Muhammet Yağcıoğlu

COMPUTATIONAL MECHANICS ▪ SCIENTIFIC COMPUTING

muhammetyagcioglu@std.iyte.edu.tr | +90 535 830 1141 | İzmir, Türkiye
github.com/adzetto | linkedin.com/in/muhammetyagcioglu

RESEARCH INTERESTS

Isogeometric analysis; NURBS and B-spline discretisation of thin shells.
Finite strain solid mechanics; hyperelasticity, elastoplasticity, consistent linearisation.
Fluid structure interaction at vanishing Reynolds number; magnetoactive materials.
Verification, benchmarking and reproducible scientific computing; open source finite element software.

EDUCATION

İzmir Institute of Technology

2021 to 2026 (expected)

BSc Civil Engineering / *Minor programme in Mathematics*

- Final year project Non linear finite element analysis of solids: formulation, implementation and verification. Abaqus user element and user material subroutines in Fortran.

RESEARCH EXPERIENCE

Research Member, Isogeometric Analysis of Magnetoactive Shells in Stokes Flow

Mar 2025 to present

Department of Civil Engineering, İzmir Institute of Technology / *Principal Investigator: Prof. Dr. İzzet Özdemir*

TÜBİTAK 1001 • Project 224M256 • 2025 to 2027

- Constitutive kernels Wrote and verified the continuum mechanics layer the element formulations are built on: deformation gradient with polar and volumetric deviatoric decomposition, Cauchy and first and second Piola–Kirchhoff stress measures with the push forward and pull back operations between them, hyperelastic tangent moduli, and the consistent linearisation of virtual work that keeps Newton quadratically convergent.
- Verification Patch tests, manufactured solutions and mesh refinement studies in Python and MATLAB, with observed convergence rates checked against the theoretical order. Every element formulation is cross checked against Abaqus and open reference solvers before it enters the production framework.
- Mixed discretisation Divergence conforming spline pairs for the coupled velocity and pressure problem; incompressibility holds pointwise. Inf-sup stability of the chosen pair verified numerically on the discrete operator.
- Shell and coupling Kirchhoff and Love kinematics on C^1 NURBS geometry, which supplies the continuity classical Lagrange elements cannot without rotational degrees of freedom. Magnetoelastic response enters through an augmented free energy carrying a Maxwell stress alongside the mechanical one; interface traction balance and kinematic continuity are solved by Newton iteration on the consistently linearised coupled residual.
- Delivery Derivations, technical documentation and TÜBİTAK period reports in LaTeX, with reproducible builds under Git and GitHub Actions.

Capability Finite strain continuum mechanics from formulation to verified code; isogeometric and mixed finite element discretisation; saddle point stability; consistent linearisation and Newton solution of coupled nonlinear residuals; solver benchmarking against commercial and open references.

Artificial Intelligence Lead and System Architect, Mycellium-Aegis

2025 to present

Pre ignition forest fire detection from buried mycelium biosensors / *adzetto/MYCELLIUM-AEGIS*

TÜBİTAK 1812 BİGG • Entrepreneurship Grant

- Detection Conjunctive rule on rates of change, requiring heat flux rate, drying rate and bioelectric spiking above baseline simultaneously, with cross checking between neighbouring mesh nodes. Replaces a fixed threshold detector, which false alarms on daily and seasonal swings.
- Digital twin Four coupled models solved live: one dimensional transient conduction by explicit finite difference over 61 nodes with moisture dependent diffusivity, a thermally driven drying front, electrode resistance by Archie's law, and 100 Hz bioelectric synthesis matched to measured laboratory amplitude and frequency.
- Finding The twin exposed a fault in the published sensor layout: at the 18 cm depth required for mycelium survival the thermal front arrives after surface ignition. Moving the thermal probe to 5 to 8 cm on the same cable advances the alarm by roughly 25 minutes ahead of ignition and raises nothing in the drought scenario.

- Architecture Measurement chain across two hardware generations, from an ESP32 bench revision to an STM32L4 field node at 1.3 µA in stop mode, with a zero drift electrode buffer, differential RS485 to the surface, 868 MHz radio and solar charging into lithium iron phosphate. Measured budget 4.77 mA at 50 percent duty.

Capability Detector design under a false positive constraint; multiphysics simulation as a design tool; low power mixed signal instrumentation from sensor to radio link; technical ownership of a funded venture.

Research Assistant, Hydraulics and Coastal Engineering Laboratory
2023 to Jan 2025

İzmir Institute of Technology

- Analysis stack Author of the laboratory's wave data analysis software: acquisition parsing with per probe calibration, separate windowing for regular and irregular runs, FFT peak detection, a time domain zero up crossing engine returning wave height and period statistics with a Rayleigh fit, multi probe incident and reflected separation, and a filter bank spanning Kalman, Savitzky–Golay, ARIMA and wavelet transform. LaTeX and Excel report output.
- Spectral model JONSWAP simulation against measured irregular seas, integrated by trapezoidal quadrature for the spectral moments and the sea state parameters that follow from them, with surge, heave and pitch natural frequencies for downstream checks.
- Instrumentation Welch and short time Fourier estimation for non stationary records; MATLAB and Simulink proportional integral derivative control of the wave generator commanded by JONSWAP parameters; multi channel probe acquisition at 1 kHz with real time processing.

Capability Laboratory instrumentation and closed loop control of an experimental rig; statistical signal processing for non stationary records; turning a manual procedure into a reproducible pipeline.

Research Assistant, TÜBİTAK Road Safety Projects
2023 to present

- Dynamic speed limit algorithm coupling road friction coefficient to vehicle stopping distance under precipitation; numerical integration of non linear adverse weather friction models on the microcontact theory of Greenwood and Williamson; ESP32 acquisition of OBD-II vehicle parameters for field data collection.

RESEARCH SOFTWARE

[1] **femlabpy.** Finite element library for Python. pypi.org/project/femlabpy adzetto/femlabpy
Sole author. Ported from the MATLAB and Scilab FemLab codebase and extended past it. Plane stress and plane strain elasticity, potential flow, large deformation bar elements with load path tracing; von Mises and Drucker–Prager return mapping with consistent algorithmic tangents; Dirichlet elimination and Lagrange multipliers, general linear constraints, periodic pairing and computational homogenisation; Newmark, HHT alpha and central difference integration, modal analysis, Rayleigh damping and seismic time history; Gmsh import and post processing. Benchmarks for the documented claims run in continuous integration.
Verification 32 by 4 quadrilateral cantilever: static tip deflection agrees with OpenSeesPy to 0.000 percent, first three natural frequencies to within 0.02 and 0.47 percent. Seismic time history, Düzce BOL090 at 0.82 g, 5,590 steps at 10 ms: peak roof displacement 5.848 mm against 5.850 mm, 0.67 percent root mean square difference across the record, solved in 1.12 s against 141 s for CalculiX.

[2] **MOTOMAP.** Routing engine for motorcycles. alipasha03/motomap
Joint author; owns the cost model, the estimation theory and the search kernels. Multiplicative edge cost over road class, surface, gradient and mode, with Bureau of Public Roads congestion blended against live speed under a confidence weight. Lane filtering modelled as a bounded low speed manoeuvre under published differential and ambient caps. Lane counts absent from the map imputed by empirical Bayes under Lidstone smoothing; the motorcycle against car speed differential estimated per road class and congestion bin by James–Stein shrinkage.
Search Bidirectional Dijkstra over compact indexed adjacency, toll allowed and toll free variants in one call; compiled customizable contraction hierarchy in Cython under nested dissection ordering, 177 fold kernel speedup at identical results; edge expanded turn aware graph in which forbidden manoeuvres are structurally absent, agreeing exactly with the turn aware oracle at 6.7 times the speed and now the default router; exact Held–Karp multi stop ordering. Live traffic assimilation by joint distance and bearing map matching at 94 percent route coverage. 1,145 passing tests.

TECHNICAL REPORTS

[1] **MOTOMAP: cost model, estimation theory and hierarchy construction.** Technical report, 116 pp., 2026. Joint author. Full lane filtering mathematics, edge expansion theory with proofs, kernel against service benchmark analysis and a nineteen entry defect log.

[2] **Non linear finite element analysis of solids.** Final year project report, İzmir Institute of Technology, 2026. Kinematics, polar and distortional decomposition of the deformation gradient, stress measures, the spatial material tangent and the linearised virtual work principle.

[3] **TÜBİTAK 1001 Project 224M256 periodic reports.** Co-author, 2025 to present. Derivations and technical documentation in LaTeX under reproducible builds.

SELECTED PROJECTS

Non Linear Finite Element Analysis of Solids
2025 to 2026

Fortran, Abaqus, MATLAB, Python, Julia / *adzetto/final_year_project*

- User subroutines Abaqus user element for an eight node hexahedral brick with its own constitutive module and output routine, verified case by case against the built in equivalent; user material subroutine for the thermomechanical response of shape memory alloys.
- Reference codes FLagSHyP restructured into eleven independent modules in MATLAB, with a Python port reproducing identical results and experimental arc length variants. Three implementations cross checked against one another.

Non Linear Truss Analysis with Path Following
2025

Python, NumPy / *adzetto/CH3_CODE*

- Equilibrium path tracing under simultaneous geometric and material non linearity on a logarithmic strain measure conjugate to the Kirchhoff stress. Isotropic hardening resolved at the material point by elastic predictor and return mapping with the consistent algorithmic tangent; internal force derived exactly and the stiffness split into material and geometric contributions.
- Instability Arc length control in a predictor corrector scheme through snap through and snap back past limit points. Benchmarks: shallow truss dome under central load, deep circular arch with unstable branches, Lee's frame clamped and unclamped.

Sea Level Analysis from Turkish Tide Gauge Records
2026

Python, pandas, harmonic analysis / *adzetto/marine_analysis*

- Fourteen stage reproducible pipeline over TUDES records, separating the Bozyazı station into tidal and non tidal components across 8.7 years of fifteen minute samples. Automated rejection of spikes, constant blocks and stuck sensors, audited by a separate verification stage.
- Products Constituent amplitude and phase, the full standard datum set from highest to lowest astronomical tide, and the non tidal residual characterised by distribution, density and exceedance curve. Analysis window end matched to a published study; the unmatched start date is a property of the archive and is documented as such.

GPS L1 Software Defined Radio Front End
2025

Python, SciPy / *adzetto/gps-sdr-pipeline*

- Offline conversion of raw eight bit real samples at 26 MS/s into interleaved complex baseband, with a verification hook at every stage: Hilbert analytic signal to suppress negative frequencies, numerically controlled oscillator translation from 1,569.03 to 1,575.42 MHz with the phase accumulator carried across chunk boundaries, polyphase resampling to 2.048 and 4.096 MS/s at 60 dB stopband attenuation, and scalar quantisation under automatic gain.

Five Storey Reinforced Concrete Moment Frame, Capacity Design
2026

SAP2000 v26.3 with the Open API, AutoCAD, TBDY 2018, TS 500 / *Course CE424*

- Seismic assessment of a planar frame in Karabağlar, İzmir, on class ZD soil at the DD-2 hazard level. Cracked section stiffness at 0.70 of gross for columns and 0.35 for beams; strong column and weak beam verification at the joints; shear sufficiency across every member; joint panel capacity verification under seismic load.
- Automation Model construction, load case management and result extraction driven through the programming interface. Parameter studies repeatable; output written straight into the report.

DASK 2026 Earthquake Resistant Building Design Competition, Twin Towers
2026

OpenSees with Tcl, Python, Rust, SAP2000, TBDY 2018 / *adzetto/DASK_26___DESIGN_AND_ANALYSIS*

- Scheme Bridge connected twin towers on an outrigger bracing system, realised as a 1:50 balsa model. The outrigger engages the perimeter columns as an axial couple against overturning; section properties were calibrated to the balsa members before analysis.
- Seismic analysis OpenSees model in Tcl carrying modal, non linear pushover and non linear time history analysis. Pushover on the calibrated stick model reached 13.47 kN base shear at 6.12 cm roof displacement over 612 steps, a 4 percent drift, first mode period 0.40 s against 0.33 s from modal analysis; ten modes extracted.
- Code assessment TBDY 2018 A1a torsional irregularity check with the eccentricity amplification of clause 4.7.4, and a Rayleigh damping parametric study sweeping the damping ratio from 0.5 to 20 percent to bound the time history response.

- Tooling *dask-modeler*, an interactive structural modeller written in Rust on an entity component system architecture: node, element, section, material and restraint commands behind a full undo stack, copy, mirror and node merge operations, and a three dimensional viewport with grid snapping.

Portable Electrocardiogram System (Hayatın Ritmi), Contributor

2026

TÜBİTAK 2209-A | Kotlin, TensorFlow Lite, STM32, Bluetooth Low Energy | adzetto/hayatin_ritmi

- Wearable twelve lead chain on four ADS1293 converters at 24 bit and 250 Hz with an STM32F103 and an nRF52832 radio. Depthwise separable one dimensional convolutional classifier, 176,599 parameters and 38.7 M operations, trained on 26,395 twelve lead records across 55 diagnostic classes: macro AUC 0.9517 in PyTorch and 0.9334 after eight bit integer quantisation, at 231.6 kB and 0.84 ms per inference on the processor.
- On device infinite impulse response filtering, Pan–Tompkins R peak detection and twelve lead fusion behind a repository pattern radio abstraction, with a synthetic waveform simulator standing in for hardware during development.

Electric Vehicle Control Architecture, İYTE Voltaris

Jan 2024 to Oct 2025

Teknofest Efficiency Challenge | MATLAB, Simulink, C, C++, Altium Designer, ANSYS Fluent, JMAG Designer

- Motor control Sensorless permanent magnet synchronous motor control on a Holtz flux observer, field oriented control with the Park and Clarke transformations and space vector modulation, and active disturbance rejection control in simulation. Third order position and speed observer with field attenuation and cross coupling compensation.
- Simulation and hardware Computational fluid dynamics in ANSYS Fluent to a drag coefficient of 0.28 through iterative mesh refinement, battery cooling thermal analysis, electromagnetic analysis in JMAG Designer for torque density, buck boost converter topology, and four layer STM32 controller boards with CAN.

AKS Vehicle Control Firmware

2025

C, STM32F411RE, ARM GNU toolchain, CMake, PlatformIO, Unity | adzetto/AKS

- Layered firmware separated into core, communication, sensor, actuator, safety, utility and hardware abstraction layers, with a cross compiled target and a parallel host build for host side unit testing. Motor torque control, regenerative braking and energy management.
- Safety and assurance High voltage isolation resistance monitoring with a 200 kΩ warning and a 50 kΩ trip wired into the emergency path; separate unit and integration suites under Unity with a mock layer and a coverage target in the build system.

FURTHER WORK

Computational Lattice Boltzmann flow experiments against a graphics accelerated solver (C++, OpenCL, FluidX3D), upstream authorship attributed. Fifty three Julia implementations of numerical methods and statistical procedures written without library shortcuts. Finite element laboratory exercise set in four languages behind femlabpy.

Structural and coastal Harbour site selection across a coastal band on protection status, depth, exposure and land access, resolving to an open coast fishery and shelter site at Dikili 9.1 km from the existing harbour, CE480. Two dimensional seepage by flow net construction, CE361.

Signal and learning Single lead electrocardiogram classification with knowledge distillation: three class task standardised across four PhysioNet databases, splits at patient level, three label purity modes, multi lead teacher distilled into a single lead student (adzetto/ECG-ResNet-Distillation). Hydrophone pipeline for fish feeding intensity: dataset characterisation identified ten low energy and five mains dominated recordings as the cause of pretrained network collapse; classifier at 0.724 accuracy and 0.677 macro F1, raised to 0.768 and 0.761 by late fusion. Around 109 MATLAB scripts spanning eigenstructure beamforming, null steering, frequency modulated continuous wave processing, recursive least squares and spectral estimation.

Embedded and systems Three phase brushless gate driver firmware with dead time inserted in the hardware modulation peripheral rather than in software, with per phase current sense and a documented bring up procedure. Advanced driver assistance stack: structure aware lane detection in PyTorch, traffic sign recognition on TensorFlow Lite, a full screen Qt interface on Raspberry Pi, and a MobileNet classifier taken through the Hailo toolchain as a separately inspectable quantisation stage. Live telemetry dashboard isolating serial acquisition from presentation by a reader thread.

Software and systems Kernel boundary packet handling in Go and eBPF: a socket operations hook inside the Linux TCP stack, and a virtual interface transparent proxy terminating TCP through a userspace network stack elsewhere. Offline single file browser reading application with click to gloss, translation, parallel audio and spaced repetition over a 65,121 word public domain corpus. Unit price and financial analysis platform on a multithreaded C++ engine with JSON ingestion, work breakdown structure linking and schedule against cost

integration. Team website in React and Three.js, with document builds moved into continuous integration.

PROFESSIONAL EXPERIENCE

Civil Engineering Intern, Office Division, ES Denizcilik
Aug to Oct 2025

Menemen, İzmir | Quantity surveying, tender pricing and progress payment control at a marine construction contractor

- Quantity surveying Full take off for the Hatay Metropolitan Municipality Arsuz solid waste facility across five buildings and external works, rough and finishing trades priced independently, bank against compacted volume distinguished for trenches, and repetitive warehouse bays standardised.
- Progress payments Files for the ISDEMIR port earthquake damage rehabilitation scope, every position item mapped onto the ledger triple of total executed, previous total and current period. Independent verification of a concrete barrier claim, reconstructed from the drawings.
- Tender pricing Pricing study for a maintenance hangar and fire extinguishing building at Afyon Airport across two cost centres, mapped item by item onto authoritative unit price sources, with composite rates built up from labour, material and equipment where no direct analogue existed.

Civil Engineering Intern, Field Division, Folkart
Jul 2024

İzmir | Site based construction internship, residential and mixed use development

Voluntary Field Internship, Ümsan İnşaat
Jan to Feb 2024

Bornova, İzmir

- Reinforced concrete inspection by ultrasonic pulse velocity across more than fifteen structural elements; quantity take off from building information model data for a 3,500 m^2 development; reinforcement placement and cover survey by ground penetrating radar.

TEACHING, OUTREACH AND SERVICE

Undergraduate Laboratory Assistant, İzmir Institute of Technology
Aug 2024 to Jan 2025

Hydraulics and coastal laboratory | Wave generation, multi channel instrumentation and spectral estimation

Technical Lead, Engineering Workshop Programme
2022 to 2023

- Parametric modelling workshops in Grasshopper and Rhino for more than forty engineering students, with training material developed on finite element methodology for structural optimisation.

Community Infrastructure Volunteer
2024

- Structural feasibility assessment of a 120 m^2 community centre by non destructive testing, needs analysis over more than 250 survey responses, and a geographic information system model prioritising infrastructure for resource allocation.

TECHNICAL COMPETENCIES

Computing Python (NumPy, SciPy, Cython, pytest), C, C++, Fortran, MATLAB, Julia. Go, Kotlin, TypeScript and Dart at working level. Git and GitHub Actions, CMake, PlatformIO, Docker, PyPI packaging.

Computational mechanics Linear and non linear finite elements, finite strain hyperelasticity, elastoplasticity with von Mises and Drucker–Prager return mapping, isogeometric analysis on NURBS and B-spline bases, arc length continuation, Newmark and HHT alpha integration, pushover and seismic time history analysis, computational homogenisation, Stokes flow, lattice Boltzmann methods.

Analysis software Abaqus with user element and user material subroutines, OpenSees and OpenSeesPy, CalculiX, Gmsh, SAP2000 including the programming interface, ETABS, ANSYS Fluent, JMAG Designer, Altium Designer, QGIS.

Signal processing and learning Fast Fourier and short time Fourier transforms, Welch spectral density, spectral moments and JONSWAP modelling, zero up crossing analysis, wave reflection separation, Kalman and Savitzky–Golay and wavelet filtering, polyphase resampling, Hilbert analytic signals. PyTorch and TensorFlow Lite, knowledge distillation, eight bit integer quantisation for edge accelerators, empirical Bayes and James–Stein shrinkage, subject level validation design.

Embedded and instrumentation STM32 with the hardware abstraction layer and ARM GNU toolchain, ESP32, STM32L4 low power design, CAN, RS485, SPI, I^2C, long range radio, Bluetooth Low Energy, OBD-II, gate driver and power stage design, four layer board layout, field oriented control of synchronous and brushless machines.

Languages Turkish (native). English (fluent; all work documented above was written in English).

References available on request. Last updated 8 August 2026.