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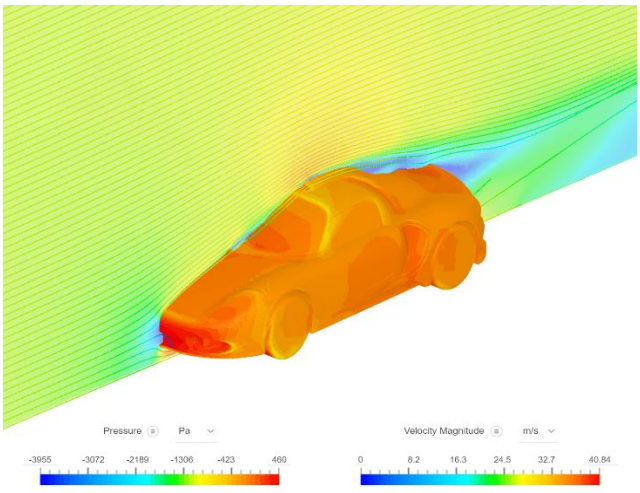
Portfolio of Engineering Projects

ONUK STC-20E Aerodynamics Development

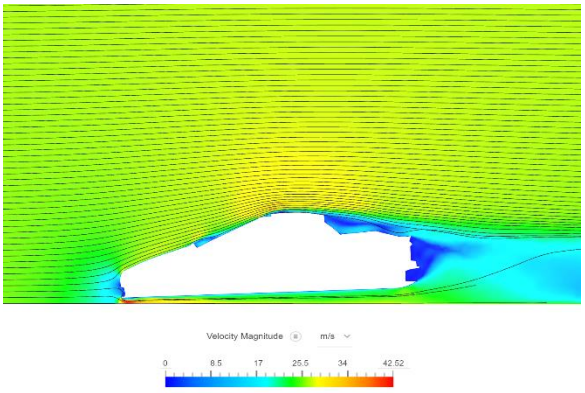
I carried out a full CFD study of the Onuk STC-20E sports car to evaluate its external aerodynamics across a range of operating conditions. The work involved creating a CAD-based model of the car, including separate bodywork and underbody components, simplified wheel and tire geometries with imposed rotation, and a moving ground plane to replicate realistic road conditions.

Alongside analysis, I developed the car's underbody by designing a splitter and rear diffuser, optimizing high-speed aerodynamics and improving downforce generation.

Simulations were conducted in SimScale using a steady-state incompressible RANS solver with the k–ω SST turbulence model. I set up the computational domain, applied appropriate boundary conditions, and developed a refined mesh with localized resolution in shear layers, wheelhouses, underbody passages, and the wake. Both half-car and full-car setups were analyzed to validate aerodynamic balance and center of pressure (CoP) calculations.



The analysis focused on reference speeds ranging from 60 km/h to 200 km/h, where I quantified drag and downforce coefficients (Cd, Cl), efficiency ratios (Cl/Cd), and total aerodynamic forces. I also examined aerodynamic balance and CoP migration with speed, providing insight into vehicle stability. Additionally, I performed a pitch sweep to assess sensitivity of drag and downforce to ride attitude, supported by streamline visualizations and pressure distribution plots.



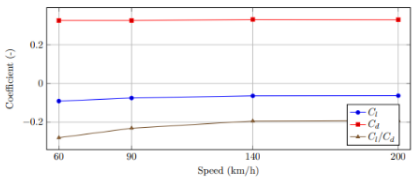


Figure 2: Coefficients vs speed: C_l, C_d, and C_l/C_d.

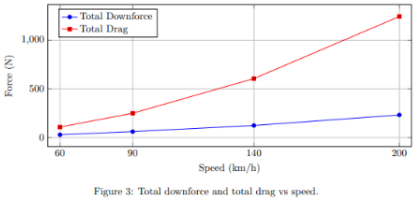


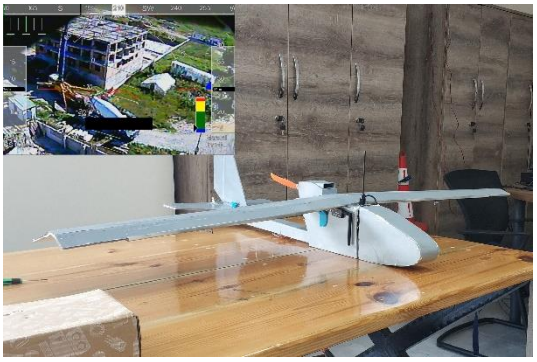
Figure 3: Total downforce and total drag vs speed.

Dartmouth Formula Racing Aerodynamics Development

As the Aerodynamics Lead of Dartmouth Formula Racing FSAE team, I led the development of a comprehensive aerodynamics package for the car, encompassing front and rear wings, an undertray, and sidepods. My primary focus was on maximizing low-speed downforce and aerodynamic , as the package was designed to improve low-speed cornering grip, and drag management around critical components such as the wheels and suspension.

Beyond aerodynamic design, I developed a lightweight carbon & aluminum bodywork, taking full responsibility for composites manufacturing. This included designing molds, performing hot-wire foam cutting for precise geometries, executing carbon fiber layups, and vacuum bagging to achieve high-quality, lightweight components.

I conducted detailed computational fluid dynamics (CFD) simulations in COMSOL and SimScale to evaluate and optimize the aerodynamic package. These analyses included parametric studies across different speeds, rake angles, and cornering scenarios, allowing me to quantify the effects of design changes on downforce, drag, and CoP shift. Results from the simulations directly informed iterative design modifications, ensuring that each component contributed to improved aerodynamic efficiency and target performance consistency.



"Martı" Coastal Search & Rescue UAV Platform

I led the development efforts of a search & rescue UAV platform for Inkumu Lifeguard of the Black Sea. I designed the airframe and structural elements and oversaw the control systems integration.

Considering the windy nature of the coast, the aircraft has a wing loading of around 17 oz/ft^2, similar to RC trainer planes. Salty seawater and high moisture levels decrease the life of the airframe considerably, so the plane was designed around a modular philosophy. UAV mainframe has a low-cost foam composite material and can be easily built and assembled en masse. Electronics-guidance systems and the motor are located on swappable base plates, and these base parts can be easily fitted on another frame after the expected service life of a single airframe.

"Naim" Explosive Ordnance Disposal Robot

"Naim" is an Explosive Ordnance Disposal (EOD) **in active service** within the Police Special Operations Department of Turkey.

I contributed to the development of videolink - telemetry data transfer systems and participated in various manufacturing and assembly processes.

Naim is used by EOD technicians for inspecting and disposing of conventional explosive threats. The robot, weighing around 13 kg, can be easily delivered to the mission location and controlled via a remote control station consisting of a 2.4 GHz encrypted transmitter, a configurable videolink antenna - screen set, and a 433 - 915 MHz dual telemetry data receiver.

The robot can be used for under-vehicle inspections thanks to its relatively small height (<160 mm), and delivery of ignition fuzes for controlled detonations. It is able to carry up to a theoretical +200 kg of payload on its chassis, with the ability to carry +160 kg tested successfully.

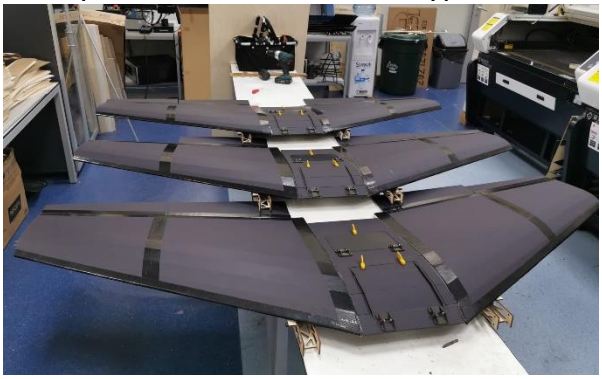
Balaban Autonomous UAV Platform

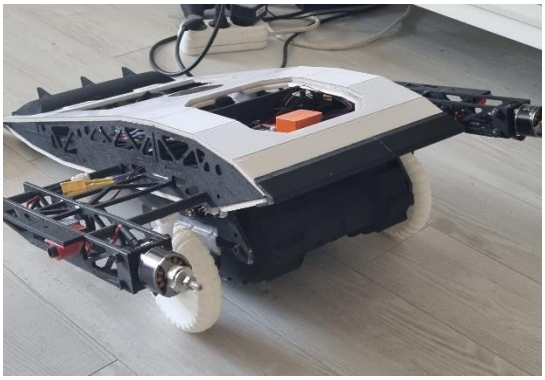
Balaban is an autonomous UAV platform designed for long range (40+ km) missions.

As a part of the design team, I contributed to the airframe and structural design, mostly focusing on the main bodyframe and payload integration systems of the body.

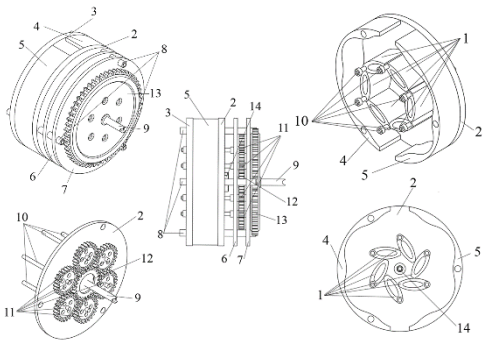
We aimed to design a launch-and-forget UAV platform, comparable in performance to professional applications while costing comparatively less. The main skeletal frame of the UAV is built with CNC laser cutting of birch wood sheets, while the outer surfaces and wings have a silicon-coated polymer foam material.

While it costs less than 2000$, it is similar (and in some parameters rather superior) to the commercial and military UAVs of its class. We have achieved a top speed of 138 km/h (around 85 mph), with a theoretical limit of 150 km/h. With a thrust-to-weight ratio of around 0.9 and wing loading less than 8 oz/ft^2, a range of 40+ km is possible with onboard encrypted telemetry radiolink.





Patent Applications

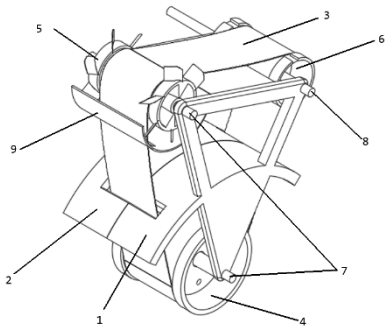


Rotary Expansion Internal Combustion Engine

The Rotary Expansion ICE is the subject of my patent application TR202103765A2 to the Turkish Patent Institute.

It is an engine design aiming to maximize the effective surface area of pistons during the combustion cycle. Pistons are placed on the corners of a hexagonal geometry, and complete two full 360-degree turns in one combustion cycle, forming a closed geometry during roughly 1/3 of the cycle.

More information can be found on the website of the European Patent Office:
https://worldwide.espacenet.com/patent/search?q=pn%3DTR202103765A2



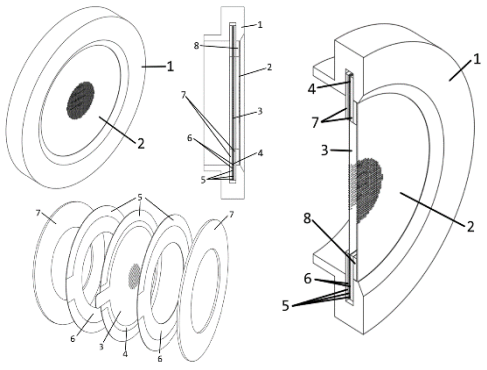
Nitinol Energy Recovery Mechanism

The Nitinol Energy Recovery Mechanism is the subject of my patent application 2021/013055 to the Turkish Patent Institute.

The mechanism recovers energy from water at high temperatures using shape-memory Nickel-Titanium alloys.

Unlike traditional Ni-Ti actuators, the design has three pulleys with different sizes instead of two for ease of movement and uses an alloy strip rather than a wire design, highly increasing the torque.

More information can be found on the website of the European Patent Office:
https://worldwide.espacenet.com/patent/search?q=pn%3DTR2021013055A2



Piezo-Electrostatic Droplet Propulsion System

The Piezo-Electrostatic Droplet Propulsion System is a conceptual design for small-scale electric propulsion applications and the subject of my patent application 2022/001490 to the Turkish Patent Institute.

The system uses two metal mesh grids with a high potential difference. A piezoelectric transducer vibrates the first mesh, triggering a spray of ionized propellant. The propellant is accelerated by the potential difference between the meshes.

More information can be found on the website of the European Patent Office:
https://worldwide.espacenet.com/patent/search?q=pn%3DTR2022001490A2