Proceedings of the Fourth Australian International Conference on Industrial Engineering and Operations Management, Melbourne, Australia, November 25-27, 2025

Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AU04.20250059
Published: November 25, 2025

AI-Driven Innovations in Healthcare: Enhancing Handwritten Digits Recognition

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Abstract

Accurately reading handwritten digits is crucial for operations such as processing patient IDs, prescription numbers, laboratory test results, and diagnostic forms. Handwritten digit recognition is a fundamental problem in computer vision with many applications in the healthcare industry. Such numerical data transcription errors may result in misdiagnosis, delays, or inappropriate treatment. Artificial Intelligence (AI) can automate this procedure, greatly reducing human error, increasing operational efficiency, and facilitating quicker, more dependable healthcare workflows. This study explores the use of two machine learning models for handwritten digit recognition: Visual Geometry Group 16-layer network (VGG16) and Multi-Layer Perceptron (MLP). The Modified National Institute of Standards and Technology (MNIST) dataset, a commonly used benchmark in image classification research, was used for training and testing the frameworks in this study. The MNIST dataset comprises a total of 70,000 grayscale images of handwritten digits ranging from 0 to 9, each measuring 28×28 pixels. Ten thousand of these were utilized for testing, and sixty thousand for training. The pictures are based on a wide variety of handwriting styles, which reflects the variation found in real-world situations like medical documents. Prior to training, the dataset underwent preprocessing, including normalization to a [0,1] pixel value range to improve training stability and performance. For the MLP model, the images were flattened into one-dimensional vectors, while for VGG16, the images were resized and converted to match the model's expected three-channel input format. Both models were trained and evaluated using key classification metrics: accuracy, precision, recall, and F1-score. The MLP achieved a test accuracy of 98.2%, outperforming the VGG16 model, which achieved 96.9%. Although VGG16 is a deep convolutional architecture with strong feature extraction capabilities, it required significantly more computational resources, leading to longer training and inference times. In contrast, the MLP demonstrated not only superior accuracy but also higher efficiency, making it a more practical choice for deployment in resource-constrained environments such as small clinics or embedded

healthcare systems. Given these results, the MLP model was selected for deployment. A web-based Minimum Viable Product (MVP) was developed to demonstrate the model's real-world usability. The front end was built using Next. JavaScript (Next.js) and Tailwind Cascading Style Sheets (CSS), ensuring a responsive and visually appealing user interface. The back end consisted of a lightweight Flask Application Programming Interface (API) responsible for receiving input data from the client, performing inference using the trained MLP model, and returning predictions. Users can draw digits directly in the browser and receive instant classification results, allowing for intuitive, hands-on interaction with the AI system. The MVP, hosted at **https://digit-ai-tau.vercel.app/**, illustrates the potential of AI-based handwritten digits recognition to automate healthcare processes, reduce manual workloads, and enhance patient data handling accuracy. Future work will explore integrating the system with real-world healthcare management platforms, expanding it to recognize multi-character handwritten entries, and optimizing it for deployment on low-power edge devices, enabling usage in remote or under-resourced healthcare facilities.

Keywords
Handwritten digit recognition, Machine learning, MLP, VGG16, Healthcare automation.

Biographies
Sarah Aliouat is an undergraduate Computer Engineering student at the University of Dubai, passionate about AI, software development, and healthcare innovation. She has hands-on experience in machine learning, full-stack web development, and mobile app creation, and has built AI-powered systems addressing real-world challenges. Sarah has showcased her work at competitions such as the AI Global Festival, NCS Hack, and BITS Tech Fest 2025 Hackathon. Sarah is an active IEEE member, also a contributor in the UD Entrepreneurship and Innovation Club, NCS Club (Algeria), and the Microsoft Tech Club (BITS Pilani), where she collaborates on impactful projects and mentors peers in technology-driven initiatives.

Mhd Nazir Sagherji is an undergraduate Computer Engineering student with a strong focus on cybersecurity, robotics, and machine learning. He has hands-on experience in network traffic analysis using Wireshark, steganography, advanced cryptography challenges, and penetration testing. In robotics, Nazir has built and programmed autonomous vehicles integrating Arduino, ESP32 camera modules, and various sensors for line tracking, obstacle detection, and real-time data processing. He has also developed an autonomous boat powered by a Raspberry Pi, equipped with an Intel RealSense depth camera and a Google Coral accelerator for real-time computer vision and object detection. Beyond hardware, Nazir also designs interactive gaming experiences on Roblox, combining creative game mechanics with technical scripting. Passionate about innovation, he actively participates in hackathons and technical competitions, including the IEEE Student Day 2025, ADPoly Cybersecurity Hackathon 2025, and the GISEC GLOBAL CTF competition, applying his skills to build impactful, security-aware, and intelligent systems.

Dr. Maisam Wahbah received the Ph.D. degree in Electrical Engineering and Computer Science from Khalifa University (KU), UAE. In 2019, she joined the Healthcare Engineering Innovation Center at the Department of Biomedical Engineering at KU as a Post-Doctoral Fellow. Dr. Wahbah is currently an assistant professor at the College of Engineering & Information Technology, University of Dubai, UAE. As a long-standing and engaged member of the IEEE, Dr. Wahbah currently holds a leadership position as Chair of the Awards & Recognition Committee for the IEEE UAE Section, where she actively promotes excellence and professional growth within the engineering community. Her research bridges renewable energy, statistical modeling, and biomedical systems, with recognized contributions including receiving the QUWA research grant– a funded research grant aligned with the UAE's D33 vision and the UN SDGs. Dr. Wahbah's work reflects her deep commitment to innovation in cross-disciplinary research, bridging engineering, leadership, and societal impact.