等；一般民間常見的有梓潼、城隍、紫姑、土地神等。此外尚有可能是屬於地方性的各種祠廟與神祇，如婆婆廟、宋仙祠、桃花廟、伏虎司徒廟、琴高先生廟、張四郎祠、柳將軍廟、菊花仙、馬仙姑、苦竹郎君等等，至於動物神則有獼猴、蛇、鼉、龍王等。

在民間奉祀的神明中，其實包括許多精怪邪神，[13]例如〈王公家怪〉:「鄱陽人王公，居魏家井側，好事邪神以求媚，至奉五侯泥像於室，香火甚謹。」（支甲卷 8，頁 773）此處的「五侯」即五通神。五通神具有偏財神和淫神的雙重身份，其信仰中另有求祠、求食，及血肉祭、裸祭、採牲祭等特殊奇異和殘酷的現象，[14]在宋代淫祠中流傳極爲廣泛。《夷堅志》中其他的邪神還有稜睜神（三志壬卷 4，頁 1497）、獰瞪神（丁志卷 10，頁 620）、猴王（甲志卷 6，頁 47）、七姑子（支甲卷 6，頁 761）、大蟒（甲志卷 14，頁 126）、瘟神（支戊卷 3，頁 1074），以及一些不知名的對象。民眾爲何會奉祀邪神，主要還是基於「畏懼」和「靈驗」所致。「畏懼」之例如下：

> 福州永福縣能仁寺護山林神，乃生縛獼猴，以泥裹塑，謂之猴王。歲月滋久，遂為居民妖祟。寺當福泉南劍興化四郡界，村俗怖聞其名。遭之者初作大寒熱，漸病狂不食，緣籬升木，自投於地，往往致死，小兒被害尤甚。於是祠者益眾，祭血未嘗一日乾也。（〈宗演去猴妖〉，甲志卷6，頁47-48）

由於懼怕猴王作祟，甚至殃及幼兒，當地民眾不得不持續血祭，以求自保，尤其在大家口耳相傳，「村俗怖聞其名」之下，勢必導致集體性的恐慌，才會造成「祠者益眾」的結果。而「靈驗」之例如下：

> 吳十郎者，新安人。淳熙初，避荒，挈家渡江，居於舒州宿松縣。初以織草屨自給，漸至賣油。才數歲，資業頓起，殆且巨萬。里落莫不致疑，以為本流寓窮民，無由可富。會豪室遭寇劫，共指為盜，執送官。困於考掠，具以實告雲：「頃者夢一腳神來言：『吾將發跡於此，汝能謹事我，凡錢物百須，皆可如意。』明日，訪屋側，得一毀廟，問鄰人，曰：『舊有獨腳五郎之廟，今亡矣。』默感昨夢之異，隨力稍加繕葺。越兩月，復夢神來曰：『荷爾至誠，即當有以奉報。』凌晨

[12]韓森（1999），《變遷之神：南宋時期的民間信仰》，杭州：浙江人民，頁 182-185。

[13]所謂邪神，王章偉根據宋人文獻所載，歸納以爲最重要的表現，就是其神格行爲與祀奉者的活動均踰越於正統以外的道德標準，具體的表現就是「殺人祭鬼」與「淫人妻女」兩大邪行妖徑。見《在國家與社會之間－宋代巫覡信仰研究》（香港：中華，2005），頁 309-310。

[14]劉燕萍（2008），〈淫祠、偏財神與淫神－論《夷堅志》中的五通〉，《淡江人文社會學刊》第 35 期，淡江大學出版中心。

> 見緡錢充塞，逐日以多，遂營建華屋。方徙居之夕，堂中得錢龍兩條，滿腹皆金。自後廣置田土，盡用此物，今將十年，未嘗敢為大盜也。」邑宰驗其不妄，即釋之。吳創祠於家，值時節及月朔日，必盛具奠祭，殺雙羊、雙豬、雙犬，並毛血糞穢，悉陳列於前。以三更行禮，不設燈燭。率家人拜禱訖，不論男女長幼，皆裸身暗坐，錯陳無別，踰時而退。常夕不閉門，恐神人往來妨礙。婦女率有感接，或產鬼胎。慶元元年，長子娶官族女，不肯隨群為邪，當祭時獨不預。旋抱病，與翁姑相繼亡。所積之錢，飛走四出，數里之內，咸有所獲。吳氏虔啟謝罪，其害乃止。至今奉事如初。(〈獨腳五通〉，支癸卷 3，頁 1238）[15]

上述「緡錢充塞，逐日以多」、「堂中得錢龍兩條，滿腹皆金」、「所積之錢，飛走四出」等情事，如以常理判斷，實爲荒誕不經。吳氏究竟如何致富不得而知，但他一定感受到某些靈驗的神蹟，才會「創祠於家，值時節及月朔日，必盛具奠祭」，並以之說服官府「驗其不妄」。而前述「畏懼」的理由，也同時出現在此例中，即吳氏媳因「不肯隨群爲邪，當祭時獨不預」而慘遭殃禍。

民眾信仰邪神，除個人因素外，妖巫的煽惑也是重要原因，這可從宋代中央政府多次的禁巫詔令中看出，例如仁宗天聖元年，曾頒一道禁巫詔令：「戊戌，詔江南東西、荊湖南北、廣南東西、兩浙、福建路轉司：自今師巫以邪神爲名，屏去病人衣食、湯藥，斷絕親識，意涉陷害者，並共謀之人，並比類咒咀律條坐之。」[16]在兩宋地方官員取締巫覡活動的禁令中，也可以明顯的看到巫祝助長邪神信仰。例如：

> 臣訪聞宣州涇縣六十里，有女巫奉邪神，名丁先生，不知所起之因一二年來邪道甚盛，一方之人，為所誑誘，焚香施財，略無虛日。去歲有姓李人，經提刑司陳告，雖陳行下本縣毀拆廟宇，而其徒利於所得，更倡神怪之事，群起占護，縣亦無如之何，即日鄰比鄉村，往往食菜，結為邪黨……。[17]

又：

> 民事瘟神謹，巫故為陰廡複屋，塑刻詭異，使祭者凜慄，疾愈眾。公（王柟）鞭巫撤祠，壞其像。[18]

從上述的載錄中，吾人可見民間的邪神信仰，實和妖巫有密不可分的關係，亦同時可見巫覡信仰在傳統民間社會深植的力量。由於宋代民間神祠信仰的普遍，因而出現眾多或大或小、或正或邪的神祇，從前述神明紛雜的屬性來看，民間神祠信仰的環境可謂開放多元，且又複雜相互包容的。

（二）成像經過

既然民間神祠信仰普遍，立廟造像及奉祀環境的精粗良窳自然參差不齊，《名公書判清明集》中便曾對孔明廟有如下的描述：

> ……然今觀道旁所立之祠，甍塵湫隘，，豈足為高臥之草廬，所塑之像，齷齪庸陋，又絕無長嘯之英氣，加以妖神厲鬼，錯雜後先，田夫野老，袒裎左右，假令牲牷肥腯，粢盛豐潔，祝史矯舉以祭，雖馬醫夏畦之鬼，亦將出而吐之矣，謂孔

[15]祭祀五通神而致富例子，亦見同書丁志卷 13，〈孔勞蟲〉，頁 647。
[16]李燾，《續資治通鑑長編》（上海：中華，2004）卷 101，頁 2340。
[17]廖剛，〈乞禁奉邪神劄子〉，《景印四庫全書珍本初集・高峯文集》（上海：商務，1935）卷 2，頁 23。
[18]葉適，〈朝議大夫祕書少監王公墓誌銘〉，《叢書集成續編・水心文集》（上海：上海書店，1994）卷 23，頁 925。

明享之乎？[19]

祠廟「囂塵湫隘」，塑像「齷齪庸陋、無長嘯之英氣」，由此可見民間的廟宇神像，並未因其享有祭祀之隆而絕對保持一定的聖潔及精美。究竟民間祠廟裡的神像樣貌如何？據《夷堅志》所載，大約可以分爲繪圖和雕塑兩種，[20]但對於神像造型的細部描述，卻極爲罕見，至多如七姑子，只寫「其狀乃七婦人」（甲支卷 6，頁 761）、五通爲「畫一巨腳，略無相貌」（支景卷 2，頁 890）而已。一般而言，製作神像都有其參考的樣本，但偶爾有一些神像的造型，卻從靈異傳說中來，使人更相信偶像具有法力神性，如〈宜都宋仙〉：

> 宣和中，外舅為峽州宜都令，盛夏不雨，遍禱諸祀無所應。邑人云：「某山宋仙祠極著靈響。」乃具饌謁其廟。才下山，片雲已起於山腹。方烈日如焚，忽大雷雨，百里霑足。邑人戴神之賜，相與出錢葺其廟，而莫知仙之為男為女，攷諸圖志，問於父老，皆無所適從。外舅晝寢，夢大輿自外來，旛蓋麾旄，儀物頗盛，巍然高出於屋。私念言：「縣門卑陋，安能容此？」轉眄間已至庭中。跂而窺之，則婦人睟容襳飾坐其內，驚起欲致敬，倏然而寤。乃命塑為女仙像。（丙志卷 14，頁 483）

在這段記載中，鄉民感念神明降雨，出錢修葺祠廟，但不知神仙爲男爲女，亦無處可考，所幸洪邁的舅舅從夢境的顯像中，得知仙人的性別，因而完成塑像。

除此之外，仙家也可能親身下凡，提供自己的畫像，如〈遠安老兵〉：

> 主人指壁間畫像示之，客注視微笑曰：「我卻曾識他（呂真人），狀貌結束，全然與此別。與我絹五尺，當為追寫一本。」主人喜，即付之。客接絹不施粉墨，但置手中挪莎，俄而大吐，就以拭殘汙。主始惡焉，度其已醉，無可奈何。……良久，納絹於空瓶，笑揖而出。一童探瓶中取視，則仙像已成，衣履穿束，宛與向客無小異。其家方悟真人下臨。（支甲卷六，頁 755）

神仙透過戲謔示現的方式，提供自己的圖像，這樣的傳聞一旦散播開來，無疑的一定會強化民眾對於神仙法力無邊的印象，進而堅定其信仰意識。經由神明指示的情形，也同樣出現在〈江安世〉，其中載有三靈官透過怪石，以朱書小紙要求頗好道士之說的江安世圖繪其昆弟的形相，並將狀貌衣冠傳示給江氏，江氏乃爲圖象置於壇側。（丙志卷 5，頁 407）成像的神奇傳說又可見〈賀觀音〉，其中載有一乞者指出一賀氏所繪的觀音像不逼真，最後竟自己化爲真相，不但金光繚繞，百寶莊嚴，甚至異香芬馥，數月不散。（補卷 24，頁 1772）。至於「生縛獼猴，以泥裹塑，謂之猴王」（〈宗演去猴妖〉，甲志卷 6，頁 47）的記載，[21]是很特殊的民俗，不過這種成像結果，因猴王「抱沉冤之痛」，最後只給居民帶來噩運。

上述所見「神授」成像的事例，看似不可思議，但時至今日，仍時有所聞。台灣各地許多廟宇，在雕塑神像之時，也常會出現神明託夢給住持或雕刻師父，告訴他們金身

[19]〈先賢不當與妖神厲鬼錯雜〉，張四維，《名公書判清明集》（明隆慶三年刻本電子版，合肥：黃山書社，2009）卷 14，懲惡門淫祠類，頁 269-270。

[20]神像除了爲奉祀目的而雕繪出來的外，另有因某些特殊原因而以其他方式示現的，如〈蚌中觀音〉就記載了有眾人烹食蚌蛤，結果釜中作響，光焰相屬，大蚌裂開，現出觀世音像，菩薩冠衣瓔珞，相好端嚴，究其原因是舟人殺生貪食。（乙志卷 13，頁 293）〈錫盆冰花〉則載盆水結冰如雕鏤者，有壽星坐磐石上，長松覆之，一龜一鶴分立左右，以爲人壽。（丙志卷 14，頁 483）

[21]同樣的情事亦見三志己卷 9，〈石牌古廟〉，頁 1374。

的模樣，廟方及信眾都會視爲一種不可多得的殊勝因緣。

三、設置神像的目的

民眾既然相信神像附著靈力，也就能夠顯發奇蹟，所以舉凡生活中諸多無法理解或企盼達成的事項，都可以藉由敬拜神像完成心願。從《夷堅志》的內容裡，吾人可以看到民眾設置神像的各種原因，今大致分類說明如下：

（一）祈福求願

傳統的社會基本上是萬靈信仰，民眾相信舉凡日月星辰、山川河流、風雨雷電、聖賢英雄、草木禽獸都附有神靈，挾帶眾生無法抗拒的強大力量，可以掌握並改變人類的命運，因而對於無形的鬼神，無不充滿敬畏之情，加以佛道信仰普及之後，透過教義宣傳、祭祀儀軌和神話傳說，更加深了民眾對於仙佛的認識和情感，所以一旦鬼神仙佛化身爲具體可見的偶像時，一般善男信女莫不虔誠以對，恭敬奉祀。有能力者便在住處設置神像，不能者則出入祠寺，頂禮膜拜。《夷堅志》載有一行乞爲生的八旬老婦，一生最大的心願便是能夠得到聖像。[22]民眾想要獲得神像的渴望，正反映出神明在他們心目中的份量。同時對於虔誠事佛者，縱使是殘缺不全的聖像，也極其敬重，爲之修復，供養不斷，〈魚腹佛頭〉載：

> 資州人何慈妻范氏，事佛甚謹。家嘗烹魚，已刳腹，見脂裹一物，極堅韌，剖之，乃二佛頭也。其家斲木為全體以承之，至今供養。（甲志卷 17，頁 151）

由上述的事例，可以看出民眾對於神像的依賴與尊重。不但奉祀會得到庇佑，如果能夠推廣信仰，也能夠獲得福報，有佛寺長老言：「吾有觀音聖相，極靈異，今以相授。能刊板印施，必獲報格。」[23]由此可見，敬拜神像在民眾的宗教生活中，實爲最起碼也是最簡單易行的表現。

神像除了供奉在寺觀或家宅外，爲了隨時獲得庇佑，外出的信眾或經商或科考，也都會隨身攜帶神像，乞求平安。例如有麗水商人王七六，除平日奉事僧伽大聖甚謹外，一旦出行，也都隨身攜帶畫像，早晚上香敬拜。[24]相反的情形是，有人在外鄉途中遺落神像，則立刻顯得心神不寧徬徨不安。[25]

透過虔誠的敬拜，求得心理安慰或需要，而神明回應以消災或賜福，這是民眾宗教生活中最基本的信仰模式。《禮記‧郊特牲》有言：「祭有祈焉、有報焉、有由辟焉」[26]，因此，除了單純的表達敬畏之情以求心安外，冀求各種心願，包括「有祈焉」、「有由辟焉」都是民眾設像的重要原因，如〈翟楫得子〉載夫妻求子：

> 翟楫年五十無子，繪觀世音像，懇禱甚至，其後妻夢白衣婦人送兒至，後遂生子。（乙志卷 17，頁 325）

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[22]〈吳江鄭媼〉：「淳熙元年，吳江長橋側居民鄭氏媼，年八十餘歲，獨處茅簷之下，日丐於市，頗爲人所憐，敝衣糲食之外，蓄其賸錢於藏瓶，欲以畫觀音像。」支景卷 3，頁 898-899。

[23]〈徐熙載禱子〉，支丁卷 1，頁 969。

[24]〈王七六僧伽〉，支丁卷 8，頁 1032。

[25]〈吳長者〉：「有異鄉客泊旅邸，貯五通神像，奉事多年，一旦屬他人，道塗無所依倚。」三志辛卷 5，頁 1418。

[26]《十三經注疏》（台北：藝文，1955）5，頁 508。

又或藉由立像治病，也有其例，如〈陶豫子〉：

> 嘉興令陶豫，有子得疾甚異，形色語笑非復平日。豫患之，聘謁巫祝，厭勝百方，終莫能治。會天竺辯才法師元淨適以事至秀，淨傳天臺教，特善呪水，疾病者飲之則愈。……（淨）杖策從至其家，除地為壇，設觀世音菩薩像，取楊枝露水灑而呪之，三繞壇而去。是夜，兒寢安然。（丙志卷 16，頁 498）

宗教的意圖和目的，就在於解決和破除人的意志和能力之間、願望和獲得之間、目的與結果之間、想像與現實之間、思想與存在之間的對立矛盾，通過對神的祈求和祝禱，使人的意志、願望、想像成爲可能和現實。[27]從上述的例子中，吾人可以看出民眾在面對束手無策的困境時，轉向追求超自然力量的心理趨勢，也由此可以肯定人與神明之間一種屬於功利成份的特殊信仰關係。

（二）表彰節義

在民間奉祀的諸多神明中，有許多是由人升格而成的，這些人在生前往往有功於世，德被鄉民，因而得到香火的尊崇。朝廷爲賢臣名將繪像，早於東漢已有先例。[28]宋代朝廷不斷追封前代先賢，太祖建隆三年詔修武成王廟時，曾命左諫議大夫崔頌檢閱唐末以來謀臣、名將勳績尤著者入廟奉祀，[29]其後類似舉措屢見不鮮，或增列從祀，或繪像殿廡。除追封前代先賢外，也爲當朝人建立新廟，受祀者無非有功一方，如何承矩、曹瑋、李繼和；政有威惠，如韓琦、范仲淹、孫冕；爲人除患，如王承偉、張夏；死於亂賊，如曹覲、趙師旦、蘇緘等。[30]這樣的做法是符合自古以來神道設教的觀點。

中國傳統社會在儒家思想的發展下，倫理教化是祭祀觀裡重要的部份，《禮記・祭義》「合鬼與神，教之至也」[31]，便是說明這種的精神；而受祭的標準，在《禮記・祭法》中也有明言：

> 夫聖王之制祭祀也，法施於民則祀之，以死勤事則祀之，以勞定國則祀之，能禦大菑則祀之，能捍大患則祀之，……此皆有功烈於民者也。[32]

從上述所列的標準看來，祭祀具有鮮明的現實功能，所謂「有功烈於民」，就是希望透過祭祀活動，追念先聖先賢，宣揚其事功精神，以達到勸導風尚，規正民俗的政治目的，民間祠神信仰中，有許多新神就是在這樣的標準下不斷被創造出來，《夷堅志》中可見的例子有：

> 有范旺夫妻及子，死於盜賊之手，邑人感其節義而祠之，圖象於城隍，其後紹興六年，建安人吳逵通判州事，以其事聞，詔贈承信郎，許立廟。（〈義夫節婦〉，甲志卷 20，頁 182）

夫妻抗敵犧牲，鄉民感念供奉，這和朝廷爲有功將相立碑，其由一也。另〈惠吉異術〉中載張僧爲人驅鬼治病，去世後，當地人也爲之立祠繪像。（甲志卷 9，頁 78）韓森在整理南宋湖州烏程、歸安、德清等縣低地的祠廟時便發現，陸續新增的許多平民神祇，其生前有的是孝子代父受刑，有的是抵抗方臘軍隊，有的是捐獻糧食，有的是救溺殉難，

[27]呂大吉主編（1989），《宗教學通論》，北京：中國社會科學，頁 288。
[28]《後漢書・馬援列傳》（台北：鼎文，1981）：「顯宗圖畫建武中名臣列將於雲臺。」頁 851。
[29]《宋史》（台北：鼎文，1980）卷 105，志第 58，禮八，頁 2556。
[30]同前註，頁 2562。
[31]《十三經注疏》（台北：藝文，1955）5，頁 813。
[32]同前註，頁 803。

這些人都無顯赫的家世背景，但都對地區有所貢獻。[33]由此可見，地方父老為使這些鄉裡義人能夠得到永久的感念，為之立廟設祭應是很普遍的現象。不過，雖同為祭祀，國家祀典和民間信仰間的意涵卻往往不盡相同，前者著眼點自在統治立場，透過禮制，詔令有司「詳其勳業優劣以聞」[34]，再考量是否加入祀典，藉以「齋明恭肅，通於神明」、「消弭天災，導迎景貺」[35]，固然其中也不免沾有靈驗色彩，但後者則摻雜更多靈感神異的成份，如〈郭節士〉所錄：

> 郭節士在草寇犯境時拒敵殉國，冥官錄其忠義，俾之為神。後託夢宰邑，宰邑為之塑像。（支丁卷 7，頁 1020）

冥官封神、託夢宰邑之說，充分顯示民間信仰的特質，同時民間為這些具有特殊事蹟者立像，除了追念其生前嘉惠於民外，其實更重要的是相信他們死後具有神力，能夠護衛眾生，保祐平安。

（三）問事、施法

神像除了做為膜拜祝禱的對象祈求心願以外，同時也是傳達神秘訊息，得知吉凶的媒介，所以民眾除了在一般時候敬拜神像外，往往也會在特殊或臨時情況下，因事不能立決，而緊急的向神像祝禱乞求指示，例如〈祁酥兒〉：

> （祁酥兒）年十五歲，其冬，母病忽加劇，酥憂急不知所為，潛持一錢詣佛堂供像前，拜而祝曰：「吾母病甚，吾將割股肉以療，敢擲此錢以卜。即可，願錢文上嚮，否則反之。」擲已驗之，文果上嚮。（三志辛卷 1，頁 1386）

上文中年僅十五的人子，藉由在佛像前擲錢問事，以確定是否可以割股療親。又如〈孫巨源官職〉載孫氏關心自己的功名仕途，問他日科第及爵位所至：

> 孫洙，字巨源，年十四，隨父錫官京東。嘗至登州謁東海廟，密禱於神，欲知它日科第及爵位所至。夜夢有告之者曰：「汝當一舉成名，位在雜學士上。（甲志卷 4，頁 33）

另如士子入廟乞夢，於書中亦屢見不鮮，可見知識份子在面對自己的前途時，仍不免想透過民俗信仰的管道預卜先知。

民眾所問之事，除了關乎性命和前途外，還有向神請藥。〈周沅州神藥〉記載，有周氏臥病，屢得神明賜藥，不但恢復自己和妾的健康，同時還治癒裏社數百人的病痛。（三志己卷 10，頁 1378-1379）神像的靈力，不僅能救難於人，還能拔苦於物，〈周世亨寫經〉記載有周氏謝役之後，發願手寫經二百卷供人持誦，有一天，當正在握筆時，屋上有群鴉數千鳴噪，逐之不退，周氏便起禱於像前，然後出而視之，結果是有一鴉中箭流血，眾鴉無法相救，因而悲鬨，周氏於是連誦佛號，最後鴉身之箭竟然自拔掉落於佛龕之側。（三志己卷 2，頁 1318-1319）另外，向神像乞問，不盡然都是正當之事，也有藉以問賭者，〈淩二賭博〉：

> 浮梁西村民淩二，世世業農。翁子次子小二者，獨嗜賭博，雖日撻不悛。遇一客，言能卜筮，以一神像畫卷並一香爐自隨，每事必祝。淩子往扣某日勝負，客曰：「今夕勝五百錢，盈數即止，不可過也。」已而詣山寺，從其徒夜博，果得錢如

[33]韓森（1999），《變遷之神：南宋時期的民間信仰》，杭州：浙江人民，頁 112。
[34]《宋史》（台北：鼎文，1980）卷 105，志第 58，禮 8，頁 2559。
[35]同前註，頁 2426。

數。默念此戲不可不求援於神，即再謁客致謝，而舉所贏買酒縱飲，伺客醉臥，負其兩物歸。客不敢訪尋，狼狽而去。淩敬其所奉，動輒如意。（支戊卷 10，頁 1134）

上載淩小二得一能卜筮者之助而贏錢，因爲極其靈驗，最後竟然偷走他的神像畫卷和香爐。

神像除了是一般民眾問事占卜吉凶的對象外，也成爲巫覡施法之用。他們爲了吸引民眾到神壇請求施法，會設置各種不同的法器，神像便是其中之一，〈陳俞治巫〉中載陳俞伯姐家遭病疫，門戶封閉，不許旁人進出，陳氏則不聽，逕自入內，看見住所奉有巫者所設的神像，（補卷 2，頁 1558-1559）此即巫祝設立神像，做爲治禳醫病之例。而其目的，有批評者以爲是「使祭者凜慄」[36]，或是「鼓氣焰以興妖，假鬼神以譁眾」[37]。爲了發揮上述的效果，其形體自然怪異，因而造型多爲「塑刻詭異」、「奇神異象」，如言「其神或擎足，或怒目，或戟手」[38]、「狀夔猓傀彪、洟陽彷徨之象」[39]。又如五通神爲一足，是「考之傳記，所謂木石之怪夔罔兩及山猓是也」，或經常「隨人心所喜慕而化形，或止見本形，至者如猴猱、如尨、如蝦蟆，體相不一」[40]。

奉祀邪神固然不符國家禮制，亦違反朝廷教化原則，但在民間相信靈驗與受制於妖巫的緣故，卻極爲普遍。不過這些邪神的下場，往往亦決定於它們真的是否靈驗，與是否受到官府取締，一旦遭逢打擊，常見的下場是焚之庭下、毀而投諸江、杖其土偶而投之溪流、毀廟碎像、投其像於江等，如果是畫像則是以書刀刮去之。

（四）其他原因：報恩、化緣

民眾設像除了上述的原因外，還有其他的一些理由，例如民眾因受靈驗事蹟的感召，或受到神明的保佑相助，出於報答之情也會設置神像奉祀。〈公安藥方〉中載向友正曾夢見一高大男子賜傳藥方而癒，後知爲壽亭關王後，繪祀於家。（支景卷 10，頁 963-964）又如〈搜山大王〉載，有道士王居常行走於荒陂之中，遇殺人者，因呼搜山大王乞命而得救，其後歸鄉，亦繪其像事之。（甲志卷 7，頁 62）此外，還有僧人爲了化緣求利，亦設像供事，如〈三將軍〉：

僧惠照者，……持石刻數本，遺院主允機，共一紙乃三將軍畫像。機志於求利，於是呼木工雕三神形模，一切與碑相類。旋闢一堂供事，且將施丹青藻繪，為化緣之資。（支丁卷 7，頁 1021）

綜合設置神像的各種目的，吾人大致可以理解民眾在神明之前所顯現的敬畏、依賴、羞愧、惶惑等不同之情。宗教在人類社會中具有生存、整合及認知的功能。所謂生存功能，是協助人類渡過在生存過程中所面臨的種種困境，並安撫其身心；整合功能則是藉由宗教信仰，凝聚社會力量，促成群體合作，共謀發展；而認知功能，則是提供生命價值的知識與安身立命之道。如此觀之，《夷堅志》所載民眾信仰生活中的神像經驗，

[36]葉適，〈朝議大夫祕書少監王公墓誌銘〉，《叢書集成續編・水心文集》（上海：上海書店，1994）卷 23，頁 925。
[37]蘇頌，〈潤州州宅後亭記〉，曾棗莊、劉琳主編，《全宋文》（上海：上海辭書、合肥：安徽教育，2006）卷 1339，頁 373。
[38]〈張子智毀廟〉，支戊卷 3，頁 1074。
[39]同註 34。
[40]〈江南木客〉，丁志卷 19，頁 695-696。

即使有許多負面發展，但不可否認的，他們也在一定的歷史階段中發揮了上述宗教的各種作用，使民眾安於生活，並認識禍福吉凶之道，以及自我和群體、宇宙之間互相依存的關係。

四、人與神像間的互動

神像之所以受人尊崇，在長期的信仰經驗中是被認爲具有靈性的，《夷堅志》載有許多類似通過各種情境感應而發生人神互動交感的經驗，茲將這些經驗整理歸納分述於下：

（一）具有與人相同的身體經驗

許多神像具有與凡人相同的身體經驗，如流汗、垂淚、病痛、飢餓、情慾等。這種經驗讓人能夠很明確的感受到他們的存在。〈鐵塔神〉便載有「神像流汗被體」的事蹟：

> 蔚州城內浮圖中有鐵塔神，素著靈驗，郡人事之甚謹。契丹將亡，州民或見其神奔走於城外，亟詣寺視之，神像流汗被體，雖頗驚異，然莫測其故。至夜，神見夢於寺主講師曰：「吾奉天符，令拘刷，城中合死人，連日奔馳，始克就緒。來日午時，女真兵至，破城，城中當死者一千三百有畸，而本寺僧四十餘，和尚亦在籍中。吾久處茲地，平日仰師戒德，輒為以它名易之，詰旦從此而逝，庶萬一可脫。」講師既寤，以語寺眾，皆笑其妄。（甲志卷 1，頁 4）

上述鐵塔神爲了要拯救城民，竟然出現神明奔走城外，而神像流汗的神奇事跡。神像不僅會流汗，還會垂淚，有例如下，〈杜默謁項王〉：

> 和州士人杜默，累舉不成名，性英儻不羈。因過烏江，入謁項王廟。時正被酒霑醉，才炷香拜訖，徑升偶坐，據神頸拊其首而慟，大聲語曰：「大王，有相虧者。英雄如大王，而不能得天下；文章如杜默，而進取不得官，好虧我。」語畢，又大慟，淚如迸泉。廟祝畏其必獲罪，強扶以下，掖之而出，猶回首長歎，不能自釋。祝秉燭檢視，神像垂淚亦未已。（三志辛卷 8，頁 1446）

項王有感士子累舉不成，也爲之落淚不止。神像既與人體相同，所以也會罹患指傷，如〈汪子毀神指〉：

> 饒州雙店民汪渙，世事善神，龕其像於室中。幼子五歲，戲折其中指。渙夢金甲神訴曰：「吾衛護翁家有年矣，未嘗令翁家有小不祥事，奈何容嬰兒毀吾指？」渙驚謝。旦而視之，信然，亟命工補治。此子即日病，中指間瘡絕痛，既愈，遂拳縮不可展。（丙志卷 6，頁 418）

又如在〈秀州司錄廳〉中，鬼怪與洪邁的先君洪皓有一段對話，說明神明具有和人類一樣的本能：

> 公曰：「吾每月朔望，以紙錢大（或作獻）土地，何為反容外鬼？汝為我往問，明日當毀其祠。」曰：「官豈不曉？雖有錢用，奈腹中飢餒何？我入人家，有所得，必分以遺之，故相容至今。」（乙志卷 8，頁 250-251）

土地神害怕飢餓，只得靠鬼怪得取食物分享，所以任由他們出入門廳，因而被視爲「不甚振職」。許多神明都被認爲是「人」的神格化，具有和凡人一樣的心理和生理活動，因此有些神像充滿情慾，進而發生和人交媾的傳說，如〈土偶胎〉：

> 仙井監超覺寺九子母堂在山顛。一行者姓黃，主給香火，顧土偶中乳婢乳垂於外，

悅之，每至，必摩拊咨惜。一旦，偶人目動，遂起行，攜手入屏後狎昵。自是日以為常，累月矣。積以臥病，猶自力登山不已。主僧陰伺之，至半山，即有婦人迎笑。明日，尾其後，婦人復至。以拄杖擊之，鏗然僕地。於碎土中得一兒胎，如數月孕者。令行者取歸，暴為屑，和藥以食，遂愈。（甲志卷 17，頁 146）

又如〈永康倡女〉：

永康軍有倡女謁靈顯王廟，見門外馬卒頎然而長，容狀偉碩，兩股文繡飛動，諦觀慕之，眷戀不能去。至暮，家人強挽以歸，如有所失，意忽忽不樂。過一夕，有客至求宿，其儀觀與所慕丈夫等。倡喜不勝情，自以為得客晚。其人遲明即去，黃昏復來。留連數宿，忽泣曰：「我實非人，乃廟中廄卒也。以爾悅我，故犯禁相就。屢不赴夜直，為主者所糾，得罪，明日當杖脊流配。至時，過爾家門，幸多買紙錢贈我。」倡亦泣許之。如期，此卒荷鐵校，血流滿體，刺面曰「配某處」，二健卒隨之，過辭倡家。倡設奠焚錢，哭而送之。他日，詣廟，偶人仆地矣。（甲志卷 17，頁 146）

類似有人悅慕神偶，神偶竟化爲人形而與之相狎的故事，在《夷堅志》中極爲常見，不過從上述的例子看來，會發生這種關係的當事人或神，其身份地位多半不高，且其下場難有善終。

（二）透過託夢、杯珓、圓光、現身等方式和人溝通

神像爲一祭祀聖物，要如何才能與民眾互動，並顯示其具有神力，《夷堅志》中吾人可以看到神像藉由託夢、杯珓、圓光或直接現身等方式與人溝通。例如〈觀音醫臂〉載：

湖州有村媼，患臂久不愈，夜夢白衣女子來謁曰：「我亦苦此，爾能醫我臂，我亦醫爾臂。」媼曰：「娘子居何地？」曰：「我寄崇寧寺西廊。」媼既寤，即入城，至崇寧寺，以所夢白西舍僧忠道者。道者思之曰：「必觀音也。吾室有白衣像，因葺舍設傷其臂。」引至室中瞻禮，果一臂損。媼遂命工修之。佛臂既全，媼病隨愈。（甲志卷 10，頁 88）

觀音像臂傷，託夢給同樣患有此疾的村媼，希望他能幫忙醫治。此類情況在書中屢見不鮮，是人神交通中最常見的方式。此外神像也會藉由一些媒介傳達靈力，以顯示吉凶，杯珓就是其中之一，〈趙善文〉：

撫州金溪縣有神廟，甚靈顯，祈請者施金帛無虛日，積錢至二千緡。宗室善文過廟下，心資其利，焚香禱曰：「損有餘補不足，人神一也。善文至貧，願神以二十萬見假，不然，將白於官，悉籍所有而焚廟。神雖怒，若我何！」既禱，即呼廟祝取錢。祝無辭以卻，但曰：「神許則可。」善文取杯珓擲之，速得吉卜，再拜謝，運鏹以出。（甲志卷 5，頁 43）

也有畫像能夠感應人心善惡，以出現圓光，或隱藏消失，具體的顯示其神威，〈趙氏二佛〉：

趙善澄有二佛，其一泥塑古佛，連座不滿二尺。澄言初在皮匠陳三家，凡人燒香作禮，有所祈祝，無不感應。聲彰中外，來者紛紛然，不能知其名。……其一水墨畫彌勒佛，標飾甚濟。遇逐月旦望，別開一室，羅陳香花，聽外人入拜。如其人平日忠信，則立現圓光，大如茶甌，從頂心出，移時徧滿軸上；如輕薄惡子至，則淡然無所睹。（三志壬卷 8，頁 1529-1530）

至如〈舞陽侯廟〉所載，則是萬州太守馮當可，以爲廟祀的樊噲是夷祆之鬼假託附著，因此撤除其祠祀，但未幾樊噲卻現形質問馮氏，馮氏則是歷詆其平生所爲，仍不復祀，樊噲無以爲計奄奄而滅，但自此以後經常騷擾太守家，並屢次執縛馮氏幼子於大木之杪，直到馮氏去郡後才停止。（丙志卷 2，頁 373）

上述這些例子，或爲巧合、或爲想像，以今視之，不免淪爲無稽之談，但這樣的感應文化，卻是民間信仰中從未間斷過的。

（三）福報與獲咎

中國神像崇祀的普遍，深受佛教雕像的影響，舉凡佛陀、菩薩、羅漢等神像的體態、容貌和氣性，都給予本土神像造型注入新的元素和啓發。同時在傳統社會，不但認爲替神佛造像可以趨吉避凶，蔭庇後代子孫，甚者如《佛說作佛形像經》、《佛說大乘造像功德經》等典籍，更明載造像爲重大的功德，可獲得不可稱數的福報，即使只有保護、修補神像，也都能得到意想不到如救命、洗冤、治病等重大的回饋。在《夷堅志》中類似的記載屢見不鮮，獲得福報的例子如〈佛救宿冤〉：

> 臨安民張公子者，嘗至一寺，見敗屋內古佛無手足，取歸，莊嚴供事之。歲餘，即有靈響，其家吉凶事輒先告之，凡二三十年。建炎間，金人犯臨安，張竄伏舂井，似夢非夢，見所事佛來與之別曰：「汝有難當死，吾無策可救，緣前世在黃巢亂中曾殺一人，其人今為丁小大，明日當至此，殺汝以報，不可免矣。」張怖懼。（甲志卷 8，頁 65）

張氏收留無手足的古佛，莊嚴供事，後來神像發生靈響，透露吉凶。又如〈隆報寺〉：

> 湖州弁山西南隆報寺，……是時寺既無子遺，偶像一切暴露，風日淋爍，或為人徙去。善神一軀仆地上，圬者吳大為和泥補葺，且舁施圓證寺。久之，吳大受顧結屋，墜梯折腰，傷勢殊亟，夢神來云：「汝昔嘗救我，我不敢忘。」授以乳香飲方，……一旬而愈。（補卷 24，頁 1773）

善待神像終將得到福報的觀念，時至今日依然如是。神像既然附著靈力，相反的，如果對神像不敬、侮慢，甚或毀損的話，必遭凶譴，得到嚴重的報復。這樣的事例，書中亦所在多有，如侮慢不敬者，見〈黑風大王〉：

> 汾陰后土祠，……女真統軍黑風大王者，領兵數萬，將窺梁益，館於祠下。腥羶汙穢，盈積如阜，不加掃除。一夕，乘醉欲入寢閣，觀後真容，且有媟瀆之意。左右固諫，弗聽，率十餘奴僕徑往。未及舉目，火光勃鬱，雜煙霧而興，冷逼於人，立不能定。統軍懼，急趨出，殿門自閉，有數輩在後，足踵為關闌翦斷。統軍百拜禱謝，乞以翼旦移屯。（甲志卷 1，頁 9）

又〈太清宮道人〉：

> 亳州蓋老君鄉里，故立太清宮崇事之。曾有道人賣藥者，敝衣貧窶，而意氣揚揚甚倨，攜藥爐詣殿下燒藥，大言自尊，指聖像曰：「此吾之弟子也，吾為老君師。」聚觀漸眾。須臾，火自爐出，灼其衣，焰發滿身，驚而走。左右以水沃之不滅。狂走庭中，火所經，他物不焚，獨焚厥身。已而北面像前若首伏者，遂斃，視其軀幹，皆灼爛矣。（丙志卷 16，頁 499）

無論是道人言語上的調戲，或統軍動作上的輕薄猥褻，都難逃惡運，甚至連群妓戲謔廟中不知爲何神的土偶，最後竟也相繼病瘴而死。（〈橫州婆婆廟〉，三志辛卷 8，頁 1447）

而毀損破壞之例如〈張八削香像〉：

溫州市人張八，居家，客持檀香觀音像來貨，張恐其作偽，欲試之，而遍體皆采繪，不可毀，乃以小刀刮足底香屑爇之。既而左足大痛，如疽毒攻其內者。藥不能施，足遂爛。至今扶杖乃能行。（丙志卷 6，頁 417）

又如〈城隍廟探雀〉：

饒州城隍廟，每歲春夏之交，多有雀巢於屋翼內孕育雛卵。黯卒錦先、楊成、魏贇皆從他郡配隸，已三十餘年。一為憲臺司閽，一為泉府庫典，一為軍頭，所居與廟近。慶元三年四月，三家之子各十五六歲，相率入其中，欲探取乳雀，而高不可升。乃踏神像夫人之肩，攀緣而上，得十數枚。像泥遭踐踏剝落地。至晚，三子同感疾，昏熱如炙，不能出語。（支癸卷 6，頁 1268）

民眾對神像不敬甚或破壞，日後必有報應，這其中的因果其實是很難查驗的，但從這些傳聞故事中，吾人正可以看到社會群體，賦予造像神聖不可侵犯的地位，以及強大的懲罰力量；而民眾同時也在不斷累積的信仰經驗下，逐漸自我凝聚並確立神聖對象的真實性。

（四）神明有求於人

人神之間，不僅人有求於神，當神自感有不足之處時，也會向人請求，而請求的事物，常與人的需求一般，例如〈瑞應尊者〉所載：

恭州報恩寺有羅漢洞，塑為巖壑五百所，人物散處，其長大與生身等。唯瑞應尊者一像，乃天生石所成。其顏狀衣服，襞摺文縷悉具，了無斲削痕跡，莫知起於何代。紹興間，或失其首。……乾道中，一蜀商泊舟江陵沙頭，夜夢異僧來謁曰：「貧僧受業於渝川之報恩寺，今行腳西歸，擬附於舟尾。如辱賜許，當先奉候於白羊口。緣寄苞笠在彼，趁便道取之。」商曰：「諾。」寤而恍然。蜀客率能於亂石中識別璞玉碼瑙，及至白羊，沙磧間得一圓石，高尺許，宛如人頭，眉目全備，而圓頂無髮。眾方聚觀，商認為夢中所遇，浴而收之。將至恭州作供，行次洞前，見一石像，方袍無首，默與心會。白方丈，辦香花，迎於江濱，置之項上，脗合無齟齬，遂復成全軀。（支癸卷 5，頁 1256）

石像託夢給商人，希望他能在指定之處，尋獲失去的頭顱，可見神明也和人一樣，要求完整的形體。除此以外，神明也非常在意自己的造像是否完好、色彩是否鮮明。〈勸善大師〉載：

饒州東嶽行官遭火蕩盡，後來草創修理，僅有屋一二十間。紹熙五年十二月，判官孟滋同妻往謁，至外舍小室，見一僧，像貌彩飾皆剝落，問何神，祝吏曰：「勸善大師也。」滋顧其妻有整治之意，而未嘗出言。是夕，夢一長僧來丐衣服禦寒，且云：「不過費君家錢三千耳。」覺而驚異。明日，即令工往，裝繪一新，正用楮幣三千。（支乙卷 7，頁 849）

神像彩飾剝蝕，代表香火寥落，神力減損，一如人間富貴正可從車馬衣裘看出端倪，所以力求神像光鮮亮麗，也保證民眾可以獲得更多的庇佑。〈胡畫工〉也有同樣的記載：

浮梁畫工胡生，居於縣市，其技素平平。邑人葺城隍祠，付以錢，使繪門衛二神。胡生嫌所得之微，視其直斟酌，但作水墨而已，衣冠略不設。夜夢二巨人，長七尺，儀貌雄偉，而衣裝極敝惡，謂曰：「我二人蒙君力，獲所依憑，霑受香火。獨恨被服不如法式，不為人所禮。願君復加藻飾，必有以報，使技日進而名益彰。」夢中恍惚許之。已覺，而未暇研究。經旬日，因過彼處，遙望兩像，宛如故知，

瞿然悚悟。即日買金箔五采，自施工藝，繪黃金甲，執金鉞，冠帶整嚴。見者悉加瞻敬，而不以夢告人。後夢其來，威容凜凜，服與貌稱，感謝至再三。自是胡日以稱遂，求者接踵。至於嫁女文繡，只以畫代之。里巷遭疫癘，無一家不病，胡氏獨免。（支戊卷 10，頁 1133）

「獨恨被服不如法式，不爲人所禮」、待藻飾後「見者悉加瞻敬」，這完全反映出神間也講究世俗的標準，且「願君復加藻飾，必有以報」，更是說明人神之間一直存在的功利關係。美觀之外，神明也會在夢中示意，添加相關的用品，如〈石城廟神〉：

贛州石城縣城隍祠，在邑治之側，水旱祈禱多應，土人敬事之。紹熙辛亥五月十七日，大雨傾注，溪流溢湧，浸通衢丈餘。祠門頹敗，士民合力一新之。門之左右元塑兩馬，是時忘設置。踰月後，知縣呂大年夢紫袍吏立庭下聲喏云：「大王令傳語長官，出入乏馬乘，欲暫假駿駟兩匹。」呂許之。覺而思之，山邑元未嘗養馬，安能遣借？悟其事，乃自捐俸錢，即東西塑飾，用錦衣四健卒控馭。至七月，兼旬不雨，致禱祠下。香火才收，陰雲正晝四合，隨得膏澤，歲以大稔。縣人或夢神導從甚偉，正乘所塑東邊馬雲。（支丁卷 3，頁 984）

又如〈神乞簾〉：

永州譙門相對有小廟，廟神見夢於錄事參軍何生曰：「吾一方土地神耳，非王侯也。郡守每出入，必徑祠下，我輒趨避之，殊不自安，就君乞一簾蔽我。」如其言，明日，夢來謝。（丙志卷 1，頁 371）

上述兩則，一是神明在夢中示意，出入缺少交通工具，希望增添座騎，另一則是乞求簾幕，以遮避郡守出入。神明之所以有求於人，實出於神祇人格化的結果。民眾想像神祇也和人一樣，希望經由各種不同的物質形式，保障並維持自身的地位和榮耀，而民眾也相信實現神祇的願望，才能獲得更多的保佑，這是民間宗教信仰長久以來深信不疑的邏輯。

五、對神像的認知與理解

神像乃是民眾表達信仰意識和進行儀式活動的對象，在具體的互動過程中，吾人可以看到民眾整體的信仰結構，包括宗教觀、神秘體驗及祭祀行爲等，是社會文化中極爲重要的一部份。在檢閱《夷堅志》記錄民眾和神像的關係中，我們大約可以看見民眾對神像有以下的認知與理解：

（一）具有靈力

1872 年英人泰勒（Edward Burnett Tylor,1832-1917）於其《原始文化》論著中，提出萬物有靈說，認爲人類各種宗教信仰活動如祖先崇拜、自然崇拜、種類神崇拜等，皆源於泛靈觀念，此一觀念普遍深植於世界各地的傳統民間信仰中。民眾之所以拜像，最重要的原因是他們相信神明具有全知和干預的超人靈力。而相信神像具有靈力，乃是一種主客因素結合的結果。在主觀心理上來說，大多數民眾相信神靈本是無所不在，且在設置神像時必經一定的儀式過程，象徵賦予神力，因而民眾對於神像自然也就保持敬畏之心；而另一方面，則是鄉裏不斷傳出神明或神像靈驗的事蹟，因而令人不得不相信確有其事。以下這則記載，便是神像顯現靈力的傳說，〈清塘石佛〉：

湖州周司戶幹僕陶忠，掌收掠僦債之直。每日暮，必經由清塘門裡，常見河畔髣髴有光自水際出，凡數十夕皆然，漫記其處。旦而往訪，尋得一方石，四面皆鐫

> 釋迦佛像，即取以歸，香火供事甚謹。石理細潤可愛，遇天將雨，先一夜必有水珠出，以之候陰晴，未嘗不驗。……至淳熙甲午，其子顯置黃頭雀籠於佛室相近處，遺矢汙像，不加拂拭。忽風雷中夜暴震，迨曉，失佛所在，窮人力搜索，不復可得。（支景卷 4，頁 911）

佛像自身能「有光自水際出」，同時又能感受「遺矢汙像」而消失不見蹤影，這樣的神奇變化，相信更會加深民眾對於神像莫名的尊敬。又如〈海中真武〉：

> 婺士葉昉，登乾道己丑進士第。因往明州訪親故，為航海之役。方升舟，見一物漂漂隨流赴舟所，試勾取視之，乃故紙一幅，畫真武仗劍坐石上，一神將甚雄猛，持斧拱立於傍，後書「道子」兩字，疑為吳生筆也。紙略不沾濕，若初未嘗著水者。葉徙居嘉禾，此像為其姪宜之所得，供事於神堂，極有靈驗。葉再調舒州懷寧令，終於官。（支景卷 3，頁 905）

一張畫有真武大帝的像紙，在水中漂流竟然不濕，這對民眾而言，是充滿想像的，不過這樣的傳聞竟然發生在知識份子身上，卻是值得令人玩味的。

當然，神明的靈力也顯現在邪惡的事蹟上，所以一旦遭受邪神威脅騷擾時，解除靈力最好的辦法就是摧毀神像。如〈西洋廟〉載：

> 永嘉胡漢臣，世居西洋。忽為祟所撓，始則揚沙擊石，石之所擊，自門廊洞達臥內，皆鏗然有聲，而壁戶略無小損。既久，則空中與人語。時置糞汙於飲食器皿中，雖買熟物亦皆然。其家良以為苦。……如是幾二年，因飲親戚家，大醉歸。及所居巷口，望見小廟，疑其為祟。乘醉就鄰家假巨斧，碎土偶並香案諸物，鎖鐍其門。自是怪不作。（丙志卷 5，頁 405）

另有一則記載，也說明這種情況，〈石牌古廟〉：

> 浮梁縣外石牌村民胡三妻董氏，以紹興四年六月暴死。慶元元年二月黃昏時，胡三在房內坐，忽困怠如睡，見董來，驚問之曰：「汝不幸下世，將及兩年，何故又到此？」董泣言：「好教你知，舊日有何師者，得一獼猴，縛之高木上，餓數日了，乃煉製熟泥，塑於案上，送入山後古廟，祭以為神。後來成精怪發靈，我遂被他取去。」言訖辭別，胡豁然醒。明日咨訪父老，果得廟，有神像，正所謂獼猴者。即用刃揮擊之，血流滿地，遂毀其室宇。（三志己卷 9，頁 1374）

以上兩則傳說都是民眾有感妖神作祟，甚至取人性命，因而最終的手段就是搗毀神像，以消除靈力。由此可見，靈力的存在與否，最終還是掌握在人的手上。原本各宗教樹立神像的目的，無非是想藉以傳達救世的思想，並透過對神像的膜拜和凝視，反觀自照，產生教化人心的功用；但立基於功利思想的信仰崇拜，卻常以靈力的表現做爲奉祀前提，於是信眾和神明之間，便無可避免的存在一種既熱衷又疏離的矛盾關係。

（二）人神交感

從《夷堅志》所載看來，民眾相信人和鬼神之間是可以相互往來溝通的，人們虔敬的禮拜，神明必然感受得到，神明也會俟機傳達吉凶的徵兆給信眾，而顯現這種人神交感的媒介常常就是神像。例如〈真仙堂小兒〉所載：

> 常州天慶觀真仙堂，塑呂洞賓象，有小兒賣豆，日過其前，見其儀狀，敬仰之，每盤旋不忍去。一日，瞻視歎息間，象忽微動，引手招之，持一錢買豆，兒不取錢，悉以奩中豆與之。象有喜色，以紅藥一粒授焉，使吞服，即覺恍惚如醉。還家，索紙筆作文章，詞翰皆美，至於天文地理，無所不通，不茹煙火食，唯飲酒

啖棗，如是歲餘。（補卷 12，頁 1653）

賣豆小兒尊敬呂洞賓像，感動仙人，仙人因而「象有喜色」授與靈藥，此說固然無稽，但民眾當有深信不疑者。又如〈柳將軍〉載饒州安仁令蔣靜叔明上任後，毀撤許多淫祠，但其中有一座柳將軍廟最靈，因而保留未廢，其後柳將軍託夢蔣氏，表達不敢忘德及感謝之情。（甲志卷 1，頁 2）

在人與神的互動過程中，神明不必然是高高在上，如遇違背常理，不符人情事理者，神明也會聽從人的建議，從善如流；不僅如此，有時人也會義正辭嚴的督責神明應該盡職，這樣才有資格接受奉祀，否則便會遭到「撤屋毀像，舉而投諸江」的懲罰，如〈鎮江都務土地〉：

> 鎮江三酒庫，陳季靈知府日，合於贍軍，每月官課二萬二千緡，數歲後，其入不登。淳熙三年，黃仲秉為守，別出錢萬緡，付節度推官王正邦，使之更張。於是舊都務料理，以土地祠先在務後柏徑中，屋久崩圮，乃建一堂於大門側。廡間一室，內有泥像十數，摧折仆地，蓋故時所奉事者。命塑工整治，就置於新堂，且一歲矣。嘗詣務監王佐者，容色倉惶，趨白云：「醅庫近釀酒五十缸，用糯米百五十石，昨日三十缸忽作臭氣。」邦人視之，皆稠起黃沫，穢不可向，疑酒匠洗米不潔之過。佐曰：「若然，當舉庫皆然，今五而壞三，疑必有異。」邦乃袍笏詣神堂，焚香再拜，正色言曰：「頃以神祠朽敗，故鼎新之，崇奉香火，所冀明靈垂福。今反見怪如此，得非他方不正鬼神，嫉吾務事，故示斯孽？神當出威力驅攘，為人捍患。不然，則是神自為妖，陰有所覬，非吾所以敬事本意也。今與神約，三日為期，返酒如初，當虔賽祀。否則撤屋毀像，舉而投諸江，二者惟命。」既禱，佐以下多竊笑，或悚慮，謂必無益，而反速禍。邦入都廳未幾，攬司吳琛來告：「酒臭稍息，願往視之。」邦不聽而歸官舍。……（明日）邦始至務，視缸中所釀，相蕩作聲，若有人以手掬轉者。少焉，一切與未臭者等，於是具羊豕鵝三牲致奠，仍召僧誦經，以答神貺。（補卷 15，頁 1686-1687）

故事中，官吏整治酒庫附近的泥像，希望「明靈垂福」，但後來卻發現酒缸發臭，官吏便焚香與神約定，限「三日爲期，返酒如初」，其後果然恢復正常。〈武師亮〉中亦載邑有三郎神作祟擲瓦石，武氏呼請道士設醮致敬，但情況未止，最後則喝令神名詬之曰：「汝爲神，當聰明正直，何暴我如是？吾之待汝亦至矣，曾不少悛，恣具邪佷。自今以往，吾不復畏汝矣。」語訖，怪事從此不再發生（丁志卷 3，頁 555）

上述人與神像之間的神秘互動，充分反映出信仰者對神明的理解和領悟。人神交感是維繫宗教信仰關係和確定宗教信仰事實非常重要的經驗依據，在中國傳統氣化論思維下的民間宗教，以爲物類無論是否同類，都有可能藉由不同的手段製造特殊的情境，使彼此交互感應，這是許多宗教共通之處，也是傳達宗教感情與聯結超自然力量重要的基礎。

（三）反射人性

宗教信仰的本質和生存的焦慮是分不開的，一些令人不愉快的感覺如恐懼、孤獨、緊張，甚如疾病、戰爭、死亡等對生命能夠產生嚴重威脅的事情，人類更是無能爲力，因而轉向求助於宗教，[41]因此民眾面對神像的態度是敬畏的，總以爲他們具有超人的力

[41] 瑪麗 • 喬 • 梅多（Mary Jo Meadow）、理查德 • 德 • 卡霍（Richard D.Kahoe）著，陳麟書等譯：《宗教心

量可以掌控人事的種種，既神祕又權威；然而我們只要檢視神明的性格和賜福降禍的標準，卻又發現它實際上是人間社會的反射。進而言之，一切宗教的神聖對象，它們都被人性化、人格化，具有人一樣的好惡和愛憎，喜好人的尊敬，厭惡對它的褻瀆，信仰者可以用種種討好的方式祈求它的幫助，它們也常常因人們對它的褻瀆而發脾氣，對人降禍示警，進行懲戒。所有這一切，待人處事的原則和方式，都是人性化的。[42]

前文引述種種設置神像的目的以及人神間的互動中，我們都可以很明顯的看出民眾賦予造像的意志和神力，其實都是來自人類自我的延伸與強化。神靈如何支配人們的日常生活，取決於人們對神靈的性質和權能的理解，即取決於人們賦予神靈以什麼樣的智慧、意志和權能。[43]〈張子智毀廟〉一則中，便載有這樣的觀點：

> 張子智知常州。……問瘟廟所在，從吏謂必加瞻敬，命炷香設褥。張悉撤去。時老弱婦女，祈賽闐咽，見使君來，爭叢繞環視。張指其中像袞冕者，問為何神，巫對曰：「太歲靈君也。」又指左右數軀：或擎足，或怒目，或戟手，曰：「此何佛？」曰：「瘟司神也。」張曰：「人神一也，貴賤高卑，當有禮度。今既乙太歲為尊，冠冕正坐，而侍其側者，顧失禮如此，於義安在？」即拘四巫還府，而選二十健卒，飲以酒，使往擊碎諸像，以供器分諸剎。（支戊卷 3，頁 1074）

其中「人神一也，貴賤高卑，當有禮度」一語，正是以人間的角度看待神明。再有一例，靖安縣寶峰寺僧堂破敗，長老意欲更新，眾僧以有九梁星煞之禁止之，長老不以爲然曰：「人神一也，皆欲安之，烏有人不可處而神可處乎？」（〈九梁星〉支乙卷 9，頁 863）

綜合前文所述，神像具有和人類相同的各種生理現象，如流汗、垂淚、疼痛、飢餓、情慾等，以及對保護或破壞神像的民眾施予報答或報復，也都是從人類自身的經驗投射到神像身上。故言：神聖對象的「神性」如果本質上不是人性，或者在神性中沒有任何一絲一毫的人性，那麼，神與人之間就沒有任何「共同語言」，不可能進行交際和交流。一切宗教的神聖對象的性能，本質上都是人性的，只不過這種人性在神聖對象身上被神聖化而已。[44]同時，吾人從《夷堅志》所描繪的民間神像經驗中，也會發現，神像不必然被視爲是絕對神聖的，只有能夠符合現實利益及信眾要求者，才得以受到尊崇，血食不斷。

六、結　語

《夷堅志》一書是觀察兩宋民間信仰文化發展非常重要的文獻，固然其中記載許多傳聞中的人神經驗都不免荒誕不經，但如從民俗的角度觀之，它卻包含了豐富的人文素材可供研究。本文從《夷堅志》中所載民眾和神像間的關係中，歸納出以下若干結論：

首先，在設置神像的目的上，最常見的是祈福求願，民眾在現實生活中無法獲得滿足的心意，往往便會藉由祝願祈禱以期實現，這也是庶民信仰生活中最重要的意涵。而人與神像間的互動現象上，常見的情況包括神像具有與人相同的身體經驗，且能透過託夢、杯珓、圓光、現身等方式和人進行溝通；再者，對造像的尊重保護與否，則可能遭致意想不到的福報與咎責，這是民眾出於敬畏，而賦予冥冥中神明無上權威力量的結

理學——個人生活中的宗教》，成都：四川人民，1990，頁 4-5。

[42]呂大吉主編（1989），《宗教學通論》，北京：中國社會科學，頁 117。

[43]同前註，頁 82。

[44]同前註，頁 118。

果；但有趣的是，少數神明卻會因爲有所不足而乞求於人，這又和神明具有無邊靈力的特質相互矛盾。另外，在人與神像間的互動中，官員似乎比較敢於冒犯神靈，原本因入境問俗或聽從勸言，往往也會行禮如儀，但是鬼神只要違情悖理，爲害過甚時，則會給予嚴重的警告和制裁，不過這種現象只出現在位階較低的神明身上。

最後，在民眾對神像的認知和理解上，筆者以爲具有靈力、人神交感及反射人性三點，提供給我們看待民眾信仰生活的不同角度，亦即許多傳說附會固然無法驗證，顯得荒誕不經，或被斥爲迷信無知，但如果從心理和社會的脈絡審視這其中的關係和意義，我們則會發現人與神靈之間的互動和彼此觀照，其實正是人間社會種種關係和意義的投射，在這投射的變化過程中不斷糾纏著複雜的神聖和世俗情結；換言之，只要人類的精神和物質生活無法令人滿意時，這樣的投射心理和行爲便不會完全消失，如此看來，神像不啻爲一個假想物而已，民眾和社會需要面對的恐怕永遠還是自己。

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[5] 張四維（2009）。名公書判清明集（明隆慶三年刻本電子版）。合肥：黃山書社。
[6] 崔默（William Calloley Tremmel）（2000）著、賴妙淨譯。宗教學導論。台北：桂冠圖書。
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對孫子兵法「虛實」篇名現有英文翻譯之研究

On the English Translations of the Title of Chapter Six in Sun Tzu's *the Art of War*

朱文章

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摘　要

在《孫子兵法》，孫子以「虛」、「實」觀念說明戰場瞬息萬變的狀態。書中第六章的陳述內容中，孫子進一步將形勢虛實做一綜合整理，並協助讀者培養對戰場的全局觀念：虛實也者，乃「智將」經由巧妙調度，經營戰場，因而得以趁勢獲致勝利之戰術部署。本文認為現行英譯本並未完全詮釋孫子調度、經營戰爭藝術全貌，並檢查比較當前流行孫子兵法譯本，以突顯孫子「虛實」二字部署、調動之軍事意義。

關鍵詞：孫子，孫子兵法，兵力部署，兵力調動，翻譯

Abstract

In his the Art of War Sun Tzu uses the terms Xu（虛）and Shi（實）to describe the ever changing conditions on the battlefield. Moreover, the title Xu-Shi（虛實）of Chapter Six is emphasized as being the area where the good general can make preparations that will set the stage of battle in his favor and lead to Shi（勢）for his forces, which will then translate to victory. The author argues that translating a culture-loaded text like Sun Tzu's Xu-Shi in a linguistic way does not tackle its entire military meaning, i.e., the deployment and redeployment of the forces in the battlefield. This paper will examine and compare the current English translations of Xu-Shi in Sun Tzu, and tries to fill the "emptiness" caused by these translations and to increase the understanding of the "fullness" of Sun Tzu's the Art of War.

Keywords: Sun Tzu, the Art of War, Deployment, Redeployment, translation

Introduction

It is uneasy to understand the terms Xing(形) and Shi(勢) in *Sun Tzu* despite the existence of an abundant number of modern translations. The difficulty lies in the fact, according to Li Ling, that they have to be totally opposite and independent in meaning, yet they also have to be able to be used symbiotically. As we can see in the choices that translators like Griffith, Ames, Sawyer, McMahon et al. used, their translations did not meet the aforementioned criteria. The gravest error we can make, according to Li, is making them totally alien to one another when in fact they are two sides of the same coin.[1]

Even though Xing is the title of Chapter Four, we do not see the word again until the end of the chapter, and even then it is used more as a metaphor than a well defined term. So when Sun Tzu is discussing Xing, he uses water as a metaphor. When you collect water in a very high and specific spot, it gains Xing, or strength. When it is no longer under tension and released from its confines, it becomes Shi, or momentum. Water that has not been manipulated in any way is formless; there is no structural integrity to speak of. But when it is forced or squeezed into a confined area, it becomes a tangible entity with immediate power and potential momentum. So Shi is the formless water, you cannot see it but you just know that it is there, whereas Xing is water which has a shape and form, the power is immediately palpable. Therefore Sun Tzu concludes at the end of Chapter Five that "as water has no constant form, there are in war no constant conditions. Thus, one able to gain the victory by modifying his tactics in accordance with the enemy situation may be said to be divine."（故兵無常勢，水無常形，能因敵變化而取勝者，謂之神。）[2]

Right after this conclusion, Sun Tzu adds a sentence "of the five elements, none is always predominant; of the four seasons, none lasts forever; of the days, some are long and some short, and the moon waxes and wanes"（故五行無常勝，四時無常位，日有短長，月有死生。）[3]at the very end of Chapter Five which Niu Xian-zhong regards as useless as tits on a boar.[4] Nonetheless, a discussion of the ancient Chinese philosophy of science would be an invaluable aid in understanding *the Art of War*. Sun Tzu modeled his five key factors (introduced in the beginning of Chapter One) after the five elements of classical Chinese science and philosophy, which is similarly how the five Greek elements influenced Western science for many generations. Sun Tzu's ideas may seem esoteric but in the context of Asian culture, it becomes much easier to understand. Much of his explanations involve what we call "complementary opposites," which is the balancing of opposing ideas which makes one dependent on the other. Westerners know this as "yin and yang" and throughout Sun Tzu's writing we can see examples of this: climate and ground create environment, command and methods create an organization, obvious action and surprise create momentum, and so on. For Sun Tzu, understanding competitive systems means working with opposing forces.

[1] 李零（2006）。兵以詐立－我讀孫子。北京：中華書局。頁 169-171
[2] 本論文所引孫子原文請對照李零（2007）。孫子譯注。頁 44
[3] 所引孫子原文請對照：李零（2007）。孫子譯注。頁 44
[4] 紐先鍾（2006）。孫子三論：從古兵法到新戰略。台北市：麥田出版社。頁 101-102

These forces are polarities: pure opposites in their very nature, though one begets the other in a cyclical manner and can only exists in the presence of the other.[5]

Strangely speaking, Li Ling does not complain about the English translations of the title of the following chapter and the equally important but often confused concept known as "emptiness and fullness." Emptiness and fullness is the description of comparative extremes that exists along a continuum of conditions (as opposed to pure polarities). For Sun Tzu, all relative conditions (large/small, fast/slow, near/far, weak/strong, unobstructed/barricaded, etc.) can be simplified into the idea of emptiness/fullness. These extremes are not "forces" but a comparison of the quality of things.

A literal translation of Chapter Six's title produces a result which does not make a lot of sense to the reader, for example, "Weak Points and Strong",[6] "Emptiness and Fullness",[7] or "Vacuity and Substance"[8]. The way we see it, "Xu-Shi" is about as informative a title as we are going to get, given the fact that Sun Tzu himself awkwardness of this title's translation makes us wonder if it is even possible for non-native reader to appreciate the delightful quirkiness of this chapter. In fact, the title of his sixth chapter is actually the Chinese characters for emptiness (poverty, need, etc.) and fullness (abundance, wealth, etc.) which Sun Tzu does not define with great clarity. In Sun Tzu's analysis in the chapter, though, what happens in one continuum affects what happens in the other, so large forces because of their size are slow and empty tracts of land create speed, etc. In this chapter Sun Tzu gives many considerations to the reader about how to go about adapting himself to the real situations in the warzone. In short, this is a matter chiefly of judgment. By pointing out the intricacies of various scenarios with regard to their maneuvering, Sun Tzu is telling the reader that theory is no substitute for firsthand knowledge during a battle. Based on such understanding, it is this paper's intention to examine whose work among the existing English translations better serve to depict the originality of Sun Tzu's "emptiness and fullness" in his mental game.

The Face Value: to Take or Not to Take

Xu-Shi is the term currently used to mean the "real situation" of something. So we see the term scattered throughout the text in books and in Chinese daily life, for example tan-ting jun-zhong xu-shi (探聽軍中虛實, to spy on the enemy's true conditions or plans); bu-zhi xu-shi (不知虛實, do not know whether it is true or false); and tan-tan xu-shi (探探虛實, try to find out the true situation about any opponent)[9]. Its reduplicative rhyming compound word xu-xu shi-shi (虛虛實實, seemingly false and real at the same time, mixture of truth and deceit, mixture of feints and ambushes) can be referred to as the deceitful military

[5] 何炳棣（2002）。有關《孫子》、《老子》的三篇考證。台北：中研院近史所。頁 2-3
[6] Lionel Giles, *The Art of Sun Tzu,* (East Bridgewater: Signature Press, 2007) p. 70
[7] Thomas Cleary, *The Art of War Sun Tzu,* (Boston: Shambhala, 1988) p. 100
[8] Ralph D. Sawyer, *The Complete Art of War Sun Tzu, Sun Pin* (Boulder: Westview, 1996) p. 67
[9] http://www.zdic.net/cd/ci//11/ZdicE8Zdic99Zdic9A302445.htm

maneuverings with which the real situations could not be spied.[10]

Linguistically speaking, Sun Tzu defined "Xu" (虛) in his second and ninth chapter as "scarce" which rings a bell with all these translators' explanation of a status as being "bare, empty, not plentiful or abundant":

- 屈力中原，內虛於家。（Chapter 2）[11]
- 鳥集者，虛也。（Chapter 9）[12]

As to the passage in Chapter Two, Lin Wusun, Huang, and Giles choose the word "bare" for Xu;[13] Ralph Sawyer depicts it as "empty"[14]; three use past participles with similar meanings to describe it: Cheng Lin (depleted), Thomas Cleary (exhausted), and Samuel Griffith (consumed)[15] while John Minford, Roger Ames[16] and Gary Gagliardi adopt adjectives: destitute, nothing in their handlings.[17] To translate the word Xu in Chapter Nine, Ralph Sawyer, Griffith and John Minford use "empty"[18]; Lin Wusun and Giles select "unoccupied"[19], Cheng Lin and Gary Gagliardi find "deserted"[20] suitable, while Thomas Cleary and Huang describe it as "vacated"[21].

By the same token, Sun Tzu defines "Shi" (實) in his ninth and thirteenth chapter as "not hollow; full of matter; solid", exactly opposite to the meaning of Xu (虛):

- 養生處實，軍無百疾，是謂必勝。（Chapter 9）[22]
- 非微妙不能得間之實。（Chapter 13）[23]

Most of the translators handle Shi in Chapter Nine as status "full of something". Like Lin Wusun and Roger Ames: "ample", Thomas Cleary: "plenty of", Ralph Sawyer: "substantial", Samuel Griffith: "firm", Giles: "hard", John Minford and Huang: "solidity."[24] Other translators emphasize their situational perceptions: Gary Gagliardi: "correctly," and Cheng Lin: "taking good care of"[25]. As for the Shi in Chapter 13, all translators but three use the

[10] http://www.zdic.net/cd/ci//11/ZdicE8Zdic99Zdic9A42874.htm
[11] 李零（2007）。孫子譯注。頁 12
[12] 李零（2007）。孫子譯注。頁 63
[13] Lin Wusun, *Sun Zi: The Art of War Sun Bin: The Art of War* (Beijing: People's China Publishing House, 1995) p. 26; J. H. Huang, *Sun Tzu: The New Translation of the Art of War*, (New York: Quill William Morrow, 1993) p. 44; and Lionel Giles, *The Art of War Sun Tzu,* p. 46
[14] Ralph D. Sawyer, *The Complete Art of War Sun Tzu and Sun Pin*, p. 46
[15] Cheng Lin, *The Work of Sun Tzu Tactics and Conquest Popular Known as The Art of War* (Taipei: the World Book Company, Ltd., 2006) p. 11; Thomas Cleary, *The Art of War Sun Tzu,* p. 58; and Samuel B. Griffith, *Sun Tzu The Art of War* (Oxford: Oxford University Press, 1963) p. 72
[16] Roger T. Ames, *Sun-Tzu The Art of War: The First English Translation Incorporating the Recently Discovered Yin-Chueh-Shan Texts*, (New York: Ballantine Books, 1993) p. 108
[17] John Minford, *The Art of War* (New York: Penguin Books, 2002) p. 10; Gary Gagliardi, *Sun Tzu's the Art of War* (Seattle: Cleanbridge Publishing, 2003) p. 28
[18] Sawyer, p. 90; Griffith, p. 118; Minford, p. 55
[19] Lin Wusun, p. 48; Giles, p. 105
[20] Cheng Lin, p. 42; Gagliardi, p. 94
[21] Cleary, p. 134; Huang, p. 84
[22] 李零（2007）。孫子譯注。頁 60
[23] 李零（2007）。孫子譯注。頁 93
[24] Lin, p. 47; Ames, 141; Cleary, p. 132; Sawyer, p. 89; Griffith, p. 117; Giles, p. 99; Minford, p. 233; Huang, p. 81
[25] Gagliardi, p. 87; Cheng, p. 40

same word "truth" for Shi, while the remaining two depict it differently: Cheng Lin: results, and Ralph Sawyer: substance.[26]

In reality, Sun Tzu originally intended for his opus to be regarded primarily as a scientific treatise. He goes to great pains to state accurately the definitions of specific military terms. In terms of military tactics, no other book from Chinese military history mentions how unique the concepts of Xing (strength) and Shi (momentum) are and tackle the importance of Xu-Shi. Shi, its meaning as understood from *Sun Tzu*, is the input of military strength. A general who knows what his capabilities and limits are will strategically spread his limited men and resources around the battlefield so that he extracts the full advantage from them. The layout of the army is called Xing-Shi (形勢). Xing and Shi should be examined as a pair because they mutually affect each other. Basically, Xing is "the comparison of physical capabilities between armies" and Shi is "the momentum necessary to locate and siege the opponent and to take the lead." [27] As we can see, if one has the power of Xing on their side, there is an obvious potential for victory, similar to Goliath and David. Yet having strength is a different matter altogether from knowing how to use it wisely to win a war.

Xing is like a gift you are born with, something that is already in place, a layout or blueprint (i.e. strength) which gives someone general guidance as to what he should do. Shi on the other hand is altering fate. It is a manipulation of your destiny by way of sheer force of will. The relationship which exists between these two is beautifully illustrated by the Game of Go (圍棋). A player can start with good Xing and rely on just that to get him through the initial stages of the game. However, when the going gets tough and your opponent shows that he has a few tricks up his sleeve, Xing is no longer enough and you must struggle with your difficulties by calling upon Shi in order to overcome them. Xing and Shi go hand in hand with strength and momentum. If you are not able to summon Shi, then the momentum will be lost and you are headed for an early grave. Therefore, in the Game of Go, you have a manual with all the rules, which would be Xing. You can have perfect knowledge of the rules but when it comes time to face your opponent, you have to play as if you were born knowing what to do because there is no chance to look up something you do not know. Xing can be explained as being the basic strength which has been cultivated beforehand, and Shi is the skill to implement the momentum to bring about victory.

The most important tactic to keep in mind is that no matter what a player does, he must keep his enemy on their toes when he wants to win the game. He should never risk everything he has on one skirmish, or as it is sometimes put, "don't put all your eggs in one basket." It is dangerous to have only two gears, slow and fast, instead he needs many gears which will allow him to put in or take out soldiers in the battlefield as the enemy becomes stronger or worn down. When they are at their peak, the "regulars" (正) can dissipate their strength and as they become weaker the "reservists" (奇) can deal the finishing blow.

[26] Sawyer, p. 119; Cheng, p. 67
[27] 李零（2006）。兵以詐立－我讀孫子。頁 158-159

Following the logic of a victorious general like Sun Tzu, it is easy to track the tactics he follows and find out the better translations on the related passages scattered in *the Art of War*:

- 實而備之 (Chapter One)[28]
- 進而不可御者，衝其虛也 (Chapter Six)[29]

It obviously takes more than a linguistic approach to manage the situations stated in the above scenarios. The excerpt about Shi in the first chapter has to do with an opponent with full alertness and strong military strength. Sun Tzu urges his readers to be prepared when confronting them. It is therefore hard to understand the translations of Gagliardi[30], and readers will be lost that preparation should be double to confront a strong enemy as Lin suggested[31]. As to the second excerpt in Chapter Six about someone who advances irresistibly like pent-up waters released and plunging into a bottomless abyss, (若決積水於千仞之谿者)[32] it should require words more descriptive or forceful than "weak" or "emptiness;" these translators need do to better describing the momentum the victorious general helps to gain.

Moment of Truth: to Seize or to Let Go

In order to make sure that the thematic focus of Chapter Six is not lost upon us, we have to identify the structure of his arguments by finding out what the premises are and the point that Sun Tzu is trying to make. A casual reader may find it daunting to have to navigate through so many unexplained concepts and is liable to lose perspective of the primary focus of Sun Tzu. For example, if we compare the choice of words the translators use to depict the scenarios of deployment at the battlefield, we find they are consistent to their own linguistic choices that they made in the previous texts:

- 兵之形，避實而擊虛（Chapter Six）[33]
  - To operate the army successfully, we must avoid the enemy's strong points and seek out his weak points. （Lin）
  - War shuns the strong and attacks the weak. （Minford）
  - A force's victory avoids superiority and strikes inferiority. （Huang）
  - So in war, the way is to avoid what is strong and to strike at what is weak. （Giles）
  - Your war can take any shape. It must avoid the strong and strike the weak. （Gagliardi）
  - the army should direct attacks on weakness and avoid strength. (Cheng)
  - the form of a military force is to avoid the full and attack the empty; (Cleary)

[28] 李零（2007）。孫子譯注。頁 5
[29] 李零（2007）。孫子譯注。頁 39
[30] Gagliardi, p.59. Part of the reason for the ambiguity is Garliardi's choice of wrong Chinese word to translate. Here, for example, in his texts it reads, "衝其處也".
[31] Lin might have mistakenly handled the word "備" (to prepare) as "倍" (double). In the context, there is no hint to lead us it takes double efforts to prepare an attack. Lin, p. 24
[32] 李零（2007）。孫子譯注。頁 29
[33] 李零（2007）。孫子譯注。頁 43-44

- The army's disposition of force avoids the substantial and strikes the vacuous. (Sawyer)
- so an army avoids strength and strikes weakness. (Griffith）
- so on the path to victory avoid the enemy's strong points and strike where he is weak.（Ames）[34]

In order to obtain a clearer understanding about Sun Tzu's originality on his winning formula, Xu-Shi, it is necessary for us to follow through from the relations between Xing and Xu-Shi. At the end of Chapter Five, Sun Tzu concludes the power of Shi by using the term Xing and points out that "when he (an able general) shows up (xing it), his enemy is bound to react;" (故善動敵者，形之，敵必從之)[35] In Chapter Six he follows through the idea of the interchangeability between Xing and Shi: "By knowing our enemy's Xing and while keeping ours hidden (to xing enemy and keep us not xinged), we become united while our enemy becomes diffused" (故形人而我無形，則我專而敵分)[36] , "If we can determine our enemy's layout (to have enemy's Xing to be seen) we can better understand where zones of safety and danger are." (形之而知死生之地)[37] and "Thus the supreme layout (the ultimate Xing can be used like physical troops) is an invisible one." (故形兵之極，至於無形)[38]

As we can see here, the concept of using Xing as a verb, "to deploy", has its origins in its use as a noun. When Xing is used as a noun, "the deployment", it is used in the following manner: "The people know that I won with a layout (the Xing with which I won the war)," (人皆知我所以勝之形)[39] but when Sun Tzu uses it as a verb, it becomes "the layout (Xing) used to produce the victorious momentum." (所以制勝之形)[40] In short, when Xing is used as a noun (deployment) it refers to the resources which an army already has at hand, whereas in verb form it becomes a constantly evolving objective which necessitates externally applied manipulation to obtain. Viewed from this perspective, Xing (strength) as a verb is pretty much the same as Shi (momentum), both can be referred to as the deployment and redeployment of forces and sustainment resources from their original locations to a specific operational area for conducting the joint operations contemplated in a given plan.[41]

In short, Xing can be seen while Shi cannot. Shi is in a state of flux and can change at any moment, whereas Xing is more predictable because it refers to the preparation you have already done. If there is one, you can count on the other being there as well. The deployment – "strength and weakness is a matter of Xing."（強弱，形也。）[42]– should be decided upon before the battle by deploying one's forces that one is ready and stronger

[34] Lin, p. 40; Minford, p. 37; Huang, p.68; Giles, p. 77; Garliardi, p. 67; Cheng, p. 30; Cleary, p. 112; Sawyer, p. 71; Griffith, p. 101; Ames, 127
[35] 李零（2007）。孫子譯注。頁 36
[36] 李零（2007）。孫子譯注。頁 39
[37] 李零（2007）。孫子譯注。頁 42
[38] 李零（2007）。孫子譯注。頁 42
[39] 李零（2007）。孫子譯注。頁 42
[40] 李零（2007）。孫子譯注。頁 42
[41] Joint Operations 3.0, http://www.fas.org/irp/doddir/dod/jp3_0.pdf
[42] 李零（2007）。孫子譯注。頁 35

compared to the opponent. Manipulating the deployment of the forces so that they are concentrated where they are needed most is like using a grindstone to crush an egg（以碫投卵）[43].

Emperor Tai of Tang Dynasty (唐太宗 599-649 A.D.) thought so highly of *Sun Tzu* that he considered his famous opus to be the crown jewel of all military pedagogy. Of the chapters in the book, he considered this chapter on Xu-Shi to be the most important. And one sentence in particular impressed Tai: an able general knows how to manipulate the enemy without being manipulated. (故善戰者，致人而不致於人)[44] It is simple yet it conveys a tremendous and extremely important concept at the same time. How well one is able to use Ji-Zheng(奇正) to fight the bigger battles which necessitate the use of Xu-Shi determines the outcome of the war. One needs to know how to use everything, not just one; otherwise he may lose even though it is a relatively simple encounter because he can rely only on strength. By the same token winning a battle deals with the concepts of military strength and strategic momentum and the transfer between the two in regards to troop movement as Sun Tzu points out at the beginning of Chapter Five:

> 孫子曰：凡治眾如治寡，分數是也；鬥眾如鬥寡，形名是也；三軍之眾，可使受敵而無敗，奇正是也。兵之所加，如以碫投卵者，虛實是也。（Chapter Five）[45]

This paragraph at the very beginning of Chapter Five explains how to use your available men to inflict the most damage. In order to do this, an army should be divided into appropriately sized units and be deployed to where they can inflict the most damage. The execution of this involves four steps: (1) knowing the number of soldiers you have: how they are organized (the manner in which this is done remains the same regardless of how small or large the force) and establishing an appropriate chain of command; (2) using appropriate signs and signals (the manner in which it is executed is not affected by the size as well) such as gongs and flags to alert the troops: (3) separating troops into regulars and reservists (to ensure that an attack from the enemy can be sustained without defeat) - which involves moving the appropriate number of troops; (4) the layout of the force, which more specifically refers to sharply concentrating the combat forces in areas where they can do the most damage. Having the force divided into regulars (正) and reservists (奇) means that we can be assured of our own safety and the defeat of the enemy in case of an attack. The focus is on the deployment of forces in a formation which can always shift itself to where they are needed most. No matter where they are, reservists and regulars are able to appear where appropriate.[46]

In this case, the ingredients of military deployment are momentum and organization, using signals, and using reservists and regulars for a small skirmish (Ji-Zheng) or a grand battle (Xu-Shi). Organization and signals are categorized as being a part of an army's strength because they are predetermined and form the foundation of an army's tactics and

[43] 孫子兵法第五章，李零（2007）。孫子譯注。頁 31-37
[44] 紐先鍾（2006）。孫子三論：從古兵法到新戰略。頁 93-94
[45] 李零（2007）。孫子譯注。頁 32
[46] 李零（2006）。兵以詐立－我讀孫子。頁 175-184

strategy. The second, Ji-Zheng and Xu-Shi, are considered momentum. In Ji-Zheng, the mission at hand is usually attacking and capturing an enemy on a small battle site (i.e., smaller-scale combats where there are specific points of engagement that contain only a relative small number of enemies), whereas Xu-Shi is called upon for larger engagements where movement is of utmost importance for a large and potentially cumbersome force that can drown in its own size. In other word, Xu-Shi is used for large scale deployments, which creates very general and broad divisions of troops for fighting in large arenas. Ji-cheng and Xu-Shi are part of momentum because they take the logistical support which form the basis of battle operations and make it into a live battle.[47] Therefore we realize that Chapter Six is the conclusion of Chapters Four to Six and ties these chapters together. In these chapters Sun Tzu uses the term Xing to cover the factors which are visible while Shi to those factors of battle which cannot be seen. Both terms are used to describe a point in time such as a fixed scene on the battlefield. It is in this Chapter Six that Sun Tzu connects all of these dots from the previous chapters and expands to the big picture. With the notion of deployment and redeployment of forces in mind when we come to know Sun Tzu's winning formula of Xu-Shi, the readers therefore can finally compare and decide by and for themselves the meaning that these translations may or may not bring on to them:

- 兵之所加，如以碬投卵者，虛實是也。[48]
  - By staying clear of the enemy's strong points and striking at his weak points, it is able to fall upon the enemy like using a whetstone to crush an egg.（Lin）
  - With an understanding of weakness and strength, an army can strike like a millstone cast at an egg. （Minford）
  - Where forces overwhelm can be like a hard rock cast onto eggs—through contrasts in strength. （Huang）
  - That the impact of your army may be like a grindstone dashed against an egg--this is effected by the science of weak points and strong. （Giles）
  - Your army's position must increase your strength. Troops flanking an enemy can smash them like eggs. You must correctly use both strength and weakness.（Gagliardi）
  - When one delivers attacks on the enemy, the impact should be forcible like a grindstone crushing eggs. In order to be able to do thus, he must ascertain the strength and weakness of the enemy. (Cheng)
  - For the impact of armed forces to be like stones thrown on eggs is a matter of emptiness and fullness. (Cleary)
  - If wherever the army attacks it is like a whetstone thrown against an egg, it is due to the vacuous and substantial. (Sawyer)
  - Troops thrown against the enemy as a grindstone against eggs is an example of a solid acting upon a void. (Griffith）

[47] 李零（2006）。兵以詐立－我讀孫子。頁 230
[48] 李零（2007）。孫子譯注。頁 32

- It is the distinction between "weak points" and "strong points" that makes one's army falling upon the enemy a whetstone being hurled at eggs.（Ames）[49]

A Game Plan: to Deal or Not to Deal

As explained above, there has to be give and take on both sides in a war, even though this may seem counterintuitive. The way to win actually is to do the opposite of what the enemy is doing. This is why Sun Tzu places such a great emphasis on switching between "Xing"(strength) and "Shi"(momentum), which is a method of blunting the enemy's strength by timely deployment and redeployment of forces (Xu-Shi). An adept must be able to react to their enemy's state of preparedness else the war will be just cycle of reoccurring semi-defeats. A decisive victory only comes from using the opposite of what your enemy is doing, whether it is deployment or redeployment.

For Sun Tzu there are three elements to mounting a strategically successful deployment and redeployment. The first is to perform 'Ji'(計) which will tell you what position you are in relative to your opponent, and any relevant information about what contingencies you need to take care of before even going near a sword.[50] The second is 'mou'(謀) which is coming up with the right formula which will put you on the path to victory.[51] The third is 'quan'(權) which is how effectively you are able to implement your plan and how best to use your forces to their maximum potential.[52] None of these elements are mutually exclusive. Anyone of these elements which is not properly dealt with will cause the performance of the campaign to suffer. But what is probably the most crucial element is always being able to see where the wind is blowing, to which Sun Tzu defines it as Xu-Shi.(虛實)[53] An astute general will never cease to stop searching for that indefinable intangible that seems like an insignificant detail but the general will know that adjusting and recalibrating his plans by a minute amount can be the difference between victory and defeat. However this hyper sensitivity to subtle shifts in strength (形) and momentum（勢）only comes with a degree of mastery that is beyond reproach of being able to comprehensively understand the situation and all the other factors relevant to mounting a successful campaign.

After comparing the English translations of Xu-Shi, we find few of the translators tackled the complex idea holistically peculiar to the Chinese tradition. Their formulaic works on Xu (虛) and Shi (實) had not covered the whole process from Ji (計) in the imperial

[49] Lin, p. 34; Minford, p. 25; Huang, p.57; Giles, p. 63; Garliardi, p. 49; Cheng, p. 23; Cleary, p. 93; Sawyer, p. 62; Griffith, p. 91; Ames, p. 119

[50] 孫子兵法第一章:「死生之地，存亡之道，不可不察也。故經之以五，校之以計，而索其情」;「計利以聽，乃爲之勢，以佐其外。」李零（2007）。孫子譯注。頁 2

[51] 孫子兵法第三章:「故上兵伐謀，其次伐交，其次伐兵，其下攻城。攻城之法，爲不得已。」;「必以全爭於天下，故兵不頓而利可全，此謀攻之法也。」李零（2007）。孫子譯注。頁 19

[52] 孫子兵法第一章:「勢者，因利而制權也。」;第七章:「懸權而動。先知迂直之計者勝，此軍爭之法也。」李零（2007）。孫子譯注。頁 5, 50

[53] 孫子兵法第五章:「兵之所加，如以碬投卵者，虛實是也。」;第六章:「兵之形，避實而擊虛」李零（2007）。孫子譯注。頁 32, 44

court to Quan (權) at the ever-changing battlefield. For translators, the difficulty lies in being able to locate two English words, which should be totally opposite and independent in meaning and still be able to be used symbiotically, to depict the abovementioned complex process before and during warfare, as Li suggests.

The main problem is to understand what a Chinese word really means. There is not necessarily just one meaning for a Chinese word for it can evolve and take on several definitions that retain the 'essence' of its original, but in a different variation. The variations may seem unrelated, but they all have a common origin in one word. Before a translator chooses a word, he has to understand it by being acquainted with all of its possible guises. An example which really shows how extreme definitions can get, is the Book of Change (Yi Jing, 易經), "Yi" has three meanings: change, prone to change and *constant*! So, in order to choose the right word the translator has to know all of the possible transformations or otherwise he or she is liable to be completely mistaken about the meaning of the word. No wonder Roger T. Ames laments the fact that we must struggle to understand how Shi (勢) can combine in one idea the following cluster of meanings:

1. aspect, situation, circumstances, conditions;
2. disposition, configuration, outward shape;
3. force, influence, momentum, authority;
4. strategic advantage, purchase[54]

Therefore if a translator looks closely at the way *the Art of War* is written, he or she will realize that there is something unusual about it. There is no discernible evidence of grammar; it almost looks like a free improvisation of words. What we must understand is that Chinese scholars were not especially concerned with trying to put together perfectly formed sentences. It is not because they were undisciplined or did not care about clarity, rather it was just a different way of presenting information, according to Gong Peng-cheng (龔鵬程). Gong asserts that ancient Chinese writers relied on having a few key words in a sentence filling in the details. They reasoned that if readers understood the main words, then the rest of it will be self explanatory. There were specific words used just for the purposes of being adverbs or signifying a change of tone. Also, the words were not linked by declensions or inflexions which are why readers do not see any evidence of subject-object agreements and so forth. And if the writers needed to express something which there was not a word for, they just combined old words for it and you still have to infer the meaning from the words themselves since there is no grammar. If the readers do not look at it holistically, they will never understand it.[55]

Because of the confusing nature of these culture-loaded words, it seems that we do not find a clearer military doctrine in *Sun Tzu* like we do in western military philosopher like Clausewitz. In *Sun Tzu*, many words are used to define other words, and often it does not

[54] Roger T. Ames, *Sun-Tzu The Art of War: The First English Translation Incorporating the Recently Discovered Yin-Chueh-Shan Texts*, (New York: Ballantine Books, 1993) p. 73

[55] 龔鵬程（1993）。文化符號學。台北：台灣學生書局。頁 131-133

seem like there is any logical foundation, but this is not the case. The culture-loaded texts are based on having numerous possibilities for each word, like Shi (勢) as Ames mentioned, so the translator has to be able to anticipate what a word might mean based on his own intuition and insight. In situations where the word 'Shi' is concerned, Chinese readers understand implicitly that the word has a primary, universally accepted meaning with the possibility of alternative secondary meanings that must be entertained and perhaps be used concurrently with the more popularly accepted way of understanding it. This has implications for how this word should be translated because the preference for a simple translation could result in neglecting all the possibilities which would contribute to a more accurate understanding.

Hans Robert Jauss, a well-known German scholar for his Aesthetics of Reception and his contribution on reader-oriented theories, uses the term 'horizon of expectations' to describe the criteria readers use to judge literary texts in any given period. Before a reader can begin to understand a work of another, according to Jauss, they have to come to terms with how their own feelings and ideas have already formed preconceived notions which become limitations to how much they can gain from the perspective of another. The author is limited only by what their imagination; it is up to the reader to figure it out what the author is saying, and then understand it through their own perspective. How a certain idea is perceived can be as varied as all the people who encounter it, because they all bring to bear their own preconceived notions and based on that form a unique personal opinion. A translator goes through this process as well, they have over time become a product of their environment and it influences everything. But the original horizon of expectations tells us how the work was valued and interpreted when it appeared, but does not establish its meaning finally;[56] therefore, when dealing with the culture-loaded text like Sun Tzu's Xu-Shi, whatever education or cultural background the translator comes from will find its presence in some way shape or form in their work.

It is advisable to include as diverse as possible definitions of the word so that every conceivable scenario is covered, even at the risk of overwhelming the reader, as this is preferable to leaving them in the dark. The meaning of a scenario described in *Sun Tzu* may not be obvious to foreign readers, but to a Chinese veteran it will be as he knows how to navigate through all the possible definitions and uses of the words and understanding the full meaning of them. So the Chinese do not have to go to a great deal of trouble to prove a point on these culture-loaded words like Xu-Shi by means of complicated conjectures. The only duty any translator bears is that of finding a simple way of presenting Sun Tzu's most profound thoughts without confusing readers.[57] By the same token, translation unit will be

[56] Raman Selden and Peter Widdowson, *A Reader's Guide to Contemporary Literature Theory, 3rd Edition,* (Lexington, Kentucky: The University Press of Kentucky, 1993) p. 53

[57] 孟祥德（2007）。《孫子兵法中「勢」的語篇意義及英譯》。蘇州大學碩士學位論文。頁：59

culture and the translation from one culture into another is intercultural translation.[58] The skill of a translator is displayed not just in his ability to say something in another language, but also in his ability to say it as if the author was not a foreigner but writing as if he were a fellow countryman. Unfortunately transmitting the kind of feeling that the original language version gives to the reader into a foreign translation is not surprisingly very difficult to do. One of the most prized characteristics in the original that gives its brilliance and soul-searching profundity is the powerful rhetorical style which Sun Tzu employs in *the Art of War*. There is no adequate substitute; it is hard to reproduce the immediacy and the evocative nature of the rich and dense vocabulary without resorting to all kinds of explanations which impede the flow of the ideas to the reader. This is one of the primary cultural stumbling blocks which must be dealt with in order for the translation to manifest the beloved *Sun Tzu* that original language readers have cherished for ages and take for granted.

Another concern which gives translator's sleepless nights is how to make sure their own cultural bias does not affect the integrity of the original.[59] Every translator carries with him not only the technical knowledge and skill necessary, but a strong cultural predilection which permeates every facet of their life including their work. They impose upon the translation their own preconceived ideas about what is important and what can be left out, not purposefully but as a byproduct of cultural conditioning that has been rooted deep in their psyche. Western translators tend to fail to recognize or try to bring to bear the powerful rhetorical presence of Sun Tzu's writing and how dynamic the work becomes as a result of it, yet they are good at reproducing details which may be important in their own right but this a very crucial element to understanding and appreciating Sun Tzu.

Conclusion

No idea stays the same, for readers now and in the future. It is constantly being shaped and interpreted by those who encounter it and bring to bear their own personal opinions. The ideas of various authors are constantly being challenged by others and will continue to be as long as we are in a state of evolution with respect to humanity. Our understanding of *Sun Tzu* is perpetually changing which also means no one can ever know everything. By the same token, translators will forever be reinterpreting classics that have been translated many times before and will in the future be translated again and again. Every stage in human history brings with it the ideas which have been formed according to the cultural aesthetic of

[58] Some scholars claim that "words only interest the translators in so far as they are elements of the text – only texts can be translated, never words." Wee J. A. Naudé, *An Overview of Recent Developments in Translation Studies with Special Reference to the Implications for Bible Translation,* http://www.ajol.info/index.php/actat/article/viewFile/5454/29592 p. 48

[59] 黃麗雲（2008）。傳輸中的文化：《孫子兵法》文化負載詞英譯研究。福建師範大學碩士學位論文。頁 ii-iii

the time and it is always a little different from what came before.[60] This is why a translation must be periodically updated, so it can reflect how the latest developments in values and ideas have affected our understanding of it.

A translator, being a bilingual mediating agent, does more than just finding words in a dictionary. If that is all that there is then anyone could do the job. As much as a translator's job is to understand the language itself, he must also recognize the subtle differences in nuances between different languages and be able to offer a sharp and clear relief of the various shades of these linguistic features. A person talking in their own native tongue will not know as well as someone new to the language – when they say something they omit many details, which they do subconsciously, since it is implicit in the language and everyone knows it. This is where the art of the translator comes into play; they have a heightened sensitivity towards these tiny discrepancies that native speakers take for granted and they are able to account for these missing details when doing their work. This is just one example of how important it is for the translator to have enormous respect and sensitivity for not leaving even the most mundane details to chance, because leaving no stone unturned is the only sure way that they have of making sure understanding is mutual.[61]

Even though it was written 2,500 years ago *The Art of War* is anything but a dinosaur, which is more than can be said for many other important books written more recently yet which have been long forgotten. It was written during a time of turmoil and political instability, and in order to be relevant it had to give meaningful advice which wise generals could use without any confusion. This is why the concept of "Xu-Shi" is so pervasive and so powerful in *The Art of War*.

Xu-Shi, as mentioned, is the description of comparative extremes that exists along a continuum of conditions (as opposed to pure polarities). It is up to a victorious general to outmaneuver his enemy with this knowledge. The concept is not only effective, but it is completely practical and devoid of any pretense of insincere complexity which is usually done for vanity's sake. When Sun Tzu depicts the art of "Xu-Shi" it is out of a practical goal to deploy his troops and not necessarily to seem fancy or philosophical which the modern English translations might lead readers to believe. That is why everything has to be taken in context of a "Xu-Shi" which does not preclude anything, not even misunderstanding, as long as it leads to victory.

Sun Tzu gives us a sense of the seriousness with which he approached his subject, the deployment, redeployment, and sustainment of forces participating in the battlefield. The premise of Chapter Six, strategic ambiguity seems unnecessarily esoteric but it is actually very important. It is about trying to make our enemy think that we are doing something when in reality we are doing something else or nothing at all. The actual execution in real live battle will determine how effective it is. Sun Tzu tells us that the differences between

[60] 張愛華（2003）。從接受理論角度論重譯現象---《孫子兵法》兩個譯本的比較研究。對外經濟貿易大學碩士論文。頁 61

[61] 徐娟（2007）。從文化角度對《孫子兵法》兩個譯本的對比分析。重慶大學碩士學位論文。頁 29-30

Xing (strength) and Shi (momentum) are so subtle that even his troops are in the dark about what really was responsible for their victory. Even though at first glance it may appear that Xing, which is visible, was responsible for their victory it was actually Shi which was created from the strength that gave us our win. Understanding this is the key to unlocking the power of Xu-Shi in Chapter Six.

If Xu-Shi has so much to do with the relocation of forces and materiel to desired operational areas[62], it helps a modern reader to appreciate Sun Tzu more if he has decent background knowledge toward his *The Art of War*. It is strange for anyone to claim he knows Plato, Aristotle, or Machiavelli if he does not possess any solid knowledge about a philosophical king, a political animal, or an armed prophet. Similarly, there is a long way for foreign readers to go if they want to understand Sun Tzu through merely relying on the existing English translations which handle Sun Tzu's core concepts only linguistically, not militarily.

[62] This is the formal definition of "deployment" US Department of Defense defines. See http://www.fas.org/man/dod-101/army/docs/fm101-5-1/f545-d.htm

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清雲科技大學《清雲學報》徵稿辦法

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