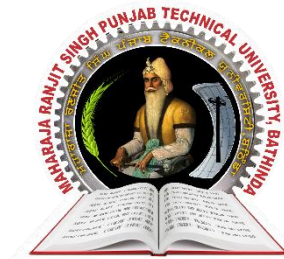


A FRAMEWORK FOR OFFLINE HANDWRITTEN DEVANAGARI WORD RECOGNITION

**A THESIS
SUBMITTED TO**



**MAHARAJA RANJIT SINGH
PUNJAB TECHNICAL UNIVERSITY
BATHINDA (PUNJAB)**

**IN FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN
FACULTY OF ENGINEERING & TECHNOLOGY**

By

SUKHJINDER SINGH
Regd. No. 1610AMPE01

Department of Electronics & Communication Engineering
MAHARAJA RANJIT SINGH PUNJAB TECHNICAL UNIVERSITY
BATHINDA-151001 (PUNJAB), INDIA

(2023)

CANDIDATE'S DECLARATION

I, **Sukhjinder Singh** hereby certify that the work which is being presented in this thesis entitled “**A Framework For Offline Handwritten Devanagari Word Recognition**” in partial fulfillment of the requirements for the award of degree of the **DOCTOR OF PHILOSOPHY** in the **Faculty of Engineering & Technology** and being submitted in **Department of Electronics & Communication Engineering at Maharaja Ranjit Singh Punjab Technical University, Bathinda-151001 (Punjab)**, is an authentic record of my own work carried out during a period from **Sept. 2016 to July 2023** under the kind guidance and supervision of **Prof. (Dr.) Naresh Kumar Garg**, Professor, Department of Computer Science & Engineering, Giani Zail Singh Campus College of Engineering & Technology, MRSPTU, Bathinda-151001 (Punjab).

The matter embodied in this thesis has not been submitted either in part or full by me to any other University or Institute for the award of any degree.

Date: _____

(Sukhjinder Singh)

Place: _____

Regd. No. 1610AMPE01

This is to certify that the above statement made by the candidate is true to the best of my knowledge and belief.

Prof. (Dr.) Naresh Kumar Garg
Professor, Deptt. of Computer Sc. & Engg.
GZSCCET, MRSPTU, Bathinda
(Supervisor ID: S107M72006)

The final Ph.D. defending/viva-voce examination of **Mr. Sukhjinder Singh** has been held on _____ and accepted.

(Signature of the Supervisor)

(Signature of the External Examiner)

(Signature of the HoD)

ACKNOWLEDGEMENTS

It was a great relief, when I collected the courage and went to **Prof. (Dr.) NARESH KUMAR GARG** to supervise my work and he agreed. It was lovely and fruitful working with him. I learnt a lot even beyond my thesis work the things to be in the kitty of a committed educationist. His advice at crucial times had been very handy to me. His sustained friendly help and healthy criticism throughout this work has been marvelous. I am thrilled having completed my work successfully. A supervisor motivating his students through every possible means including phone calls, is unparalleled.

I owe my heartfelt sincerest gratitude towards **Dr. MUNISH KUMAR**, Associate Professor, Deptt. of Computational Sciences, MRSPTU, Bathinda for his valuable motivation which helped me a lot. Also thanks to him, due to those enlightening discussions during paper writing and technical details. Without his encouragement and patience, this work could not have been completed within this time. A number of publications from this work are a handiwork of his sustained motivation. I also hereby express my sincere gratitude to **Dr. NEERAJ GILL**, Associate Professor & Head, Deptt. of ECE, GZSCCET-MRSPTU, Bathinda for giving me the opportunity to work in the area of my choice. His systematic and persuasive style of working has a great impact on my teaching skills to a considerable extent.

I shall be failing in my duty, if I don't thank **Prof. (Dr.) JYOTI SAXENA**, Ex-Professor, Deptt. of ECE, GZSCCET-MRSPTU, Bathinda due to her ever untiring supportive nature, she has always been encouraging me even having extended the discussions several times much beyond the duty hours. I would also like to thank **Prof. (Dr.) SAVINA BANSAL** and **Prof. (Dr.) RAKESH KUMAR BANSAL** for their constructive criticism which fueled my thesis work. They always says, "*A mind developed using best engineering means does not cave in but rather work with maximum efficiency under pressure*". These words inspired me to adapt the challenges of life and remained focused.

I would also like to thank and acknowledge my gratitude to **Dr. MANOJ SHARMA** who has been cooperative to me with his technical support and motivation in hard times. I also hereby express my sincere gratitude to **Prof. (Dr.) ASHOK KUMAR GOEL**,

Dr. AVTAR SINGH BUTTAR, Dr. KAMALJIT SINGH BHATIA, Dr. SHWETA RANI, Er. NIKITA SEHGAL PURI and other faculty of my parent, CSE and CS departments for their kind support and unyielding encouragement. I am also thankful to Er. Rekha Garg, Sh. PS Aulakh, Sh. Rajinder Singh, Ms. Karamjit Kaur and other staff members of my parent and CSE departments for their obstinate support.

I also hereby express my sincere gratitude to **Prof. (Dr.) BUTA SINGH SIDHU, Hon'ble Vice Chancellor, Registrar, Dean (R&D), Dean (Academic Affairs), Dean Faculty (Engg. & Tech.), CoE, Professor In-Charge (Finance), Professor In-Charge (ITES), Professor In-Charge (Library), Dean (Consultancy & Industry Linkage), HoD (CSE), HoD (CS), DDRC Members, BoS Members, URB Members, Academic Council Members and other Authorities of Maharaja Ranjit Singh Punjab Technical University, Bathinda** for giving me an opportunity to work in the area of my choice.

I would also like to thank my colleagues and friends especially Dr. Amrit Pal, Dr. Haramritpal Singh Sidhu, Dr. Veena Sharma, Dr. PS Bullar, Dr. Amit Singla, Dr. Sudhanshu P. Singh, Harpreet, Ruchika, Rahul Menon, Baljeet Brar, Darshan, Deepi, Navdeep, Raman, Lakhan and Vicky who helped me during my thesis work. I would also like to thank everyone who has knowingly and unknowingly helped me throughout this work and arranged some valuable old research papers for me as and when required. To those I am sure to miss out, my sincerest apologies.

I find it difficult to verbalize my deepest sense of indebtedness to my beloved parents **SARDAR BALJINDER SINGH** and **SARDARNI PARWINDER KAUR** who encouraged me to pursue higher education and supported me throughout the highs and lows in my career and also for their boundless love, blessings, affection and moral support. I also owe respects to father-in-law **S. HARWANT SINGH** and mother-in-law **BALJEET KAUR**, who always showed their blessings on me.

I would like to express my heartfelt gratitude to my dear wife **MANPREET KAUR** for her unwavering support and understanding throughout the entire journey of completing this thesis. Her love, patience and encouragement have been instrumental in overcoming challenges and persevering through the demanding research process. Her presence and belief in my abilities have been a constant source of motivation, inspiring

me to strive for excellence. I am truly grateful for the sacrifices she have made and the countless hours of understanding and support she have provided. Thank you for being my pillars of strength and for always standing by my side.

The naughty moments of beloved daughter **MANRAJ KAUR (NIKKU)** during this period particularly during the code, manuscript and thesis writing work has made this thesis memorable. Her stubborn quarrels for taking over my laptop and then charming face for paint app can't be felt through any camera or movie. She has been my cheerleader, my sounding board and my guiding light. Her bright smile and infectious enthusiasm have lifted my spirits and reminded me of the importance of perseverance.

I express my deep gratitude to my sisters **MANPREET** and **VEERPAL** for sharing some very odd and even moments during the period. I also owe respect to my brothers-in-law **KAMALPREET** and **RAJINDER** for always posing great confidence and instilling faith in me. I am eternally grateful to **HARMEET, PREET** and **HARINDER** from my in-laws' family for their boundless love, unwavering support and constant encouragement throughout my thesis journey. The bright spirits, infectious laughter, and boundless energy of my beloved nephews-**NOOR, KARAN** and **HARVEER** have been a constant source of inspiration for me during this work.

At places work has been taken from various publications dully listed in the bibliography, I express my unconditional words of gratitude for the **AUTHORS OF ALL THOSE BOOKS AND PAPERS** which I have been consulted during my thesis work as well as for preparing the report. I express appreciation to all of them. I extend my heartfelt appreciation and gratitude to the **DEDICATED WRITERS** who have contributed their words for the preparation of the dataset used in the experimentation work. I am immensely grateful for the invaluable contribution and for sharing their creativity in the form of dataset. Thank you for their invaluable contribution and for being an integral part of this research journey.

I would like to express my deepest gratitude to the esteemed External Examiner - **Dr. SURENDER SINGH SAINI**, Sr. Principal Scientist, CSIR-CSIO, Chandigarh for his invaluable contribution and expertise in evaluating and examining my thesis. His insightful feedback, constructive criticism and thorough assessment have immensely enriched the quality and depth of my research. I am truly grateful for his time,

dedication and commitment to ensuring the rigor and integrity of my work. His valuable insights and suggestions have played a pivotal role in shaping the final outcome of my thesis. I extend my sincerest appreciation for his professionalism, guidance and expertise, which have greatly contributed to my academic and personal growth.

Last but not least, thanks to the **ALMIGHTY** for bestowing self-confidence, strength and ability in me to complete my thesis work.

(Sukhjinder Singh)

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LIST OF ABBREVIATIONS

AdaBoost	Adaptive Boosting
ACNN	Alexnet Convolutional Neural Network
ASCII	American Standard Code for Information Interchange
AUC	Area Under the Curve
ANN	Artificial Neural Networks
BPNN	Back Propagation Neural Network
BayesNet	Bayesian Network
BLSTM	Bidirectional Long-Short Term Memory
BLSTM-NN	Bidirectional Long-Short Term Memory Neural Network
CF-BPN	Cascade-Forward Back Propagation Network
CMQDF	Compound Modified Quadratic Discriminant Function
CPD	Compound Projection Distance
DT	Decision Tree
DCNN	Deep Convolutional Neural Networks
DDD	Directional Distance Distribution
DEF	Directional Element Features
DCT	Discrete Cosine Transform
DiscCNN	Discriminative Convolutional Neural Network
DP	Dynamic Programming
EM	Elastic Matching
E-BPN	Elman Back Propagation Network
ED	Euclidean Distance

XGBoost	eXtreme Gradient Boosting
ELM	Extreme Learning Machine
FS	F1-Score
FAR	False Acceptance Rate
FN	False Negative
FP	False Positive
FRR	False Rejection Rate
FF-BPN	Feed Forward Back Propagation Network
FFNN	Feed-Forward Neural Network
F-ratio	Fisher-ratio
FD	Fourier Descriptors
FURIA	Fuzzy Unordered Rule Induction Algorithm
Gaussian NB	Gaussian Naive Based
GFIPML	Generic Feature Independent Pyramid Multilevel Model
GBDT	Gradient Boosted Decision Tree
GLAC	Gradient Local Auto-Correlation
GSC	Gradient, Structural and Concavity
GHa	Guo-Hall
HCR	Handwritten Character Recognition
HDWR	Handwritten Devanagari Word Recognition
HWR	Handwritten Word Recognition
HMM	Hidden Markov Models
HFS	Hierarchical Feature Selection

HOG	Histogram of Oriented Gradients
IHOD	Integral Histogram of Oriented Displacement
KNN	K-Nearest Neighbor
LKC	Lee-Kashyab-Chu
LibLINEAR	Library for Linear classifier
LDA	Linear Discriminant Analyses
LDF	Linear Discriminant Function
LBP	Local Binary Patterns
LR	Logistic Regression
MV	Majority Voting
MCC	Matthew's Correlation Coefficient
MoS	Mean Opinion Score
MA	Memetic Algorithm
MED	Minimum Edit Distance
MIL	Mirror Image Learning
MLCNN	Modified Lenet Convolutional Neural Network
MPD	Modified Projection Distance
MQDF	Modified Quadratic Discriminant Function
MLP	Multi-Layer Perceptron
ML	Multi-Level
NB	Naive Bayes
NC	Nearest Centroid
OSI	Offline Script Identification

OVO	One-Versus-One
OCR	Optical Character Recognition
ORB	Oriented Fast and Rotated BRIEF
PR	Precision
PCA	Principal Component Analysis
PNN	Probabilistic Neural Network
PD	Projection Distance
PHOG	Pyramid Histogram of Oriented Gradients
PML	Pyramid Multi-Level
QTLR	Quad-Tree-based Longest Run
RBF-SVM	Radial Basis Function- Support Vector Machine
RF	Random Forest
RC	Recall
RA	Recognition Accuracy
ROVER	Recognizer Output Voting Error Reduction
RR	Reduction Rate
RE	Regular Expressions
RLE	Run-Length Encoding
SIFT	Scale-Invariant Feature Transform
SM	Sensitivity Measurement
SL	Simple Logistic
SURF	Speeded Up Robust Feature
SCF	Statistical and Contour based Features

SGD	Stochastic Gradient Descent
SRF	Sub-stroke-wise Relative Feature
SVM	Support Vector Machine
TM	Thinness Measurement
TN	True Negative
TP	True Positive
TPR	True Positive Rate
VGG16	Visual Geometry Group
WOAR-SVM	Weighted One-Against-Rest Support Vector Machine
ZSu	Zhang-Suen
ZSDP	Zone-wise Slopes of Dominant Points
ZSD	Zone-wise Structural and Directional