# ENGINEERING PORTFOLIO *TILL 2022*

## Designing and building a Remotely Operated Vehicle from scratch

An in-progress ROV project aimed to be an alternative to the OpenROV design with a minimum design depth of 100 metres. Apart from the usual features expected from an entry-level ROV, it is designed to be modular and built from hobby-grade components. These modular sections, so called compartments, are fastened to each other via a screw-in mechanism eliminating the need for gaskets. The dimensions are based on easily available standard sizes to be able to build it with minimal modifications yet strong and light enough to be useful.

Figure: CAD Design of the ROV with just the main components and wiring hidden.

## SG-90 servo based writing robot

A writer that employs three inexpensive SG90 servos (~$3 total) in a 5-bar/pantograph arrangement controlled by an arduino. To reduce the load on the servos and as an added challenge, styrofoam boards are used as links. The program is capable of writing all of the english alphabets and has functions that draw straight lines and bezier curves to draw custom shapes. The setup is cheap and can be up and running in under thirty minutes. The letters are slightly wobbly due to the SG90's inaccuracy and the flexibility of the styrofoam.
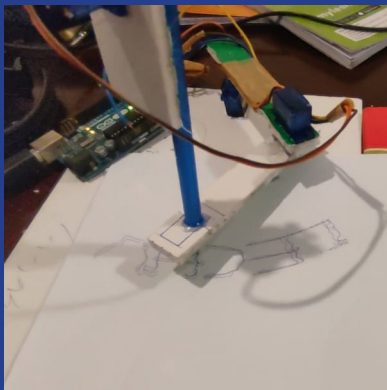
## CFD study of a Two-Way Fluid-Structure Interaction of a flexible hyperelastic tail

This is a CFD study of the two-way fluid structure interaction of a flexible fishtail for the bio-inspired unmanned underwater vehicle project. The study is conducted using both transient structural and RANS-based unsteady fluid simulations coupled through a "System Coupling" node. The tail was initially simulated in the unpowered state and in later simulations a sinusoidal displacement was provided using the User Defined Function (UDF) feature of ANSYS Fluent.
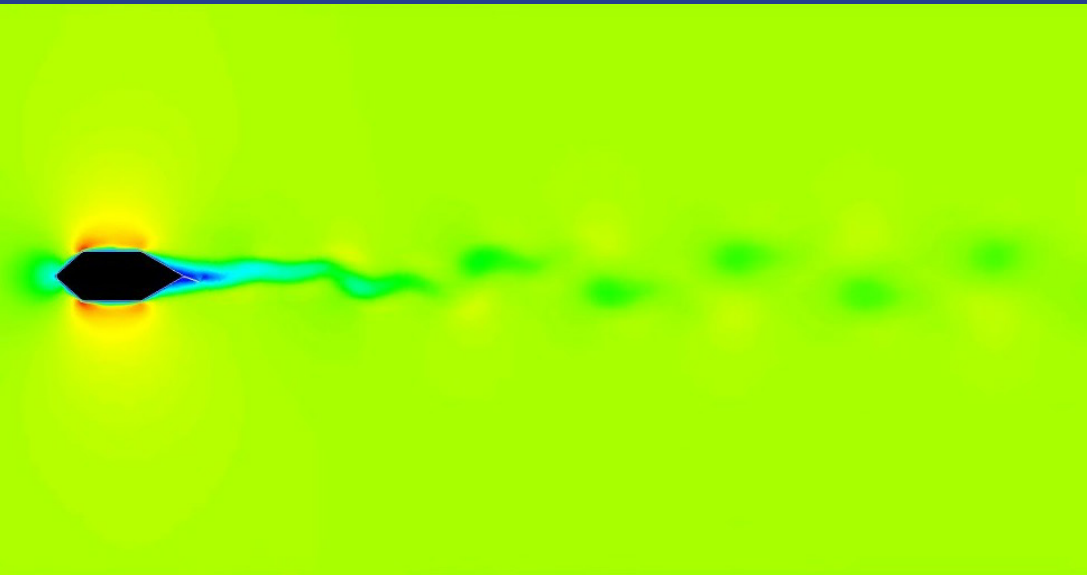
Figure: Velocity field of the FSI simulation

## Acoustic/Optical Wireless Underwater Modem *RESEARCH*

The wireless modem project began as a feature add-on to the ROV project for short-range video transmission. As of now, the transmission and reception is simulated via speakers and microphones, respectively. The modulation/demodulation is taken care by the soundcard and a python program. The system can achieve upto 80kbps and transmit 320x240 video at 24fps as of now, under ideal conditions. Optical comms at low speeds are also simulated by converting optical to acoustic signals and vice-versa. A custom protocol tailored to transmit H-265 video is being developed alongwith a custom TIA and a FPGA-based high-speed OFDM modulator/demodulator.
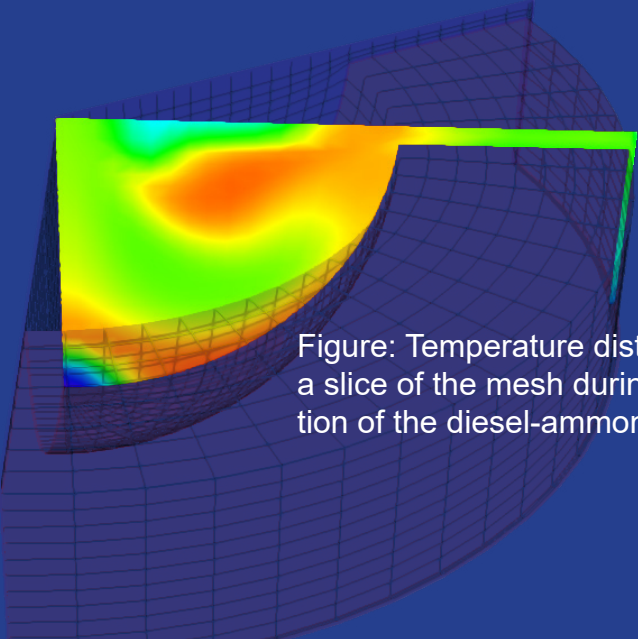
## Analysis of V8 Engine Block using Altair HyperWorks *INTERNSHIP*

This was an internship project at Eleation Pvt. Ltd., a CAE consulting company. Altair HyperWorks was used to repair and mesh geometry, and perform various analyses. The types of analyses used were static and transient structural, modal, thermal, and S-N fatigue analysis. Rigorous mesh checks and grid convergence studies were done in order to ensure the reliability of the results. The analyses were performed with various materials and a suitable one was found.
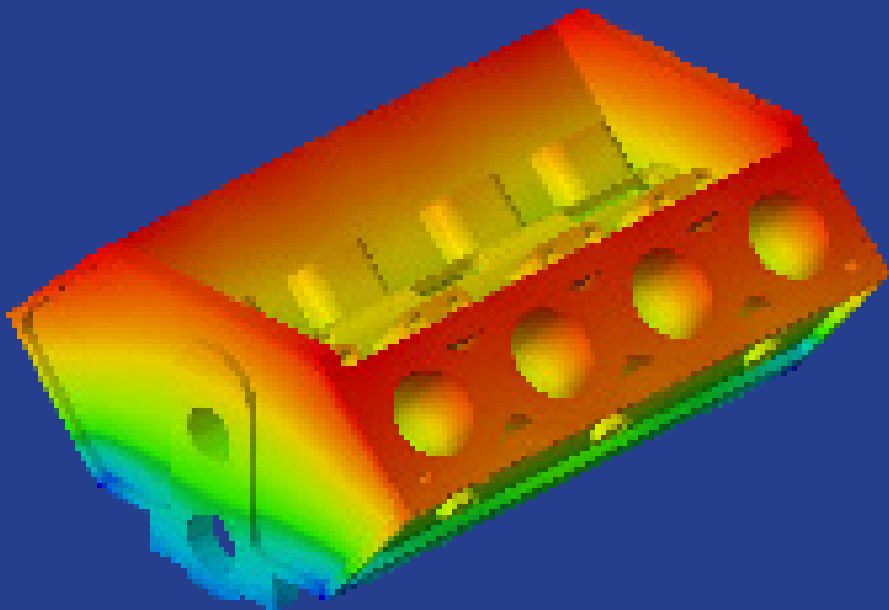
Figure: Displacement due to thermal expansion

Figure: Writer in the process of writing the letters "L E C H U"

## Solar-Powered Electric Stoves: A feasibility study

This is a minor study on the feasibility of portable electric stoves that can sustain itself based only on solar energy. The reasoning is based on first principles and readily available data. It also explores the possibility of electric stoves which partially employs TECs to increase overall thermal efficiency.

## "Towards the development of a bio-inspired shark-shaped unmanned underwater vehicle" *PAPER*

The Bio-Inspired ROV project, codenamed NEMO, has resulted in a conference paper published in the scopus-indexed journal "Sustainable Development and Innovations in Marine Technologies" by Taylor and Francis and presented in the annual congress of the International Maritime Association of the Mediterranean held in Varna, Bulgaria.

## CFD Simulations of Diesel-Ammonia fuel mixtures in Compression-Ignition engines *RESEARCH*

What would happen if ammonia is introduced into a diesel engine's combustion chamber? This is the topic being investigated through CFD modelling. An axisymmetric mesh is created using ANSYS Forte's Sector mesh generator and simulated in Forte. A custom Chemkin file is created for modeling the combustion kinetics of ammonia. A separate simulation written in Python calculates the wall temperature using good old thermal resistance networks. Another script automates the whole process, solving them iteratively. These simulations are repeated for a couple of diesel-ammonia fuel injection amounts. While it is possible that ammonia can be used to augment the engine while reducing $CO_2$ emissions, it requires significantly higher compression ratios and careful timing for this to work properly. In case it is not operating under design conditions, significant amounts of $NH_3$ could be released which is a strong greenhouse gas and a safety hazard.

Figure: Temperature distribution of a slice of the mesh during the ignition of the diesel-ammonia mixture.