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Portfolio of Engineering Projects

Unmanned Aerial Vehicles

Balaban Autonomous UAV Platform

Balaban is a 4+ kg class Autonomous UAV platform designed for Long-Range (40+ km) missions.

As a part of the design team and the project planning coordinator, 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 foam-like polymer 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.

"Martı" Coastal Search & Rescue UAV Platform

I coordinated the project and 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.

The project was completely funded by the city municipality, as part of a general funding scheme to decrease incidents of drowning on the Inkumu coast.

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.

Robotics

"Naim" Explosive Ordnance Disposal Robot

"Naim" is an Explosive Ordnance Disposal (EOD) robot platform developed by INTEGRA 3646 team. It is currently 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 less than 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 +300 kg of payload on its chassis, with the ability to carry +160 kg tested successfully.

Air-Launched Rover Payload

Air-Launched Rover Payload is a parachute-launched rover originally designed for the Balaban UAV platform.

I contributed to the design of the drivetrain and parachute mechanisms, set up the RC circuit as well as being the rover operator.

The rover is able to send encrypted real-time video data and data packets to a near aerial or ground platform. It is compatible with a range of sensors and subsystems, and it can be configured to be carried on a Picatinny rail.

Most of the structural parts are 3D printed with elastic TPU material and are able to absorb and disperse the shock during the landing. During the testing process, the rover performed 2-meter free falls on hard concrete surfaces without any damage.

Outputting a shaft torque of 2kg/cm per wheel to four wheels driving the 3D-printed TPU tracks, the rover has shown a sufficient ability to operate in rugged terrain.

Rocket Propulsion Systems

Hydrogen Peroxide - PLA Hybrid Rocket Engine

I designed the engine as a proof-of-concept prototype to test the feasibility of a storable oxidizer-fuel combination for small-scale applications. Potassium permanganate was used as the catalyst for decomposition.

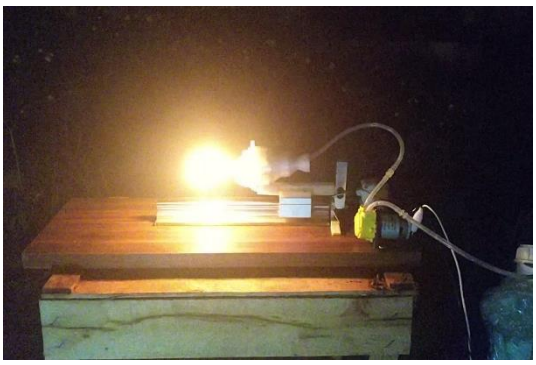
Due to insufficient decomposition of the peroxide, combustion instability occurred. Increasing fuel flow rate achieved sustained combustion but damaged the injector assembly in the process, rendering the engine out of use.

Peroxide Catalyst Stage & Cold Gas Thruster

I designed the engine as a catalyst stage for hydrogen peroxide decomposition.

The catalyst used is potassium permanganate in solid form, with crystals dispersed in polyurethane.

The thruster is tested successfully, achieving stable operation with different propellant flow rates.



Ethanol-H_2O_2 Liquid-Fueled Rocket Engine

I designed the engine to test the feasibility of a liquid-fueled hydrogen peroxide oxidized concept.

The oxidizer stage had potassium permanganate crystals dispersed in a polyurethane coating. Ethanol was injected in front of the grid assembly separating the catalytic stage from the combustion chamber.

Two different types of pumps were used for injection. A peristaltic pump was used for the peroxide oxidizer, while a rotary multi-diaphragm pump with a higher flow rate was used for the fuel.

The engine used a hydrotreated naphtha-based solution for the test firing, achieving combustion successfully.

During the subsequent test firing for thrust testing, the plastic surrounding the main engine block catched fire during ignition. Fire damaged the fuel line, and leaking fuel set all of the testing setup on fire. Most of the engine (except the combustion chamber), sensors and ADC circuit used for thrust testing and control purposes were destroyed.

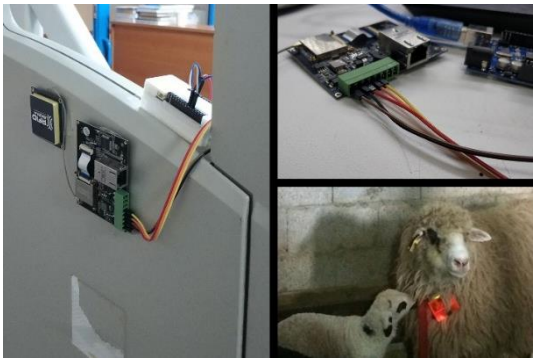
Other Projects

Gas-fed Pulsed Plasma Thruster

I designed the Gas-fed Pulsed Plasma Thruster is a proof-of-concept experimental gas-fed thruster.

Gaseous CO2 is used as fuel and the thruster is operated with a 2kV voltage difference between electrodes. Ionization/ignition is achieved with an additional arcing electrode pair with a 20 kV voltage difference.

Using an Arduino-based controller circuit, it managed to achieve reliable operation at ~1 Hz under atmospheric conditions.



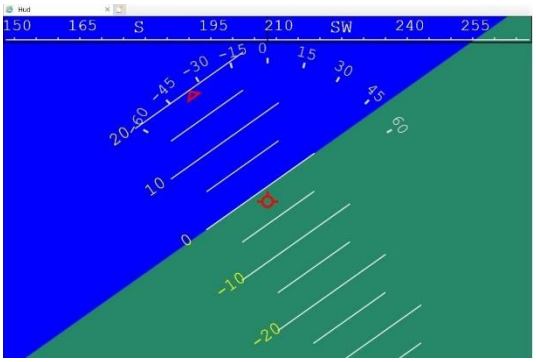
Radio-Frequency Animal Tag Identification System

The system is designed for a farm in Giresun, in northern Turkey.

It uses a UHF Radio-Frequency-Identification (RFID) system to read data of the animal ear tags remotely, with a range of around 3 meters, and uploads the data to the cloud. I designed the hardware assembly and converter circuit as well as contributed to the programming of the Arduino-based processor module.

The RFID module operation consists of a transmitter tag and a receiver module. The receiver sends high-frequency radio waves, inducing a current in the antenna of the tag, and the resulting signal is detected by the reader.

The reader outputs data in RS232 format, and a converter converts the data to TTL protocol, sending it to the processor module. Here, the data is tagged and parsed, then sent to a Wi-Fi module and uploaded to a virtual Linux machine working on the AWS cloud server.

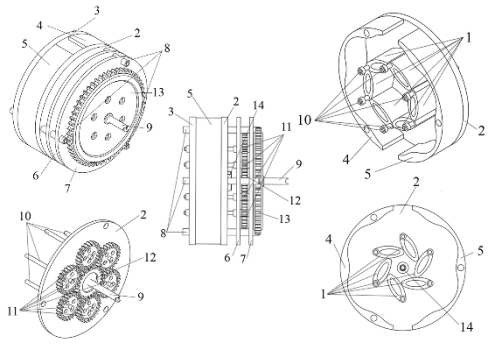


HTML-based Attitude Indicator Module for MAVLink

The software is an HTML-based attitude indication - artificial horizon HUD module, based on the MAVLink protocol for data input and a pipeline for HUD visualization. Heading info and supporting data were also displayed in the interface

Based on Ardupilot libraries, it was tested on both desktop and mobile devices successfully.

Patent Applications

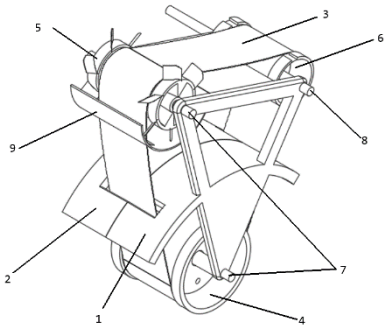


Rotary Expansion Internal Combustion Engine

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



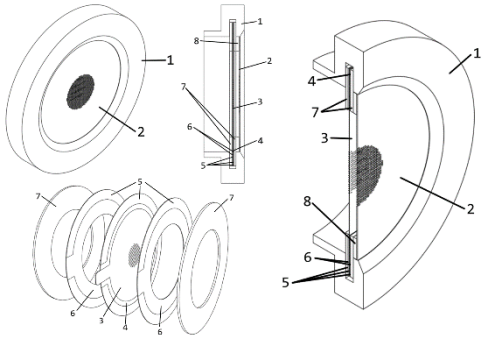
Nitinol Energy Recovery Mechanism

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.

Unlike a gridded ion thruster, in the case of the use of a mixed-ion propellant, both positive and negative ions can be accelerated simultaneously thanks to the velocity of the initial spray.

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