Hüseyin PEKKAN

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Ankara, Turkey

AI/ML Engineer | Computer Vision | Robotics | RAG & NLP

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SUMMARY

AI/ML Engineer specialising in **computer vision** (object detection, multi-object tracking, point-based counting, segmentation, EO/GIS imagery), **robotics** (swarm control, learned state estimation, imitation learning, sim-to-real transfer, ROS 2) and production NLP/RAG systems. M.Sc. student in Robotics at METU, doing research on swarm robotics and bio-hybrid honeybee robotics. Experienced building end-to-end pipelines from raw sensor and video data to trained models, closed-loop evaluation and deployed FastAPI services, across robotics, legal AI, healthcare imaging and geospatial domains.

CORE SKILLS

Computer Vision | Object Detection & Tracking | Swarm Robotics | State Estimation | Imitation Learning | Production ML | NLP/RAG | System Design | Experimentation | Mentoring

TECH STACK

Languages	Python, C/C++, Java, JavaScript/TypeScript
Computer Vision	YOLO / YOLOE, P2PNet, U-Net, GAN/DCGAN, BoT-SORT, ByteTrack, OpenCV, Supervision
Robotics	ROS 2 Humble, Unity, KalmanNet / Kalman Filtering, DAgger, Taichi, Crazyflie, ESP32
ML/AI	PyTorch, TensorFlow, Hugging Face, LSTM/GRU, Google Earth Engine
Data & Retrieval	SQL, PostgreSQL, SQLite, pgvector, Qdrant, Redis
Backend & Ops	FastAPI, React Native/Expo, Docker, Kubernetes/K3s, Celery, Linux
Observability	OpenTelemetry, Prometheus, Grafana

LANGUAGES

English: TOEFL iBT 90/120 (CEFR B2, Mar 2026) **Turkish:** Native

INTERESTS

Swarm & bio-hybrid robotics, computer vision & video analytics, legal AI, healthcare AI, EO/GIS analytics, mentoring.

METU ROMER — Center for Robotics and Artificial Intelligence

2026 – Present | Ankara, TR

Research Engineer · Swarm Robotics & Computer Vision

KOVAN Research Lab — Decentralized Neural Swarm Flocking (ICRA 2027 submission)

- **Problem:** Reynolds' alignment rule needs neighbours' headings or velocities, which real robots cannot measure directly; most decentralized flocking methods therefore rely on inter-agent communication or drop alignment altogether.
- **Approach:** Developed a lightweight neural flocking model that pairs a GRU-based **hybrid KalmanNet** estimator (mean neighbour heading plus uncertainty) with an **MLP** that generates flocking forces from local range-and-bearing measurements only, augmented with situational-awareness features (neighbour count, neighbourhood-change events, obstacle proximity).
- **Training:** Trained estimator and controller jointly **in the loop with DAgger imitation learning**, using an extended Reynolds model as the expert policy over 100-boid simulations in Taichi.
- **Sim-to-real transfer:** Transferred the boid-trained model with only linear gain adjustments to Kobot differential-drive robots in the Unity-based **Kobot Hive** simulator (32-zone range-and-bearing, 100 trials) and to physical **Crazyflie** micro quadcopters (Lighthouse motion capture), matching Reynolds' algorithm with ground-truth headings and sustaining flocking order above **90%** throughout all real flights.
- **Infrastructure:** Works on the ROS 2 + Unity swarm simulator and its behaviour nodes; designed a core-limited parallel runner for large multi-experiment batches.

RoboRoyale — Bio-Hybrid Honeybee Robotics (EU Project)

- **Bee counting:** Built a point-based counting pipeline (**P2PNet**) on high-resolution comb scans from an automated XY-scanner; reached **3.04% MAPE** (count MAE 7.64, F1 0.93) on hand-labelled images, outperforming the previous model on all subsets.
- **Data pipeline:** Built ingestion from ∼87 GB of ROS bag recordings and multi-camera image stitching into a labelling and training workflow (local GPU labelling, cloud training).
- **Tracking:** Designing a pollen-trap entrance system with YOLO detection and per-bee tracking that counts directional transits without double counting.
- **Ownership:** Taking over the project codebase (38 repositories); audited and documented its architecture and maintains the

lab's scanning hardware (PLC-controlled XY stages, scheduled scans).

Elvin — AI-Powered Skills & Micro-Credential App 2026 – Present | Ankara, TR

Founding Engineer · AI & Full-Stack

- **What it is:** A gamified learning platform for university students and new graduates that tracks **ESCO** skills with mastery scores from transcripts, CVs, quizzes and activity.
- **AI assessment:** Integrating an LLM-based adaptive assessment engine for transversal skills (5 dimensions, 34 behavioural indicators, BARS levels) with an evidence extractor feeding a deterministic decision engine.
- **Stack: FastAPI** + SQLite backend (learning paths, XP/streaks, job-posting matching), React Native/Expo mobile app, self-hosted production server and mail infrastructure (SPF/DKIM/DMARC); preparing App Store and Google Play launch.

CodeMiner — AdilAnaliz / Owlex Legal AI Platform Sep 2025 – Mar 2026 | Hybrid (Ankara, TR)

AI/Backend Engineer · Legal AI & Computer Vision

Legal AI Platform (Primary Role)

- **What it is:** A production Turkish legal AI platform that delivers cited, real-time answers over legislation and case law — streamed live to the user via SSE, think "Perplexity for Turkish law."
- **Retrieval pipeline:** Designed a dual RAG architecture that first routes user intent to either procedural law (USÜL) or substantive law (ESAS), then retrieves via hybrid BM25 + dense search, re-ranks results with a cross-encoder, and returns answers with strict numeric source citations.
- **Ingestion stack:** Built end-to-end data ingestion — resumable scrapers with proxy rotation and anti-detection, HTML/PDF extraction with OCR fallback, semantic chunking, embedding generation, and storage in **Qdrant** with rich metadata.
- **Backend & infrastructure:** Shipped a clean-architecture **FastAPI** service with async PostgreSQL/pgvector, Redis + Celery task queues, JWT + API key auth, RBAC, rate limiting, audit logs, and usage analytics. Deployed on **K8s/K3s** with TLS ingress, OpenTelemetry tracing, Prometheus/Grafana dashboards, iyzico subscription billing, and auto-generated DOCX petition output.

Marina Vessel-Tracking System (Computer Vision Project)

- **What it is:** A real-time vessel monitoring system running entirely on a single overhead CCTV feed at a marina — no additional hardware.
- **Detection:** Dual-model pipeline — **YOLO26x** for boat detection and **YOLOE-26x-seg** for open-vocabulary travel-lift (cekek) detection.
- **Tracking: BoT-SORT** multi-object tracker, custom-tuned for 10 fps harbour footage with GMC wave-shake compensation to handle water movement artifacts.
- **Business logic:** Zone/line-crossing counting with a debounce state machine, signed cross-product exit detection, mode-switching gate (NORMAL ↔ CEKEK), and a 300-frame zone-absence trigger — producing fully annotated output video with per-pool enter/exit counters and a live HUD.
- **Dashboard:** Desktop operator dashboard in **PyQt6** (live tracking view, records table, hourly density chart), packaged with PyInstaller for macOS and Windows.

UDENE — Horizon Europe Research Project May 2024 – Jan 2026 | Remote (Ankara, TR)

ML Engineer (EO/GIS & Computer Vision) · Full-Stack Developer

Earth Observation & ML

- Developed **EO segmentation workflows** using U-Net on Sentinel/Landsat imagery for remote-sensing and urban heat island (UHI) analysis, with reproducible training and evaluation pipelines.
- Automated large-scale multispectral data ingestion and preprocessing via **Google Earth Engine** for scalable experimentation across satellite datasets.

AI Tooling & Full-Stack

- Implemented an **LLM tool-routing** pattern (intent detection → tool selection → execution → structured output) and exposed it as a **FastAPI** service with a web UI for non-technical research users.

Publications

- Co-authored a paper accepted at **GLOC 2026** (IAF Global Space Conference on Climate Change, Kigali) — "Developing a Virtual Laboratory for Climate Adaptation with the AI-Powered UDENE Tool."

TOBB University of Economics & Technology (TOBB ETÜ) Dec 2023 – Jan 2026 | Hybrid (Ankara, TR)

Research Assistant · AI & Computer Vision

Medical Imaging — Liver Cancer (HCC) Detection

- **Problem:** Limited labelled medical data makes training reliable deep learning models for early HCC (hepatocellular carcinoma) detection extremely difficult.
- **Approach:** Augmented training sets with **DCGAN**-generated synthetic samples to expand effective dataset size without additional real annotations.
- **Result:** Achieved strong validation performance in controlled experiments; co-authoring a manuscript on generative augmentation for medical imaging (in preparation / under review).

NLP — News Classification Pipeline

- Built a full NLP news-classification pipeline with systematic feature engineering and model iteration, supported by structured experiment tracking.
- Reached **87% accuracy**; co-authoring a manuscript on the NLP classification methodology (in preparation / under review).

TEACHING

Union of Municipalities of Türkiye (Türkiye Belediyeler Birliği) Ankara, TR

Lecturer · Practical Applications of Artificial Intelligence (Train-the-Trainer Programme)

- Delivered **32 hours** of lectures on machine learning, deep learning and their mathematical foundations (linear algebra and probability basics), focused on hands-on, practical AI implementation for participants from non-technical backgrounds.
- Participants earned certificates qualifying them as **future AI educators**, who in turn train municipal staff across Türkiye.

SELECTED PROJECTS

- **ESP32 Micro-Drone (from scratch):** Designed the BOM and 3D-printed frame, built the electronics (TB6612 motor drivers, MT3608 boost converter, MPU6050 IMU) and flight firmware.

PUBLICATIONS & PRESENTATIONS

- **From Boids to Robots: Decentralized Neural Swarm Flocking from Local Measurements**. Submitted to IEEE International Conference on Robotics and Automation (ICRA 2027); Co-author. Under Review
- **Deep learning framework for urban seismic risk assessment: a two-phase similarity algorithm for damage prediction and loss estimation**. SPIE FST 2025; Paper 13710-77; Oral Presentation. SPIE Published
- **From spectral indices to actionable insights: sensitivity analysis of a multispectral U-Net for spatially-optimized urban heat island mitigation**. SPIE FST 2025; Paper 13710-62; Co-author. SPIE Published
- **OP-44 Harnessing EO and Natural Experiments for Urban Development: The UDENE Approach**. GeoVISIONS 2025; Co-author. Program Published
- **Developing a Virtual Laboratory for Climate Adaptation with the AI-Powered UDENE Tool**. IAF Global Space Conference on Climate Change (GLOC 2026); Session 3: AI for Climate Adaptation and Resilience; Paper ID: GLOC-2026,T,3,34,x104101; Interactive Presentation; Kigali, Rwanda, 2–4 June 2026. Accepted

EDUCATION

Middle East Technical University (METU) Sep 2026 – Present (expected 2028) | Ankara, TR

M.Sc. in Robotics (with Thesis)

- Research focus: **swarm robotics** and learning-based swarm coordination, with Assoc. Prof. Ali Emre Turgut; programme advisor Prof. Erol Şahin.

TOBB University of Economics and Technology (TOBB ETÜ) 2020 – Apr 2025 | Ankara, TR

*B.Sc. in Artificial Intelligence Engineering · GPA **3.17/4.00***

- Scholarship **50%**; medium of instruction **100% English**.

LEADERSHIP & MENTORSHIP

- Mentored junior engineers on model evaluation, computer vision pipeline design, deployment patterns, and API-first ML system design.
- Created bilingual (Turkish/English) university course materials as Jupyter notebooks on machine learning, deep learning and algorithmic fairness.
- Supported research methods, reproducible experimentation, and practical project execution for student teams.