

## Mohammed Hamdan, Ph.D.

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## Professional Summary

Innovative machine learning researcher and AI engineer with a Ph.D. in Machine Learning and Computer Vision from École de Technologie Supérieure (ÉTS), specializing in developing state-of-the-art AI solutions across healthcare, document analysis, and business intelligence. Led ground-breaking research in computer vision and deep learning, achieving significant improvements in recognition accuracy and system performance. Pioneered advanced AI architectures spanning document analysis, medical imaging, and financial analytics, with expertise in attention mechanisms, multi-modal systems, and large language models. Technical proficiency encompasses cutting-edge frameworks (Transformers, GANs, CNNs) and emerging technologies including generative AI, retrieval-augmented generation (RAG), and Google Cloud's Gemini technology. Authored high-impact publications in premier journals (IEEE TPAMI, Pattern Recognition, IJDAR), demonstrating consistent innovation in AI research. Successfully translated complex research into production-ready solutions across diverse domains including healthcare diagnostics, financial services, and enterprise process optimization. Demonstrated excellence in leading technical teams, managing distributed computing infrastructure, and driving technological innovation through the full ML lifecycle from research to deployment. Proven track record in mentoring teams and bridging academia-industry collaboration, resulting in efficient, scalable AI systems that deliver measurable business impact.

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## Education

### Ph.D. in Engineering (ML & Computer Vision)

École de Technologie Supérieure (ÉTS), Montreal, QC, Canada | 2019 – 2024

- **Excellence in Thesis Award (2024):** Developed advanced models for handwriting recognition and decision frameworks.

### M.Sc. in Computer Science (NLP & Arabic Script Processing)

King Abdulaziz University, Jeddah, Saudi Arabia | 2015 – 2018

- **Dean's Excellence Awards.**

### B.Sc. in Computer Science

University of Hail, Hail, Saudi Arabia | 2009 – 2013

- Graduated with **First Class Honors & Prince Prize** recipient.

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## Publications

- Mohammed Hamdan, Abderrahmane Rahiche, and Mohamed Cheriet. "**HAND: Hierarchical Attention Network for Multi-Scale Handwritten Document Recognition and Layout Analysis.**" IEEE Transactions on Pattern Analysis and Machine Intelligence. (Submitted in October 2024).
  - Mohammed Hamdan, Abderrahmane Rahiche, and Mohamed Cheriet. "**HTR-JAND: Handwritten Text Recognition with Joint Attention Network and Knowledge Distillation.**" IEEE Transactions on Image Processing. (Submitted in November 2024).

- Mohammed Hamdan and Mohamed Cheriet. "**ResneSt-Transformer: Joint attention segmentation-free for end-to-end handwriting paragraph recognition model.**" Array 19 (2023): 100300.
  - Mhiri, Mohamed, Mohammed Hamdan, and Mohamed Cheriet. "**Handwriting word spotting in the space of difference between representations using vision transformers.**" Pattern Recognition Letters 174 (2023): 39-45.
  - Cheriet, M., Dentamaro, V., Hamdan, M., Impedovo, D., & Pirlo, G. (2023). "**Multi-speed transformer network for neurodegenerative disease assessment and activity recognition.**" Computer Methods and Programs in Biomedicine, 230, 107344.
  - Mohammed Hamdan, Himanshu Chaudhary, Ahmed Bali, Mohamed Cheriet. "**Refocus attention span networks for handwriting line recognition.**" International Journal on Document Analysis and Recognition (IJDAR) 26.2 (2022): 131-147.
  - Hamdan, Mohammed H., and Intiaz H. Khan. "**An analysis of prepositional-phrase attachment disambiguation.**" International Journal of Computational Linguistics Research 9.2 (2018): 60-80.
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## Key Skills

- **AI & ML Engineering:** Expertise in deep learning (CNN, Transformer, GAN) and decision-making frameworks for large-scale applications.
  - **Generative AI & LLMs:** Skilled in fine-tuning models, integrating retrieval-augmented generation (RAG), and advanced embedding techniques.
  - **Multi-Agent Systems & Adaptive Coordination:** Development of systems for distributed workflows and real-time collaboration.
  - **Multi-Modal AI Systems:** Integration of text, sound, and image processing for end-to-end applications.
  - **Predictive Analytics:** Design of algorithms for real-time inference and decision optimization under uncertainty.
  - **MLOps & Deployment:** Proficient in Docker, Kubernetes, AWS, GCP, ONNX, and distributed pipelines for scalable AI systems.
  - **Tools & Frameworks:** HuggingFace, LangChain, Gradio, PyTorch, TensorFlow, Keras, OpenCV, and PyTorch Lightning.
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## Industry-Relevant Experience

**Ph.D. Researcher & AI Engineer** | Synchromedia Lab, ÉTS | Montreal, Canada (2020 – 2024)

- Developed adaptive AI frameworks for complex workflows, integrating multi-modal data processing with predictive analytics.
- Designed modular architectures enabling seamless integration of automation and real-time coordination.
- Published innovative methodologies for OCR, document recognition, and semantic parsing in high-stakes environments.
- Mentored peers on advanced ML methodologies, infrastructure optimization, and project execution.

**Administrator** | Synchromedia Lab, ÉTS | Montreal, Canada (2020 – 2024)

- Streamlined **computing infrastructure** to support distributed AI model training and deployment using Compute Canada and Calcul Quebec compute resources.
- Collaborated with academia and industry to translate research innovations into production-ready applications.

**Machine Learning Intern** | *Water Research Center (KAU)* | *Jeddah, Saudi Arabia (January 2015 – December 2015)*

- Applied machine learning algorithms, including linear regression and time series analysis, to develop predictive models for optimizing water distribution and resource management.
  - Utilized anomaly detection techniques, such as k-means clustering and statistical outlier detection, to analyze sensor data for real-time water quality monitoring.
  - Designed and implemented an automated reporting tool powered by supervised learning models, enabling efficient decision-making and actionable insights for operational scenarios.
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## **Highlighted Projects**

### **Category: Document Analysis & Recognition**

**Project Title: Merged Projects - Research and Development of Advanced Machine Learning Models for Document Analysis and Neurodegenerative Disease Assessment (Period: 4 years)**

#### **Description:**

Conducted extensive research and developed state-of-the-art machine learning models for handwriting recognition, document layout analysis, and neurodegenerative disease assessment. The projects spanned various domains, integrating deep learning architectures, vision transformers, and advanced attention mechanisms.

#### **Key Contributions:**

- Hierarchical Attention Network (HAND): Proposed a multi-scale handwritten document recognition model, leveraging hierarchical attention mechanisms for improved layout analysis.
  - **Publication:** IEEE Transactions on Pattern Analysis and Machine Intelligence (Submitted in October 2024).
- HTR-JAND: Developed a joint attention network for handwritten text recognition with knowledge distillation, focusing on segmentation-free methods.
  - **Publication:** IEEE Transactions on Image Processing (Submitted in November 2024).
- ResneSt-Transformer: Introduced a joint attention segmentation-free model for end-to-end handwriting paragraph recognition.
  - **Publication:** Array, 2023.
- Vision Transformers for Word Spotting: Implemented handwriting word spotting by analyzing differences in representation spaces using vision transformers.
  - **Publication:** Pattern Recognition Letters, 2023.
- Multi-Speed Transformer Network: Designed a transformer-based network for activity recognition in neurodegenerative disease assessment.
  - **Publication:** Computer Methods and Programs in Biomedicine, 2023.
- Refocus Attention Span Networks: Enhanced handwriting line recognition by introducing attention span mechanisms.

- **Publication:** International Journal on Document Analysis and Recognition (IJDAR), 2022.
  - Prepositional-Phrase Attachment Disambiguation: Analyzed linguistic ambiguities in Arabic script using supervised learning techniques.
    - **Publication:** International Journal of Computational Linguistics Research, 2018.  
**Technologies Used:** Vision Transformers, Attention Mechanisms, ResNeSt, PyTorch, TensorFlow, Neuro-symbolic AI, Natural Language Processing (NLP).  
**Decision-Making Support:** These research outputs contributed to advancing academic knowledge and practical solutions in handwriting recognition, document analysis, and neurodegenerative disease assessment.  
**Timeline:**
      - Start Date: March 2020
      - End Date: November 2024**Client:** Synchromedia Lab, ÉTS, Montreal, Canada
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## Category: Healthcare & Medical Imaging

**Project Title:** Merged Projects - Research and Development of Advanced Machine Learning Models for Neurodegenerative Disease Assessment (**Period: 4 months**)

**Description:**

Developed transformer-based networks and machine learning models for activity recognition, focusing on neurodegenerative disease assessment.

**Key Contributions:**

- Multi-Speed Transformer Network: Designed and optimized transformer-based networks to identify activities relevant to neurodegenerative disorders.
    - **Publication:** Computer Methods and Programs in Biomedicine, 2023.  
**Technologies Used:** Vision Transformers, Attention Mechanisms, PyTorch, TensorFlow.  
**Timeline:**
      - Start Date: April 2023
      - End Date: August 2023**Client:** Synchromedia Lab, ÉTS, Montreal, Canada
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## Category: Workflow Optimization & Automation

**Project Title:** Advanced AI Solutions for Workflow Optimization and Automation (**Period: 2 months**)

**Objective:**

Developed and deployed a suite of AI-based systems to enhance operational workflows, optimize code performance, and provide real-time decision-making insights across dynamic environments.

**Key Contributions:**

1. Predictive Analytics for Adaptive Workflows:
  - Built an AI system for real-time outcome prediction and task optimization, improving resource allocation and operational efficiency in uncertain environments.
2. Multi-Modal AI for Workflow Automation:

- Designed a system integrating text, image, and sound recognition for seamless workflow automation.
  - 3. Code Optimization with LLMs:
    - Leveraged LLMs to transform Python code into optimized C++ for complex computations, boosting performance and reducing execution time.
  - 4. Scalable AI Solutions for Traffic and Chatbot Management:
    - Deployed AI-driven solutions for real-time traffic management and chatbot functionalities, delivering interactive user support and operational insights.

**Technologies Used:** Python, TensorFlow, PyTorch, Gradio, Multi-Modal AI Frameworks, LLM Architectures, C++, Optimization Libraries.

**Timeline:**

    - Start Date: October 2024
    - End Date: December 2024

**Client:** Self-initiated (Research-based project).
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## Category: Computer Vision

**Project Title: Comprehensive AI Applications in Computer Vision (Period: 20 months)**

**Objective:**

Developed and deployed multiple computer vision-based systems addressing challenges in surveillance, object recognition, image retrieval, and biometric authentication.

**Key Contributions:**

1. Custom Object Detector for Surveillance Systems:
  - Designed a HOG-based custom object detector with non-maxima suppression and hard-negative mining.
2. Content-Based Image Retrieval (CBIR) System:
  - Built an engine for retrieving similar images using techniques like SIFT, ORB, and bag-of-visual-words.
3. Automatic License Plate Recognition (ANPR):
  - Created an end-to-end system for vehicle identification by detecting, segmenting, and recognizing license plate characters.
4. Facial Recognition Pipeline:
  - Implemented a face recognition system with LBPs and Eigenfaces.
5. Plant Classification with Image Descriptors:
  - Automated plant species identification using features like Haralick texture, Hu moments, and color histograms.
6. Hand Gesture Recognition for Touchless Interfaces:
  - Built a system leveraging contour and motion segmentation for touchless interaction.
7. Real-Time Face Detection for Security Systems:
  - Developed a robust face detection pipeline using Haar cascades and deep learning.

**Technologies Used:** Python, OpenCV, Scikit-learn, TensorFlow, SIFT, ORB, LBP, Haar Cascades.

**Timeline:**

  - Start Date: January 2021
  - End Date: August 2022

**Client:** PyImageSearch Gurus Course

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## Category: Business Analytics & Decision Support

### Project Title: AI-Driven Insights for Business Operations and Analysis (Period: 9 months)

#### Objective:

Developed AI systems to tackle business challenges, including employee attrition analysis, customer behavior modeling, and predictive insights for operational improvements.

#### Key Contributions:

1. IBM HR Analytics Employee Attrition Modeling:
  - o Built predictive models to identify key factors driving employee turnover.
2. House Loan Data Analysis:
  - o Developed classification models to predict loan approvals.
3. User-Based Recommendation Model for Amazon:
  - o Designed a personalized recommendation system to enhance customer experience.
4. Income Qualification for Families in Latin America:
  - o Conducted predictive modeling for income qualification assessments.

**Technologies Used:** Python, Scikit-learn, TensorFlow, Pandas, Matplotlib, Seaborn.  
**Timeline:**

- Start Date: March 2022
- End Date: December 2022

**Client:** Self-initiated and Kaggle competitions.

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## Technical Skills

- **Programming Languages & Frameworks:** Python, C++, C#, Java, SQL, PyTorch, TensorFlow, Keras, OpenCV, PyTorch Lightning, Gradio, Hugging Face, Sentence-BERT, Scikit-learn, Pandas, NumPy, Matplotlib, Seaborn.
  - **Machine Learning & Deep Learning:** Vision Transformers, Attention Mechanisms, ResNeSt, YOLOv3, DensePose, LinkNet, VGG16, Transfer Learning, NLP, Speech-to-Text Models, Multi-Modal AI, Large Language Models (LLMs), Collaborative Filtering Algorithms, Topic Modeling, Sentiment Analysis.
  - **Cloud & MLOps:** AWS (S3, EC2, Lambda, SageMaker), GCP (Vertex AI, BigQuery), Docker, Kubernetes, Git, ONNX, MLflow, Weights & Biases.
  - **Computer Vision & Image Processing:** Object Detection, Semantic Segmentation, Pose Estimation, Facial Recognition, Handwriting Recognition, Document Layout Analysis, OCR (Tesseract), Image Retrieval (SIFT, ORB, Bag-of-Visual-Words), Haar Cascades, LBP, Eigenfaces, Haralick Texture, Hu Moments.
  - **Web & Front-End Development:** Bootstrap, PHP, HTML, CSS, JavaScript, Gradio, Flask, Streamlit.
  - **Data Analysis & Visualization:** Pandas, NumPy, Matplotlib, Seaborn, Tableau, Power BI.
  - **Optimization & Deployment:** Code Optimization (Python to C++), Model Quantization, Model Serving, Real-Time Inference, Scalable AI Solutions.
  - **Tools & Libraries:** Jupyter Notebook, Google Colab, Visual Studio Code, PyCharm, Git, GitHub, Kaggle API, AWS Alexa SDK.
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## **Certifications & Professional Training**

### **Generative AI Specializations (2024-2025)**

- **Natural Language Processing on Google Cloud** (January 2025)
- **Inspect Rich Documents with Gemini Multimodality and Multimodal RAG** (Jan. 2025)
- **Prompt Design in Vertex AI** (January 2025)

### **Generative AI, from GANs to CLIP with Python and PyTorch (April 2024)**

- Advanced image generation and editing using **Stable Diffusion**.
- Multimodal AI architectures combining **text and image processing**.
- Deep dive into **neural network latent spaces**.
- Hands-on implementation of **GANs** and generative models.

### **Mastering Generative AI and LLMs (8-Week Intensive Program)**

- Practical implementation of **large language models (LLMs)**.
- **RAG system development** and fine-tuning.
- Production deployment of **generative AI solutions**.

### **Advanced AI/ML Certification, IIIT Hyderabad ML Lab**

- Practical ML deployment, optimization techniques, and real-world hackathon experiences.
- **Hackathons Achieved:**
  - Voice Commands Based Ordering System | Alexa Chatbot
  - Expression Face Recognition - Mobile App
  - Dogs vs. Cats Binary Class Classification with PyTorch
  - Image Transformations - Kaggle Competition
  - Sales Forecast - Kaggle Competition

### **Deep Learning Specialization (Andrew Ng)**

- Expertise in **CNNs, RNNs, Transformers**, and advanced neural network architectures.
- Hands-on experience with **TensorFlow** and **Keras**.

### **TensorFlow Developer & MLOps Specializations**

- **CI/CD pipelines** for machine learning workflows.
- Scalable model serving and efficient compute resource management.
- **MLOps tools:** Docker, Kubernetes, Git, ONNX, MLflow, Weights & Biases.

### **Generative AI, PyImageSearch Gurus, and Various Online Courses**

- **OCR:** Fundamentals of Optical Character Recognition, Tesseract, and OCR techniques.
- **Image Detection & Segmentation:** YOLOv3, U-Net, LinkNet, and semantic segmentation.
- **Object Tracking:** Real-time object detection and tracking using OpenCV & deep learning.

### **Full Stack Deep Learning (FSDL) 2022 (UC Berkeley)**

- Completed the full lecture and lab series covering the **end-to-end ML pipeline**, including:
  - Development infrastructure & tooling.
  - Experiment management with **Weights & Biases**.
  - Troubleshooting & testing ML models.
  - Data management and annotation.
  - Web deployment and serverless model services.
  - Continual learning and model monitoring.
  - Foundation models, ML teams & project management, and ethics.

### **Artificial Intelligence Engineer with Eight Projects (Simplilearn)**

- **Projects Achieved:**

- IBM HR Analytics Employee Attrition Modeling
- House Loan Data Analysis | Topic Analysis of Review Data
- Building a User-Based Recommendation Model for Amazon
- Income Qualification for Families in Latin America
- Classify Hate vs. Nonhate Tweets
- Customer Service Requests Analysis
- AI Capstone Project – Finance, Retail, and E-commerce

## Deep Learning with PyTorch OpenCV Course

- **Projects Achieved:**
  - Implement a CNN-based Image Classifier from Scratch with PyTorch
  - Kaggle Competition Classification
  - Object Detection of Automatic Number Plate Recognition
  - Kaggle Competition - Semantic Segmentation

## PyImageSearch Gurus Course

- **Skills Achieved:**
  - Custom Object Detection, Content-Based Image Retrieval (CBIR), Face Recognition, Automatic License Plate Recognition (ANPR), and Hand Gesture Recognition.
  - Deep Learning: CNNs, Transfer Learning, and Object Detection.

## PyImageSearch University ImageNet Bundle

- **Skills Achieved:**
  - Deep Learning for Computer Vision with Python using TensorFlow and Keras.
  - Advanced topics: Super Resolution, GANs, Siamese Networks, and Spatial Transformer Networks.

## Selected Online Courses and Certificates (Udemy)

- Deep Learning for Computer Vision with TensorFlow and Keras
- PyTorch for Deep Learning with Python Bootcamp
- Deep Learning and Computer Vision A-Z: OpenCV, SSD & GANs
- Practical Deep Learning with PyTorch
- Complete Machine Learning - Learn From Scratch

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## Awards & Recognition

- Excellence in Ph.D Thesis Award, ÉTS (2024)
- Best Paper Award, ScienceFather on Document Analysis Conference (2023)
- Dean's Excellence Awards, King Abdulaziz University (2015, 2016)
- Prince Prize for Excellence, University of Hail (2013)

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## Languages

- **Arabic:** Native proficiency
- **English:** Fluent (Professional proficiency, CEFR Level C1)
- **French:** Limited working proficiency (CEFR Level B1, **actively improving**)

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**References** available upon request. High-level endorsements from academic supervisors can be provided as detailed in my Long CV.