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# Invariant Symmetry Modeling of an Observer-based Seaglider

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***Abstract*** **-**An undersea glider is a winged autonomous undersea vehicle that regulates its buoyancy to rise or sink and takes advantage of the gravity for moving forward in an energy efficient manner by means of its hydrodynamic shape. The governing equations, obtained by Euler-Poincare method through recognizing the group symmetries, are of reduced order. A perturbation study on the system's equations permits to establish the correlation of control inputs with the plausible steady motions. Based on these investigations, schemes for performing quasi-steady motions toward desired directions can be planned. Meanwhile, undersea navigation via inertial sensors is mainly apt to error accumulation which represents a serious practical issue. To compensate for the attitude drift, the gyros outputs and other reference set of measured variables are merged to form a required observer that preserves the rich geometric structure of the system, resulting in an invariant error equation that simplifies the convergence analysis.

***Keywords*****:** Seaglider- Symmetry Groups-Sensor Data Fusion-Simulation

## 1. Introduction

Internal actuation is mostly used for systems floating in harsh and inaccessible environments such as space or oceans depths. Mounting of the equipments in the interior keeps them safe and moreover doesn't affect the body hydrodynamics shape. In other hand, underactuation may arise which cause a challenge in the control task of such systems. Concerning underwater navigation, buoyancy-driven undersea gliders are energy-efficient winged underwater vehicles which transit by creating unbalance via internal mechanisms and navigate by surfing steadily in the depths. Undersea gliders are under the influence of hydrodynamic forces but also buoyancy and added mass effects that don't appear in conventional gliders. It is by properly phasing buoyancy and pitch control that an undersea glider rectifies the vertical motion due to buoyancy or gravity into forward motion caused by the lift force on the fixed wings. The system can also change direction by operating in a spiral pattern. The locomotive system owes its efficiency to the fact that it spend much of its time in a steady, gliding flight. Little control effort is required except at transition points, where the glider switches from downward to upward flight or vice-versa. Early efforts to design flight control systems for undersea gliders focused on establishing steady motions and controlling the vehicles about these nominal motions. Existing undersea glider control systems are not so sophisticated. Typically, the net weight and center of mass are servo-controlled to preset positions that correspond to desired steady motions. "Flight" control consists of outer loop corrections to attain the desired pitch and heading angles. The vehicle can lose directional stability while gliding about the zero pitch and glide path angles which implies additional control effort. Although a properly designed glider is stable in pitch, nonetheless may prove neutrally stable in heading. As a consequence the vehicle will be