Kemal Kaan Keseroğlu

Mechatronics Engineer | R&D Team Lead

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Professional Summary

Mechatronics engineer with 4+ years of hands-on experience in autonomous vehicle conversion, industrial robotics, and full-cycle hardware product development. Core expertise spans mechanical design (SolidWorks, Fusion 360, FEA, sheet metal, custom gear design), electrical/electronics engineering (E-Plan schematics, KiCad PCB design, industrial control panel design, CAN-bus reverse engineering, inline signal intercept), safety systems (SICK FlexiSoft PLC programming, safety zone configuration, Performance Level calculation, CE Machinery Directive compliance), and ROS-based autonomous navigation. Designed and owns the Symphony modular hardware platform — a proprietary product family of autonomous vehicle conversion modules deployed at Mercedes-Benz, Arçelik, Ülker, and Colgate production facilities. Parallel track in indie software/app development with live products on App Store and web platforms built with Flutter, React/Next.js, and WordPress.

Work Experience

SK Teknoloji — R&D Team Lead — Mar. 2025 – Present

Istanbul, Turkey

- Leading full-cycle hardware development of autonomous mobile robot platforms from concept through field deployment: mechanical CAD design, electrical schematic design (E-Plan), component selection and sourcing, bill of materials (BOM) management, wiring harness design, industrial control panel assembly, and on-site commissioning
- Owning the **Symphony** modular hardware platform — a proprietary family of autonomous vehicle conversion modules (symphonydrive, symphonysense, symphonycamera, symphonysteer) developed from initial concept through production-ready field deployment; responsible for all mechanical, electrical, and PCB design across the product family
- Managing cross-functional coordination between mechanical, electrical, and software engineering teams on concurrent robotics projects deployed in active industrial environments at major clients including Mercedes-Benz Aksaray, Arçelik, Ülker Gebze, and Colgate
- Conducting on-site vehicle analysis for new platform integrations: determining conversion architecture, mapping OEM communication topology (CAN-bus message sets, EtherCAT networks, Profinet configurations), and selecting components for each unique vehicle platform
- Overseeing hardware replication and quality control for fleet-scale deployments (up to 22 vehicles per site)

SK Robotik — R&D Engineer — Mar. 2021 – Mar. 2025

Istanbul, Turkey

Autonomous Vehicle Conversion — Mechanical Design

- Executed end-to-end autonomous conversion projects for three distinct vehicle platforms: Yale ERP-30VL electric forklift, Jungheinrich ETV-216 reach truck, and Still LTX-70 tow tractor — each requiring unique mechanical, electrical, and communication solutions tailored to the specific OEM platform
- Produced 35–50 custom mechanical part drawings per conversion project in SolidWorks and Fusion 360, covering: sensor mounting brackets (LiDAR, radar, safety laser scanner), cable tray systems, enclosure brackets, steering actuator housings, vehicle-specific adapter plates, and structural reinforcement components
- Performed FEA (Finite Element Analysis) on critical structural components — static stress and thermal simulations — and revised designs based on simulation results to ensure mechanical integrity under operational loads
- Designed all sheet metal enclosures and brackets using SolidWorks Sheet Metal: performed K-factor and bend radius calculations, produced DXF flat patterns, and prepared complete bend instruction packages for external fabrication suppliers

- Specified tolerances manually on all technical drawings for machined and fabricated parts; delivered complete drawing packages including material specifications, surface finish requirements (primarily powder coating for metal parts), and dimensional tolerances
- Worked with a broad range of materials: steel and aluminum sheet/plate for structural components and enclosures, 3D-printed parts in PLA, PETG, ABS, Nylon (FDM) and SLA resin for prototyping and non-structural components; all metal parts powder-coated for corrosion protection and professional finish
- Designed and fabricated custom CNC-machined spur gears for the symphonysteer steering actuator module: one gear press-fitted onto the stepper motor shaft, one onto the steering shaft; connected via GT4-profile toothed belt for zero-backlash torque transmission; gear ratio calculated based on field-measured steering torque (measured using a torque wrench applied directly to the steering wheel/shaft)

Autonomous Vehicle Conversion — Electrical & Electronics Design

- Produced full electrical schematics in E-Plan for every conversion project: complete wiring diagrams, cable numbering schemes, terminal block diagrams, and wiring interconnect drawings covering the entire autonomous vehicle system from sensor inputs through control logic to actuator outputs
- Designed and assembled industrial control panels from scratch for each conversion: defined the complete internal architecture including safety-rated PLC (SICK FX3CPU), power contactors, relays, terminal blocks, industrial fanless PC, CAN-bus interface module, managed industrial Ethernet switch, industrial Wi-Fi client, and multi-rail DIN power supply system — every component individually selected and specified based on IP rating, vibration tolerance, operating temperature range, and communication interface compatibility
- Defined the complete communication architecture per vehicle platform: evaluated and integrated combinations of CAN-bus, RS-485, RS-232, Profinet, EtherCAT, DeviceNet, IO-Link, and Ethernet/IP protocols based on the vehicle's OEM communication interfaces, sensor requirements, and real-time performance constraints
- Performed field analysis of each vehicle prior to conversion: mapped OEM wiring harnesses by physically tracing cable runs, identified all relevant connectors and pinouts, documented signal types and voltage levels for throttle, braking, steering, and vehicle status signals
- Reverse-engineered OEM CAN-bus communication on each vehicle platform using BUSMASTER: connected to the vehicle's CAN network, systematically captured raw CAN frames during manual vehicle operation (driving, steering, braking, lifting), filtered and analyzed traffic patterns to isolate and decode arbitration IDs corresponding to throttle position, brake command, steering angle, and vehicle status messages; mapped the complete message set required for autonomous control
- Used Wireshark for network-level protocol analysis and debugging on Ethernet-based industrial communication (Profinet, EtherCAT) during system integration and commissioning
- Designed passive inline intercept PCBs in KiCad for vehicle OEM signal manipulation: the board splices between the vehicle's OEM motherboard/ECU connector and the original wiring harness; incoming OEM connector pins are routed to terminal blocks on the intercept board, where target signals (throttle, brake, steering) are redirected to the autonomous control system for manipulation, while all remaining signals are passed through unmodified directly to the OEM motherboard — achieving vehicle control without any modification to OEM software or firmware; boards are purely passive (terminal blocks, trace routing, connectors) with no active components
- Vehicle control achieved through two simultaneous methods: (1) CAN-bus message injection — transmitting decoded control messages onto the vehicle's CAN network to command throttle, braking, and steering functions, and (2) analog signal manipulation — intercepting and overriding analog voltage/current signals for functions not accessible via CAN

Safety Systems & Certification

- Configured SICK safety sensor systems end-to-end for every conversion project: parameterized safeRS3 safety radar, nanoScan3 safety laser scanner, and microScan3 safety laser scanner sensors — including field of view configuration, detection zone geometry, response times, and object classification settings
- Programmed SICK FlexiSoft safety PLC systems in SICK SafetyDesigner: configured and wired FX3CPU main processing unit with expansion modules including GMOD (general monitoring), Gateway module,

XTIO (extended I/O), Safety Encoder Module (for monitoring vehicle speed/position), and Profinet Module (for integration with plant-level networks)

- Designed safety zone geometries tailored to each deployment environment: defined warning zones, protective stop zones, and reduced-speed zones based on vehicle operating speed, braking distance, and facility layout; configured dynamic zone switching logic to automatically adjust safety zones based on vehicle speed and direction of travel
- Performed Performance Level (PL) calculations per EN ISO 13849 for each safety function: verified that the complete safety chain (sensor → safety PLC → actuator) met the required Performance Level for the application
- Supported CE certification process under the Machinery Directive (2006/42/EC) for autonomous vehicle systems: coordinated with a third-party certification body, provided all required engineering deliverables including technical documentation, risk assessment inputs, and safety function specifications; managed the documentation exchange and audit process

ROS-Based Autonomous Navigation Software

- *Note: Software contributions were at a beginner-to-intermediate level; primary responsibilities were hardware and electrical, with hands-on involvement in ROS integration and tuning*
- Worked with multiple SLAM (Simultaneous Localization and Mapping) algorithms across projects to evaluate performance in different industrial environments: gmapping (2D grid-based, laser-only), hector_slam (2D, IMU-fused, no odometry required), cartographer (Google's 2D/3D real-time SLAM with loop closure), and hdl_graph_slam (3D LiDAR-based graph SLAM for large-scale environments)
- Configured and tuned localization systems for autonomous operation: AMCL (Adaptive Monte Carlo Localization) for probabilistic 2D pose estimation against a known map, hdl_localization (3D point cloud matching for LiDAR-based localization), and cartographer in pure localization mode
- Set up move_base navigation stack: configured local and global costmaps (inflation radius, obstacle layers, static map layers), tuned local planner parameters (max/min velocities, acceleration limits, path scoring), and configured recovery behaviors (rotate recovery, clearing costmap, backing up) for robust operation in dynamic warehouse environments
- Implemented sensor fusion using the robot_localization package: configured Extended Kalman Filter (EKF) node to fuse odometry data (wheel encoders), IMU (inertial measurement unit), LiDAR-based pose estimates, and radar data into a unified, smooth robot state estimate (position, orientation, velocity)
- Generated URDF (Unified Robot Description Format) and Xacro models from SolidWorks CAD assemblies: exported robot geometry, defined joint types and limits, specified sensor positions and orientations, and configured the TF (transform) tree for proper coordinate frame relationships between base_link, laser frames, IMU frame, and odom frame
- All ROS work was done in ROS1 (not ROS2)

Motor Drives, Power Electronics & Actuation

- Selected, sized, and commissioned motor drive systems for autonomous steering and traction control across all vehicle platforms: evaluated and deployed both stepper motors and servo motors depending on the application requirements (torque, speed, precision, cost)
- Worked with multiple motor drive brands: Leadshine (stepper and servo drives), Roboteq (brushless DC motor controllers for traction), and ZLTECH (integrated hub motors and controllers), as well as various no-brand Chinese stepper/servo drives for prototype and cost-sensitive applications
- Performed torque-based motor sizing for the symphonysteer steering actuator: measured the steering torque required to turn each vehicle's steering wheel/shaft at standstill using a calibrated torque wrench, then selected a stepper motor with sufficient torque margin and designed the gear ratio (custom CNC gears + GT-profile belt) to match the required output torque at the target steering speed
- Configured regenerative braking on conversion projects: on OEM vehicle conversions (Yale, Jungheinrich, Still), utilized the vehicle's existing regenerative braking system integrated through the OEM drive controller; on the MA9-PS custom-built solar survey robot, implemented regenerative braking using the motor drive's built-in regen capability combined with an external braking resistor to dissipate excess energy

- Designed RF-based vehicle-to-infrastructure communication systems using 433 MHz transceiver modules: installed transmitters on vehicles and receivers at facility door controllers to trigger automatic door opening/closing as autonomous vehicles approach; deployed across multi-vehicle environments (Ülker Gebze 22-vehicle fleet) for coordinated facility-level interactions

Other Projects

- Designed the complete hardware for an OpenCV-based face recognition terminal, currently deployed at Turkish border crossings (Emniyet Genel Müdürlüğü border control points): designed a custom PCB in KiCad featuring a 40-pin flex cable interface for Raspberry Pi communication, dual optocoupler isolation circuits for signal isolation, relay output for door/gate control, power LED driver circuit for illumination, and multiple dry contact I/O terminals for integration with existing border control infrastructure; hardware design only — the OpenCV-based face recognition software was developed by a separate team member

KME Teknoloji — Co-founder & Developer **2023 – Present**

Istanbul, Turkey

- Co-founded a technology company focused on Electronic Shelf Label (ESL) solutions for retail environments
- Developing modular web-based ESL management systems: hardware device communication layer over BLE (Bluetooth Low Energy), real-time device status monitoring and diagnostics, product/pricing data management, and business process digitalization
- Tech stack: Flutter/Dart for cross-platform mobile and web applications, Next.js (React, TypeScript) for web dashboard and management interface
- Responsible for both hardware communication protocol implementation (BLE device discovery, connection management, data synchronization) and full-stack application development

Hardware Product Portfolio — Symphony Modular Platform

All Symphony modules were designed end-to-end by the author: mechanical enclosures designed in SolidWorks Sheet Metal (K-factor calculation, bend radius specification, DXF flat pattern export with complete bend instructions — fabricated by external sheet metal suppliers from author-produced drawings), full electrical schematics produced in E-Plan (cable numbering, terminal diagrams, wiring interconnect drawings), PCB layouts designed in KiCad (manufactured externally by PCB fabrication houses, SMT and through-hole assembly), component selection and sourcing, bill of materials (BOM) management, wiring harness design, and field integration and commissioning.

symphonydrive — Autonomous Vehicle Conversion Control Unit

- Industrial-grade control enclosure serving as the central hardware module for converting conventional forklifts and tow tractors into fully autonomous vehicles — the core of every conversion project
- Internal architecture designed and specified entirely by author:
  - SICK FX3CPU safety-rated PLC with GMOD, Gateway, XTIO, Safety Encoder, and Profinet expansion modules
  - Power contactors and relays for motor control and safety switching
  - Terminal blocks for all field wiring termination
  - Industrial fanless PC (onboard computer running ROS)
  - CAN-bus interface module for vehicle OEM communication
  - Managed industrial Ethernet switch for internal network
  - Industrial Wi-Fi client for wireless connectivity to facility network
  - Multi-rail DIN power supply system (24V, 12V, 5V rails as required by components)
- Every component individually selected based on: IP rating (minimum IP54 for industrial environment), vibration tolerance (forklift/tow tractor operating conditions), operating temperature range, and communication interface compatibility
- Interfaced to vehicle OEM systems via reverse-engineered wiring harness interception using custom passive inline intercept PCBs; vehicle control achieved through simultaneous CAN-bus message injection

and analog signal manipulation (throttle, braking, steering)
- Successfully integrated into and deployed on: Yale ERP-30VL (electric forklift), Jungheinrich ETV-216 (reach truck), and Still LTX-70 (tow tractor)

symphonysense — Industrial Sensor Interface Module

- Compact Ethernet I/O gateway module designed to bridge M12-connected industrial sensors (both digital and analog) to the onboard computer over standard Ethernet
- Contains an industrial Ethernet I/O device that converts sensor signals to Ethernet packets; eliminates the need for point-to-point sensor wiring runs back to the control panel by allowing sensor arrays to be addressed as networked peripherals directly from the ROS stack
- Mechanical enclosure designed in SolidWorks Sheet Metal; internal PCB designed in KiCad
- Enables modular sensor deployment: additional sensors can be added to the vehicle by simply connecting them to the nearest symphonysense module rather than running new cables to the central control panel

symphonycamera — Embedded AI Vision Module

- Self-contained AI camera module built around the NVIDIA Jetson platform with an integrated camera sensor and onboard inference capability
- Designed for real-time computer vision tasks directly on the vehicle: lane detection, pedestrian recognition, and traffic sign classification — processing performed onboard without requiring cloud or central server connectivity
- Custom enclosure designed with thermal management considerations (heat dissipation for Jetson GPU under continuous inference load); designed for direct chassis mounting on the vehicle exterior
- Mechanical enclosure designed in SolidWorks; interfaces to the vehicle's ROS network over Ethernet

symphonysteer — Electromechanical Steering Actuation Module

- Vehicle-agnostic steering actuator module that attaches to either the steering wheel hub or the steering shaft to enable fully autonomous directional control on any vehicle platform
- Actuation via stepper motor coupled through a custom-designed gear and belt-drive transmission:
  - Two CNC-machined custom spur gears: one press-fitted onto the stepper motor shaft, one onto the vehicle steering shaft
  - GT4-profile toothed belt connecting the two gears for zero-backlash, maintenance-free torque transmission
  - Gear ratio and motor torque sized per vehicle based on field-measured steering load (measured using a calibrated torque wrench applied to the steering wheel/shaft at standstill)
- Mechanical drivetrain housing and mounting system designed in SolidWorks and Fusion 360
- Motor driver circuit and power electronics (motor driver, power supply conditioning, signal interface to ROS control) designed in KiCad

Key Project Deployments

Mercedes-Benz Aksaray — Still LTX-70 Autonomous Tow Tractor **2023–2025**

- Full autonomous conversion of a Still LTX-70 tow tractor for deployment in an active Mercedes-Benz Aksaray production facility
- Responsible A-to-Z: conducted on-site field vehicle analysis, performed OEM wiring harness mapping and CAN-bus reverse engineering (BUSMASTER), designed 35+ custom mechanical parts (SolidWorks, FEA-validated), produced full E-Plan electrical schematics with cable numbering and terminal diagrams, managed complete BOM, designed wiring harness, assembled symphonydrive control panel, configured SICK safety system (sensor parameterization, safety zone design, FX3CPU PLC programming), and managed CE certification documentation with third-party certification body
- Communication interfaces designed and integrated: CAN-bus (OEM intercept and autonomous message injection), RS-485 (sensor communication), Ethernet (internal network and ROS)
- Vehicle operates autonomously in an active truck production facility alongside human workers and manned vehicles

Arçelik — Yale ERP-30VL Autonomous Forklift **2022–2024**

- Autonomous conversion of a Yale ERP-30VL electric forklift for Arçelik production/warehouse facility

- Conducted on-site vehicle analysis, performed CAN-bus reverse engineering (BUSMASTER) and analog signal mapping for throttle and braking, designed full electrical schematics and wiring harness (E-Plan), selected all components, and assembled symphonydrive control enclosure
- Configured SICK safety laser system with nanoScan3 and microScan3 scanners: programmed FX3CPU safety PLC with full safety logic (zone-based protective stops, warning zones, speed-dependent zone switching), performed Performance Level (PL) calculation and field validation
- Communication interfaces: CAN-bus (OEM intercept/injection), RS-485, Ethernet, Profinet (plant network integration)

Jungheinrich ETV-216 Autonomous Reach Truck **2022–2023**

- Performed OEM system reverse engineering and autonomous conversion of a Jungheinrich ETV-216 reach truck
- Full mechanical CAD (SolidWorks), electrical schematic design (E-Plan), BOM management, wiring harness design, and symphonydrive panel integration
- Communication interfaces: CAN-bus (OEM intercept/injection), EtherCAT (high-speed deterministic communication), RS-232 (serial device communication), Ethernet

Ülker Gebze — 22-Vehicle Autonomous iFork Fleet **2024–2025**

- Fleet-scale deployment of 22 autonomous forklifts at Ülker's Gebze production/warehouse facility — the largest fleet deployment in the company's history
- Coordinated hardware replication across all 22 vehicles: ensured component consistency, managed bulk BOM procurement, oversaw parallel assembly of multiple symphonydrive units, and performed site-specific adaptations for each vehicle's operating zone
- Designed and deployed 433 MHz RF transceiver-based vehicle-to-infrastructure communication system: installed transmitter modules on each vehicle and receiver modules at facility door controllers; enabled automatic door triggering as autonomous vehicles approach/depart, providing real-time fleet coordination across the entire facility
- Provided software support for fleet management system integration: vehicle task assignment, traffic management, and multi-vehicle coordination

MA9-SC — Autonomous Cleaning Vehicle **2025**

- Designed the complete system — mechanical, electrical, and software — for a custom-built autonomous cleaning robot operating on a 3,000 m^2 indoor floor area
- Mechanical design: full chassis CAD in Fusion 360 with FEA validation of structural components; designed mounting systems for cleaning mechanisms, water tanks, and sensor arrays
- Electrical design: complete E-Plan schematics, component selection, BOM, and wiring harness design
- Embedded software: path planning algorithms for complete floor coverage, coverage optimization to minimize redundant passes, automatic charging station docking routines, and water tank level management with automatic refill scheduling

MA9-PS — Solar Field Survey Robot **2025–Present**

- Developing a fully autonomous outdoor field robot built from scratch for solar panel installation site analysis and survey
- Full mechanical CAD design, BOM management, and component selection for an outdoor-rated mobile robot platform
- Arduino-based embedded control system: motor control, sensor reading, navigation logic, and communication with tablet-based monitoring application
- Motor drive configuration with regenerative braking: implemented using the motor drive's built-in regenerative braking capability combined with an external braking resistor for energy dissipation during deceleration and downhill operation
- Tablet-based monitoring and control application for field operators

Border Crossing Face Recognition Terminal **SK Robotik**

- Designed the complete hardware for an OpenCV-based face recognition system currently deployed at Turkish border crossings under Emniyet Genel Müdürlüğü (Turkish National Police) at border control checkpoints

- Custom PCB designed in KiCad featuring:
  - 40-pin flex cable connector for Raspberry Pi GPIO/communication interface
  - Dual optocoupler isolation circuits for electrical isolation between the Raspberry Pi logic and external field devices
  - Relay output for gate/door/turnstile control
  - Power LED driver circuit for face illumination
  - Multiple dry contact I/O terminals for integration with existing border control infrastructure (gate sensors, alarm systems, status indicators)
- Hardware design only — the face recognition software (OpenCV-based) was developed by a separate team member
- System is currently operational at active border crossing points

Independent Software & App Development

Parallel to robotics/hardware career, actively developing and shipping indie software products across mobile and web platforms. All projects are self-initiated, self-designed, and self-deployed.

Namaz App — Islamic Prayer Times & Tracking (App Store — Live)

- Flutter/Dart mobile application published on the Apple App Store
- Features: prayer time calculation, prayer tracking, qibla compass, and Islamic calendar
- Tech: Flutter, Dart, Hive (local database), RevenueCat (subscription/in-app purchase management), Google Mobile Ads (monetization), Dio (HTTP client)

Artinit — E-Commerce Platform (Web — Live)

- Full-stack e-commerce platform for art and creative products
- Tech: React, Next.js, Three.js and React Three Fiber (3D product visualization), Prisma ORM, PostgreSQL database, NextAuth (authentication), Framer Motion (animations), Zod (schema validation), WebSocket (real-time features)
- Deployment: VPS with Nginx reverse proxy, SSL certificates, custom domain/DNS configuration

Calma — White Noise & Sleep Sounds App (Launch-Ready)

- Flutter/Dart mobile application for ambient sound mixing and sleep aid
- Features: curated sound library, custom mix creation, sleep timer, background audio playback

WordFall — Typing Speed Game (Launch-Ready)

- Interactive typing game built for speed improvement and gamified learning
- Built with Flutter/Dart

Fitness App — Gym Management Platform (Launch-Ready)

- Full-stack gym/fitness center management platform
- Features: member management, workout tracking, class scheduling, trainer assignment

Kuğu Müzik — Music School Website (Web — Live)

- WordPress-based website for a music school
- Custom design, SEO optimization, and content management
- Deployment: domain/DNS configuration, hosting setup

Education

Istanbul Commerce University 2016–2021
B.Sc. Mechatronics Engineering — Istanbul, Turkey

Handan Hayrettin Yelkikanat Anatolian Vocational High School 2011–2015
Electrical & Electronics Technology — specialized vocational training in electrical systems, electronics, and industrial wiring prior to university

Technical Skills — Detailed Breakdown

Mechanical Design & Manufacturing

- **CAD Software:** SolidWorks (Part, Assembly, Sheet Metal, Technical Drawing, FEA — Static and Thermal simulation), Fusion 360 (Part, Assembly, Sheet Metal, CAM basics)
- **Sheet Metal:** Complete sheet metal design workflow — K-factor calculation, bend radius specification, bend allowance/deduction, DXF flat pattern export, and preparation of bend instruction packages for external fabrication suppliers
- **Technical Drawing:** Manual tolerance specification on all drawings (does not use automated GD&T tools), material callouts, surface finish specifications, and complete dimensioning per manufacturing requirements
- **FEA / Simulation:** Static stress analysis and thermal simulation in SolidWorks Simulation; designs revised and validated based on FEA results before fabrication
- **3D Printing:** FDM printing with PLA, PETG, ABS, and Nylon filaments; SLA resin printing for high-detail prototypes; STL/STEP file preparation and export for both in-house and external printing
- **Custom Machining:** Designed CNC-machined custom spur gears (motor shaft gear and steering shaft gear for symphonysteer); specified material, tooth profile, bore tolerances, and surface finish for external CNC machining
- **Wiring Harness Design:** Schematic-level harness design including connector pinouts, wire gauges, cable lengths, and harness routing (not 3D routing — schematic/2D level)
- **Enclosure & Panel Layout:** DIN-rail panel layout design for industrial control enclosures, component placement optimization for thermal management and wiring accessibility
- **Materials:** Steel (sheet, plate, structural profiles), aluminum (sheet, extrusion), iron; all metals typically finished with powder coating
- **File Formats:** STEP, STL, DXF, SLDPRT, SLDASM, F3D

Electrical & Electronics Design

- **Schematic Design:** E-Plan for full electrical schematics — complete cable numbering schemes, terminal block diagrams, wiring interconnect drawings, and panel layout documentation; produces the complete electrical documentation package for each project
- **PCB Design:** KiCad for schematic capture and PCB layout; designed inline intercept boards (passive signal routing with terminal blocks), sensor interface boards, and application-specific boards (Raspberry Pi interface with optocouplers, relays, LED drivers, dry contacts); PCBs manufactured externally from author-produced Gerber files, both SMT and through-hole assembly
- **Industrial Control Panel Design:** End-to-end panel design and assembly — component selection (safety PLCs, contactors, relays, terminal blocks, circuit breakers, power supplies), DIN-rail layout, internal wiring, and on-site commissioning; all components selected against IP rating, vibration tolerance, operating temperature, and communication interface requirements
- **Signal Conditioning:** Analog signal level shifting, voltage dividers, current-to-voltage conversion for sensor interfaces
- **Component Selection & BOM:** Complete bill of materials management from initial specification through procurement; evaluates components across multiple parameters (electrical ratings, mechanical fit, environmental ratings, cost, lead time, availability)

Industrial Communication Protocols

- **CAN-bus:** Deep hands-on experience in CAN-bus reverse engineering — frame capture, traffic filtering, arbitration ID identification and mapping, message decoding, and autonomous message injection using BUSMASTER; designed systems that simultaneously read OEM CAN traffic and inject control messages for vehicle automation
- **Fieldbus / Industrial Ethernet:** RS-485 (sensor communication, multi-drop networks), RS-232 (point-to-point serial device communication), Profinet (plant-level industrial Ethernet), EtherCAT (high-speed deterministic I/O), DeviceNet (CAN-based industrial automation), IO-Link (smart sensor communication), Ethernet/IP (industrial Ethernet)
- **IoT / Messaging:** MQTT (publish-subscribe messaging for IoT/fleet telemetry), OPC-UA (industrial interoperability)

- **Wireless:** 433 MHz RF transceiver modules (vehicle-to-infrastructure communication), BLE / Bluetooth Low Energy (ESL device communication), Industrial Wi-Fi (vehicle-to-network connectivity)
- **Connectors / Interfaces:** M12 industrial sensor connectors (circular, IP-rated), various automotive and industrial multi-pin connectors for vehicle OEM interfaces
- **Analysis Tools:** BUSMASTER (CAN-bus capture, decode, transmit), Wireshark (Ethernet/network protocol analysis and debugging)

Safety Systems & Certification

- **Safety Sensors:** SICK safeRS3 (safety radar), SICK nanoScan3 (safety laser scanner), SICK microScan3 (safety laser scanner) — complete sensor parameterization including field of view, detection zones, response times, and object classification
- **Safety PLC:** SICK FlexiSoft safety PLC system — FX3CPU main processing unit with expansion modules: GMOD (general monitoring), Gateway (network bridge), XTIO (extended digital I/O), Safety Encoder Module (speed/position monitoring), Profinet Module (industrial Ethernet integration); programmed in SICK SafetyDesigner software
- **Safety Logic:** Designed safety zone geometries (warning, protective stop, reduced speed zones), configured zone switching logic (speed-dependent, direction-dependent zone activation), defined safety function behavior (emergency stop, reduced speed operation, protective field violation response)
- **Performance Level:** Performed PL (Performance Level) calculations per EN ISO 13849 for complete safety chains (sensor → safety PLC → actuator) to verify compliance with required safety integrity levels
- **CE Certification:** Supported CE certification under Machinery Directive 2006/42/EC: coordinated with external certification body, prepared and supplied technical documentation, risk assessment inputs, safety function specifications, and managed audit/documentation process

Motor Drives & Power Electronics

- **Motor Types:** Stepper motors (for precision positioning, e.g., steering actuation) and servo motors (for high-dynamic traction and positioning applications)
- **Drive Brands:** Leadshine (stepper and servo drives), Roboteq (brushless DC motor controllers), ZLTECH (integrated hub motors/controllers), plus various Chinese no-brand drives for prototyping
- **Motor Sizing:** Torque-based motor selection using field measurements — measured required steering torque with calibrated torque wrench, calculated gear ratio for belt transmission, and selected motor with appropriate torque margin
- **Regenerative Braking:** Configured OEM regenerative braking on vehicle conversions; designed custom regenerative braking system on MA9-PS using drive-integrated regen capability with external braking resistor for energy dissipation
- **Transmission Design:** Custom gear and belt-drive systems — CNC-machined spur gears with GT4-profile toothed belt for zero-backlash torque transmission

Robotics & Autonomous Systems (ROS1)

- **SLAM:** gmapping (2D, laser-based), hector_slam (2D, no-odometry), cartographer (2D/3D, loop closure), hdl_graph_slam (3D LiDAR graph-based)
- **Localization:** AMCL (Adaptive Monte Carlo, 2D), hdl_localization (3D point cloud matching), cartographer (pure localization mode)
- **Navigation:** move_base (global/local costmap configuration, recovery behaviors, planner tuning), costmap parameterization (inflation radius, obstacle/static layers), local planner tuning (velocity/acceleration limits)
- **Sensor Fusion:** robot_localization package — Extended Kalman Filter (EKF) fusing wheel odometry, IMU, LiDAR pose, and radar data
- **Robot Modeling:** URDF/Xacro generation from SolidWorks assemblies; TF tree configuration (base_link, sensor frames, odom)
- **Sensors:** LiDAR (2D and 3D), radar, IMU, wheel encoders, safety laser scanners
- **Level:** Beginner-to-intermediate; primary role was hardware/electrical, with hands-on ROS integration and tuning support

Software Development

- **Languages:** Python (scripting, ROS nodes, automation), C/C++ (embedded, Arduino, ROS nodes), Dart (Flutter mobile/web apps), TypeScript/JavaScript (Next.js, React web apps)
- **Mobile / Cross-Platform:** Flutter/Dart — Hive (local NoSQL database), RevenueCat (in-app purchases/subscriptions), Dio (HTTP client), Google Mobile Ads (monetization), background audio, platform-specific integrations
- **Web / Full-Stack:** React, Next.js (App Router, Server Components), Three.js and React Three Fiber (3D web graphics), Prisma ORM, PostgreSQL, NextAuth (authentication), Framer Motion (animation), Zod (validation), WebSocket (real-time communication)
- **CMS:** WordPress (custom themes, SEO, content management)
- **Embedded:** Arduino (sensor reading, motor control, serial communication), Raspberry Pi (GPIO, camera, custom PCB interfacing), NVIDIA Jetson (GPU-accelerated inference, computer vision)
- **DevOps / Infrastructure:** Linux/Bash, Git/GitHub, VPS deployment with Nginx reverse proxy and SSL, Vercel (Next.js hosting), domain registration and DNS configuration
- **Computer Vision:** OpenCV (integration-level — hardware interface for face recognition system; software developed by others)
- **Analysis / Debug Tools:** BUSMASTER (CAN-bus), Wireshark (network protocols), SICK Safety-Designer (safety PLC programming)

Languages

- **Turkish:** Native
- **English:** Professional Working Proficiency