**Name(s)**
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**Project Number**
S0302

**Project Title**
# The Boxfish Advantage: A Novel Biomimetic AUV Design for Coral Habitat Research

**Abstract**

**Objectives/Goals**
Significant need exists to develop a submersible that will be able to meet research goals in the spatially complex and turbulent coral reef environments. Superior impact resistance, low drag coefficient, high hydrodynamic stability and maneuverability of Ostracion cubicus (yellow boxfish) point to the performance advantages stemming from the O.cubicus' unique structural adaptations, and as such should be incorporated into a specialized AUV for operating in boxfishes' native coral reef environments. I propose that coral reef research goals can be more successfully met by utilizing a novel AUV design, which leverages Ostracion cubicus' hydrodynamic adaptations. My engineering goal was to design the body of a specialized AUV for coral habitat research, which leverages unique hydrodynamic adaptations of Ostracion cubicus and performs within 15% or better of O.cubicus in the areas of drag (as characterized by drag coefficient, Cd) and stability (as characterized by turbulence intensity, TI).

**Methods/Materials**
I obtained a micro-CT scan of an Ostracion cubicus specimen; prepared a 3D model using Autodesk Inventor, Meshmixer, Mudbox, and Maya; designed 3 AUV iterations based on the O.cubicus scan; used Autodesk CFD to test the four models for drag coefficient (Cd) and turbulence intensity (TI), using O.cubicus as a control; recorded and analyzed the data to determine which AUV iteration(s) met my engineering goal; rapid-prototyped the two most successful AUV body iterations.

**Results**
CFD testing demonstrated the following in comparison to the O.cubicus control:
1) AUV_v.1: (close approximation of O.cubicus) Cd -26% TI -19%
2) AUV_v.2: (lower frontal surface profile) Cd + 22% TI +39%
3) AUV_v.3: (keel surface extended by 5%) Cd ± 0% TI +10%

**Conclusions/Discussion**
CFD data analysis suggests that it is possible to design an AUV body which not only meets, but exceeds the hydrodynamic performance of O.cubicus, as characterized by the drag coefficient and turbulence intensity. Testing demonstrated that closely approximating the O.cubicus' shape, as well as extending keel surface, produced the most hydrodynamically efficient AUV hulls. Two of the iterations met my engineering goal: AUV_v.1 and AUV_v.3 drag coefficient and turbulence intensity measurements were lower than or within 10% of Ostracion cubicus.

**Summary Statement**
I leveraged unique hydrodynamic adaptations of the yellow boxfish to design, CFD-test, and optimize the body of an AUV for coral reef research.

**Help Received**
I did all of the research, 3D design, CFD-testing, and rapid prototyping on my own, after Dr. Adam Summers (University of Washington) provided the Ostracion cubicus micro-CT scan and Dr. Stacy Farina (Harvard University) converted the CT stack into an STL file.