OPTICAL CHARACTER RECOGNITION PREDICTION USING MACHINE LEARNING

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Abstract: Optical Character Recognition (OCR) is a key research area in the field of machine learning and artificial intelligence, with significant applications in digitizing handwritten documents, postal systems, banking, and more. The advent of Convolutional Neural Networks (CNNs) has significantly improved the accuracy and efficiency of handwritten character recognition. Traditional methods, which relied on feature extraction and classification techniques, have struggled to maintain high accuracy across different writing styles and diverse character sets. In contrast, CNNs excel at learning hierarchical features directly from raw pixel data, making them highly effective for image-based tasks such as character recognition. This paper explores the use of CNN algorithms for handwritten character recognition, providing an in-depth analysis of existing systems, their limitations, and the proposed improvements. By utilizing deep learning techniques, the model improves upon previous systems by achieving higher accuracy, robustness against noisy data, and greater adaptability to various writing styles. Additionally, the proposed system integrates data augmentation techniques to further enhance the model's generalization capability, enabling it to perform well on unseen handwritten samples.

Keywords: CNN architecture for character recognition,OCR using convolutional neural networks,deep learning OCR handwritten,CNN for OCR,document digitization with CNN,banking OCR automation CNN, OCR in postal systems deep learning.

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INTRODUCTION

Optical Character Recognition (OCR) is the automated process identifying handwritten characters, with uses in document digitization, form processing, and more. Handwriting recognition is challenging due to variations in style, distortions, and noise. Early OCR relied on manual feature extraction and classical machine learning algorithms like K-NN, SVM, and decision trees, which performed well on controlled data but struggled with real-world variability. The advent of Convolutional Neural Networks (CNNs) has significantly improved OCR accuracy. CNNs automatically learn features from raw images, eliminating the need for manual extraction. Their architecture comprising convolutional, pooling, and fully connected layers enables them to detect patterns, reduce data complexity, and classify characters effectively. CNNs handle diverse handwriting styles and noisy inputs better than traditional methods and scale well across languages and writing systems

1.CONVOLUTIONAL NEURAL NETWORK CNNs are powerful neural networks designed specifically for processing grid-like data, such as images. These models are especially effective in visual recognition tasks due to their ability to automatically detect essential patterns within images. By applying filters that scan across the image in horizontal and vertical directions, CNNs capture distinct features edges, textures, shapes which are later used to identify the contents of the image, be it a human organ, an anomaly, or something else entirely. CNNs are resilient to transformations such as rotation, scaling, or translation, making them well-suited for real-world image data.

2.MACHINE LEARNING Machine Learning (ML) is a branch of AI that enables computers to learn from data and make predictions or decisions without explicit programming. Unlike traditional programming, where rules are predefined, ML algorithms learn patterns from data to improve performance over time. For example, instead of teaching a computer what a cat looks like, ML uses thousands of cat images to learn distinguishing features on its own. This self-improving ability powers technologies like voice assistants, recommendation systems, self-driving cars, and predictive analytics.

Literature Review

1. Title: Early Predicting of Students Performance in Higher Education Name: Essa Alhazmi, Abdullah Shena Emer Serial No: ISSN: 10056943 This study aims to analyze students' performance in higher education and predict it at an early stage. The authors employ clustering and classification techniques using T-SNE and various machine learning models. The dataset comprises admission scores, first-level course results, AAT, and GAT scores. The research highlights the merit of early identification of performance issues and helps in mitigating failure risks. However, it falls short as it cannot combine non-academic features with academic ones.

2. Title: A Novel Student Achievement Prediction Method Based on Deep Learning and Attention Mechanism Name: Yu Liu, Yanchuan Hui Serial No: ISSN: 10216940 The paper predicts student achievement by analyzing correlations between factors and emphasizing key influences. It utilizes deep learning and attention mechanisms supported by Maximum Information Coefficient. The dataset is based on a survey conducted among sophomore, junior, and senior students at a university in Nanjing, China. The proposed approach achieves a high accuracy of 94.22%. A suggested improvement is to explore more advanced deep learning architectures for even better predictive performance.

SYSTEM DESIGN AND IMPLEMENTATION

DESIGN

1.Input Image
The system starts when a user uploads an image of handwritten or printed text.
Sources: scanned documents, mobile photos, form scans, etc.
2.Preprocessing
This stage prepares the raw image for better recognition. It includes:

- Grayscale Conversion: Converts RGB image to grayscale, simplifying data.
- Noise Removal: Eliminates small dots, smudges using filters (like Gaussian blur).
- Thresholding/Binarization: Converts grayscale to black & white to highlight text.
- Resizing: Standardizes character size to feed into the CNN.
- Normalization: Scales pixel values to a uniform range (e.g., 0–1).
- Goal: Make the image clean and uniform for consistent model input.

3.Segmentation
This breaks the text image into smaller, more manageable parts:

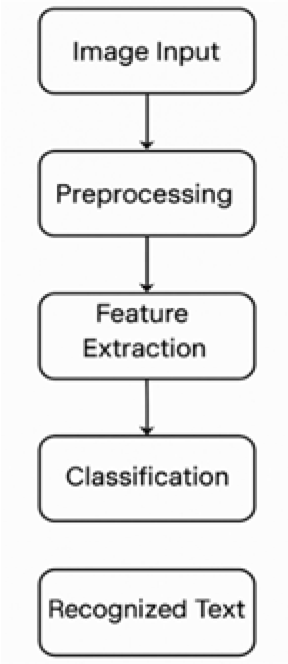
- Line segmentation – separates each line of text.
- Word segmentation – separates each word in a line.
- Character segmentation – breaks down each word into characters. Important for character-level recognition, especially in CNN-based models.

PROPOSED SYSTEM
The system uses CNNs for OCR enabling automatic feature extraction and classification from input images. CNNs learn features directly from data, overcoming the limitations of traditional methods.

Advantages

Automatic Feature Learning: No manual extraction needed.
Higher Accuracy: Performs well across various handwriting styles and languages.
Robustness: Handles noise, distortion, and handwriting variation effectively.
Scalability: Suitable for large datasets and multilingual scripts.

SYSTEM ARCHITECTURE



MODULE DESIGN

1. Dataset Collection Gather diverse handwritten character images from various sources to train a robust, multi-language model adaptable to writing variations.

2. Image Preprocessing & Labeling Cleans and standardizes images (grayscale, crop, thresholding), removes noise, and assigns correct labels for effective training.

3. Data Augmentation Expands dataset using rotations, flips, noise, etc., to simulate real-world handwriting variation and improve generalization.

4. CNN Processing Uses convolutional, pooling, and fully connected layers to extract features and classify characters directly from raw image data.

5. Dropout & Regularization Applies dropout during training to prevent overfitting and improve model generalization across varied handwriting.

6. Model Training & Validation Trains the CNN on labeled, augmented data; tunes hyperparameters; validates performance to ensure accuracy and robustness.

CONCLUSION

In conclusion, OCR is vital for tasks like document digitization and form processing. Traditional methods fall short in accuracy and scalability. CNNs improve OCR by learning features directly from images, handling diverse handwriting and distortions effectively. This paper highlights the strengths of deep CNNs, enhanced with data augmentation and transfer learning, in delivering more accurate and robust character recognition. The current OCR system effectively digitizes handwritten characters and offers strong potential for future growth. A key improvement area is multilingual and multiscript support. Most systems focus on English or one language, but incorporating diverse datasets can enable recognition of scripts like Devanagari, Bengali, Tamil, Urdu, Chinese, and Arabic. This would greatly expand its use across global, multilingual contexts in fields like education, administration, archiving, and public services.

REFERENCES:

1. Raju, P., Arun, R., Turlapati, V. R., Veeran, L., & Rajesh, S. (2024). Next-Generation Management on Exploring AI-Driven Decision Support in Business. In *Optimizing Intelligent Systems for Cross-Industry Application* (pp. 61-78). IGI Global.
2. Turlapati, V. R., Thirunavukkarasu, T., Aiswarya, G., Thoti, K. K., Swaroop, K. R., & Mythily, R. (2024, November). The Impact of Influencer Marketing on Consumer Purchasing Decisions in the Digital Age Based on Prophet ARIMA-LSTM Model. In *2024 International Conference on Integrated Intelligence and Communication Systems (ICIICS)* (pp. 1-6). IEEE.
3. Sidharth, S. (2023). AI-Driven Anomaly Detection for Advanced Threat Detection.
4. Sidharth, S. (2023). Homomorphic Encryption: Enabling Secure Cloud Data Processing.
5. Sidharth, S. (2024). Strengthening Cloud Security with AI-Based Intrusion Detection Systems.
6. Sidharth, S. (2022). Enhancing Generative AI Models for Secure and Private Data Synthesis.
7. Sidharth, S. (2021). Multi-Cloud Environments: Reducing Security Risks in Distributed Architectures.
8. Sidharth, S. (2020). The Rising Threat of Deepfakes: Security and Privacy Implications.
9. Sidharth, S. (2019). Quantum-Enhanced Encryption Methods for Securing Cloud Data.
10. Sidharth, S. (2019). Enhancing Security of Cloud-Native Microservices with Service Mesh Technologies.
11. Srinivasan, R. (2025). Friction Stir Additive Manufacturing of AA7075/Al2O3 and Al/MgB2 Composites for Improved Wear and Radiation Resistance in Aerospace Applications. *J. Environ. Nanotechnol*, *14*(1), 295-305.
12. Vijayalakshmi, K., Amuthakkannan, R., Ramachandran, K., & Rajkavin, S. A. (2024). Federated Learning-Based Futuristic Fault Diagnosis and Standardization in Rotating Machinery. *SSRG International Journal of Electronics and Communication Engineering*, *11*(9), 223-236.
13. Rajakannu, A. (2024). Implementation of Quality Function Deployment to Improve Online Learning and Teaching in Higher Education Institutes of Engineering in Oman. *International Journal of Learning, Teaching and Educational Research*, *23*(12), 463-486.
14. Rajakannu, A., Ramachandran, K. P., & Vijayalakshmi, K. (2024). Application of Artificial Intelligence in Condition Monitoring for Oil and Gas Industries.
15. Al Haddabi, T., Rajakannu, A., & Al Hasni, H. (2024). Design and Development of a Low-Cost Parabolic Type Solar Dryer and Its Performance Evaluation in Drying of King Fish–Case Study in Oman.
16. Rajakannu, A., Ramachandran, K. P., & Vijayalakshmi, K. (2024). Condition Monitoring of Drill Bit for Manufacturing Sector Using Wavelet Analysis and Artificial Neural Network (ANN).
17. Sakthibalan, P., Saravanan, M., Ansal, V., Rajakannu, A., Vijayalakshmi, K., & Vani, K. D. (2023). A Federated Learning Approach for ResourceConstrained IoT Security Monitoring. In *Handbook on Federated Learning* (pp. 131-154). CRC Press.
18. Amuthakkannan, R., & Al Yaqoubi, M. H. A. (2023). Development of IoT based water pollution identification to avoid destruction of aquatic life and to improve the quality of water. *International journal of engineering trends and technology*, *71*(10), 355-370.
19. Amuthakkannan, R., Vijayalakshmi, K., Kamarunisha, M., Kumar, S. G., Ajithkumar, P., & Vikram, P. (2023). Optimization of multi parameters of WEDM using ANN based on principal component analysis for AA6063/B4C metal matrix composites. *Materials Today: Proceedings*.
20. Amuthakkannan, R., Muthuraj, M., Ademi, E., Rajesh, V., & Ahammad, S. H. (2023). Analysis of fatigue strength on friction stir lap weld AA2198/Ti6Al4V joints. *Materials Today: Proceedings*.
21. Thamma, S. R. T. S. R. (2024). Optimization of Generative AI Costs in Multi-Agent and Multi-Cloud Systems.
22. Thamma, S. R. T. S. R. (2024). Revolutionizing Healthcare: Spatial Computing Meets Generative AI.

23. Jadhav, S., Machale, A., Mharnur, P., Munot, P., & Math, S. (2019, September). Text based stress detection techniques analysis using social media. In *2019 5th International Conference On Computing, Communication, Control And Automation (ICCUBEA)* (pp. 1-5). IEEE.
24. Thepade, D. S., Mandal, P. R., & Jadhav, S. (2015). Performance Comparison of Novel Iris Recognition Techniques Using Partial Energies of Transformed Iris Images and Enegy CompactionWith Hybrid Wavelet Transforms. In *Annual IEEE India Conference (INDICON)*.
25. Kiran, A., Sonker, A., Jadhav, S., Jadhav, M. M., Naga Ramesh, J. V., & Muniyandy, E. (2024). Secure Communications with THz Reconfigurable Intelligent Surfaces and Deep Learning in 6G Systems. *Wireless Personal Communications*, 1-17.
26. Anitha, C., Tellur, A., Rao, K. B., Kumbhar, V., Gopi, T., Jadhav, S., & Vidhya, R. G. (2024). Enhancing Cyber-Physical Systems Dependability through Integrated CPS-IoT Monitoring. *International Research Journal of Multidisciplinary Scope*, *5*(2), 706-713.
27. Vandana, C. P., Basha, S. A., Madiajagan, M., Jadhav, S., Matheen, M. A., & Maguluri, L. P. (2024). IoT resource discovery based on multi faected attribute enriched CoAP: smart office seating discovery. *Wireless Personal Communications*, 1-18.
28. Jadhav, S., Durairaj, M., Reenadevi, R., Subbulakshmi, R., Gupta, V., & Ramesh, J. V. N. (2024). Spatiotemporal data fusion and deep learning for remote sensing-based sustainable urban planning. *International Journal of System Assurance Engineering and Management*, 1-9.
29. Thamma, S. R. (2024). Cardiovascular image analysis: AI can analyze heart images to assess cardiovascular health and identify potential risks.
30. Thamma, S. R. T. S. R. (2024). Generative AI in Graph-Based Spatial Computing: Techniques and Use Cases.
31. Vasista, T. G. K. (2016). Thoughtful approaches to implementation of electronic rulemaking. *Int. J. Manag. Pub. Sect. Inf. Commun. Technol*, *7*(2), 43-53.
32. Kalaiselvi, B., & Thangamani, M. (2020). An efficient Pearson correlation based improved random forest classification for protein structure prediction techniques. *Measurement*, *162*, 107885.
33. Prabhu Kavin, B., Karki, S., Hemalatha, S., Singh, D., Vijayalakshmi, R., Thangamani, M., ... & Adigo, A. G. (2022). Machine learning-based secure data acquisition for fake accounts detection in future mobile communication networks. *Wireless Communications and Mobile Computing*, *2022*(1), 6356152.
34. Geeitha, S., & Thangamani, M. (2018). Incorporating EBO-HSIC with SVM for gene selection associated with cervical cancer classification. *Journal of medical systems*, *42*(11), 225.
35. Thangamani, M., & Thangaraj, P. (2010). Integrated Clustering and Feature Selection Scheme for Text Documents. *Journal of Computer Science*, *6*(5), 536.
36. Gangadhar, C., Chanthirasekaran, K., Chandra, K. R., Sharma, A., Thangamani, M., & Kumar, P. S. (2022). An energy efficient NOMA-based spectrum sharing techniques for cell-free massive MIMO. *International Journal of Engineering Systems Modelling and Simulation*, *13*(4), 284-288.
37. Narmatha, C., Thangamani, M., & Ibrahim, S. J. A. (2020). Research scenario of medical data mining using fuzzy and graph theory. *International Journal of Advanced Trends in Computer Science and Engineering*, *9*(1), 349-355.
38. Thangamani, M., & Thangaraj, P. (2013). Fuzzy ontology for distributed document clustering based on genetic algorithm. *Applied Mathematics & Information Sciences*, *7*(4), 1563-1574.
39. Surendiran, R., Aarthi, R., Thangamani, M., Sugavanam, S., & Sarumathy, R. (2022). A Systematic Review Using Machine Learning Algorithms for Predicting Preterm Birth. *International Journal of Engineering Trends and Technology*, *70*(5), 46-59.
40. Thangamani, M., & Thangaraj, P. (2010). Ontology based fuzzy document clustering scheme. *Modern Applied Science*, *4*(7), 148.
41. Ibrahim, S. J. A., & Thangamani, M. (2018, November). Momentous Innovations in the prospective method of Drug development. In *Proceedings of the 2018 International Conference on Digital Medicine and Image Processing* (pp. 37-41).
42. Anandasubramanian, C. P., & Selvaraj, J. (2024). NAVIGATING BANKING LIQUIDITY-FACTORS, CHALLENGES, AND STRATEGIES IN CORPORATE LOAN PORTFOLIOS. *Tec Empresarial*, *6*(1).
43. Madem, S., Katuri, P. K., Kalra, A., & Singh, P. (2023, May). System Design for Financial and Economic Monitoring Using Big Data Clustering. In *2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI)* (pp. 1-7). IEEE.

44. Kumar, J. S., Archana, B., Muralidharan, K., & Kumar, V. S. (2025). Graph Theory: Modelling and Analyzing Complex System. *Metallurgical and Materials Engineering*, *31*(3), 70-77.
45. Kumar, J. S., Archana, B., Muralidharan, K., & Srija, R. (2025). Spectral Graph Theory: Eigen Values Laplacians and Graph Connectivity. *Metallurgical and Materials Engineering*, *31*(3), 78-84.
46. Srija, R., Kumar, J. S., & Muralidharan, K. (2025). An improvement in estimating the population mean by using quartiles and correlation coefficient. *Mathematics in Engineering, Science & Aerospace (MESA)*, *16*(1).
47. Kumar, J. S., Murthy, S., Kumar, B. R., & Solaiappam, S. (2017, January). p-Value analyze the set of optimal value in MOFTP. In *2017 4th International Conference on Advanced Computing and Communication Systems (ICACCS)* (pp. 1-5). IEEE.
48. Ramesh, T. R., Lilhore, U. K., Poongodi, M., Simaiya, S., Kaur, A., & Hamdi, M. (2022). Predictive analysis of heart diseases with machine learning approaches. *Malaysian Journal of Computer Science*, 132-148.
49. Ramesh, T. R., Vijayaragavan, M., Poongodi, M., Hamdi, M., Wang, H., & Bourouis, S. (2022). Peer-to-peer trust management in intelligent transportation system: An Aumann's agreement theorem based approach. *ICT Express*, *8*(3), 340-346.
50. Ramesh, T. R., & Kavitha, C. (2013). Web user interest prediction framework based on user behavior for dynamic websites. *Life Sci. J*, *10*(2), 1736-1739.
51. Ali, A., Naeem, S., Anam, S., & Ahmed, M. M. (2022). Machine learning for intrusion detection in cyber security: Applications, challenges, and recommendations. *UMT Artif. Intell. Rev*, *2*(2), 41-64.
52. Ramesh, T. R., Raghavendra, R., Vantamuri, S. B., Pallavi, R., & Easwaran, B. (2023). IMPROVING THE QUALITY OF VANET COMMUNICATION USING FEDERATED PEER-TO-PEER LEARNING. *ICTACT Journal on Communication Technology*, *14*(1).
53. Gopinath, S., Sakthivel, K., & Lalitha, S. (2022). A plant disease image using convolutional recurrent neural network procedure intended for big data plant classification. *Journal of Intelligent & Fuzzy Systems*, *43*(4), 4173-4186.
54. Bharathi, V., & Sakthivel, K. (2022). Unmanned mobile robot in unknown obstacle environments for multi switching control tracking using adaptive nonlinear sliding mode control method. *Journal of Intelligent & Fuzzy Systems*, *43*(3), 3513-3525.
55. Sakthivel, K., Nallusamy, R., & Kavitha, C. (2014). Image retrieval using fused features. *World Academy of Science, Engineering and Technology International Journal of Computer, Information, Systems and Control Engineering*, *8*(9).
56. Kavitha, C., Krishnan, A., & Sakthivel, K. (2005, January). Similarity based retrieval of image database: using dynamic clustering. In *Proceedings of 2005 International Conference on Intelligent Sensing and Information Processing, 2005.* (pp. 147-151). IEEE.
57. Sakthivel, K., Ravichandran, T., & Kavitha, C. (2009). Performance analysis in image retrieval using IRM and K-Means Algorithm. *i-Manager's Journal on Software Engineering*, *3*(4), 55.