

**ADAPTIVE AND AUTOMATED  
PERSONALIZED PHOTO COLLECTION  
MANAGEMENT SYSTEMS**

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DEPARTMENT OF ELECTRICAL ENGINEERING  
INDIAN INSTITUTE OF TECHNOLOGY DELHI

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PERSONALIZED PHOTO COLLECTION  
MANAGEMENT SYSTEMS**

by

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DEPARTMENT OF ELECTRICAL ENGINEERING

Submitted

in fulfillment of the requirements of the degree of Doctor of Philosophy

to the



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To my family

# Certificate

This is to certify that the thesis titled **Adaptive and Automated Personalized Photo Collection Management Systems** being submitted by **Mrs. Vandna Bhalla** to the **Department of Electrical Engineering**, Indian Institute of Technology Delhi, for the award of **Doctor of Philosophy** is a record of bona-fide research work carried out by her under my guidance and supervision. In my opinion, the thesis has reached the standards fulfilling the requirements of the regulations relating to the degree. The work presented in this thesis has not been submitted elsewhere, either in part or full, for the award of any other degree or diploma.

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Vandna Bhalla

# Abstract

The burgeoning of low priced affordable multimedia devices has resulted in an unprecedented escalation of personal data which may or may not be interrelated. Since the storage is highly unstructured consequently the retrieval too is laborious. A multitude of prevailing algorithms result in good classification accuracy but they require abundant training data which needs to be labelled. The data set sizes are for ever increasing but acquiring the label information for these data is a demanding and complicated task. Additionally all categories in a personal repository may not have adequate training data size. We design and develop Innovative Hybrid Personalized Classifier Architectures which give appreciable results when working with small sized labelled and unlabelled datasets specifically in the domain of personal photo collections. The approaches of the generative models in the past have not only been non scalable and inefficient but to a large extent inflexible too. We show that our generative hybrid deep frame work utilizing artificial immune system principles provides a highly competitive approach for learning, recognition and classification.

We propose the following novel techniques: 1) Design and development of an Artificial Immune System Inspired Hybrid Personalized Classifier(AIHC) capable of learning from small size datasets, tried and tested in the domain of personal photo collections. 2) Evolving this Architecture for classifying small datasets in a supervised environment by integrating with machine learning, a Hybrid CNN-AIHC Pattern recognition Engine and Classifier. 3) Extending the design of the evolved intelligent AIHC to perform in a Semi Supervised environment and 4) Study and implementation of a Unsupervised novel model which automatically identifies a particular individual's *photoclusters* on the basis of photo profile information and the arrangement

of a graphical structure networking the various photos.

The existing literature has been reviewed extensively and the current challenges were identified at the onset of our research. We present optimistic resolutions and also share futuristic recommendations. The proposed architecture, its extensions and techniques have been tested on small repository of personal photo album with very inspiring results indicating that the hybrid architecture can culminate into a very competitive and robust model for learning and classifying small size datasets in all three, Supervised, Semi Supervised and Unsupervised, environments.

## सार

कम कीमत वाले किफायती मल्टीमीडिया उपकरणों की बढ़ती के परिणामस्वरूप व्यक्तिगत डेटा की अभूतपूर्व वृद्धि हुई है जो कि इससे संबंधित हो सकता है या नहीं। चूंकि भंडारण अत्यधिक अनियंत्रित है जिसके परिणामस्वरूप पुनर्प्राप्ति भी श्रमिक है। प्रचलित एल्गोरिदम की भीड़ के परिणामस्वरूप अच्छी वर्गीकरण सटीकता होती है लेकिन उन्हें प्रचुर मात्रा में प्रशिक्षण डेटा की आवश्यकता होती है जिसे लेबल करने की आवश्यकता होती है। डेटा सेट आकार हमेशा बढ़ रहे हैं लेकिन इन आंकड़ों के लिए लेबल जानकारी प्राप्त करना एक मांग और जटिल कार्य है। इसके अतिरिक्त व्यक्तिगत भंडार में सभी श्रेणियों में पर्याप्त प्रशिक्षण डेटा आकार नहीं हो सकता है। हम इनोवेटिव हाइब्रिड पर्सिलाइज्ड क्लासिफायर आर्किटेक्चर का डिजाइन और विकास करते हैं जो विशेष रूप से व्यक्तिगत फोटो संग्रह के डोमेन में छोटे आकार के लेबल वाले और अनलॉक किए गए डेटासेट के साथ काम करते समय सराहनीय परिणाम देते हैं। अतीत में जनरेटिव मॉडल के दृष्टिकोण न केवल स्केलेबल और अक्षम हैं बल्कि काफी हद तक भी लचीले हैं। हम दिखाते हैं कि कृत्रिम प्रतिरक्षा प्रणाली सिद्धांतों का उपयोग करने वाले हमारे जनरेटिव हाइब्रिड गहरे फ्रेम कार्य सीखने, मान्यता और वर्गीकरण के लिए एक अत्यधिक प्रतिस्पर्धी दृष्टिकोण प्रदान करते हैं।

हम निम्नलिखित उपन्यास तकनीकों का प्रस्ताव देते हैं: 1) एक कृत्रिम प्रतिरक्षा प्रणाली के डिजाइन और विकास प्रेरित हाइब्रिड व्यक्तिगत वर्गीकृत (एआईएचसी) छोटे आकार के डेटासेट से सीखने में सक्षम, व्यक्तिगत फोटो संग्रह के डोमेन में कोशिश की और परीक्षण किया। 2) मशीन लर्निंग, एक हाइब्रिड सीएनएन-एआईएचसी पैटर्न मान्यता इंजन और क्लासिफायरफायर के साथ एकीकृत करके पर्यवेक्षित वातावरण में छोटे डेटासेट को वर्गीकृत करने के लिए इस आर्किटेक्चर को विकसित करना। 3) एक अर्द्ध पर्यवेक्षित वातावरण में प्रदर्शन करने के लिए विकसित बुद्धिमान एआईएचसी के डिजाइन को विस्तारित करना और 4) एक अप्रशिक्षित उपन्यास मॉडल का अध्ययन और कार्यान्वयन जो फोटो प्रोफाइल जानकारी के आधार पर स्वचालित रूप से किसी विशेष व्यक्ति के "फोटो क्लस्टर" की पहचान करता है और विभिन्न तस्वीरों को नेटवर्क करने वाली एक ग्राफिकल संरचना की व्यवस्था।

मौजूदा साहित्य की समीक्षा व्यापक रूप से की गई है और वर्तमान शोधों की पहचान हमारे शोध की शुरुआत में की गई थी। हम आशावादी प्रस्ताव प्रस्तुत करते हैं और भविष्य की सिफारिशों को भी साझा करते हैं। प्रस्तावित आर्किटेक्चर, इसके विस्तार और तकनीकों का परीक्षण व्यक्तिगत फोटो एलबम के छोटे भंडार पर बहुत प्रेरणादायक परिणामों के साथ किया गया है, यह दर्शाता है कि हाइब्रिड आर्किटेक्चर तीनों, पर्यवेक्षित, सेमी में छोटे आकार के डेटासेट सीखने और वर्गीकृत करने के लिए एक बहुत प्रतिस्पर्धी और मजबूत मॉडल में समाप्त हो सकता है। पर्यवेक्षित और अप्रशिक्षित, वातावरण।

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