Design Optimisation of a Search and Rescue Micro-Submarine

Muhammad Firdaus Abong Abdullah [1], Mastika Lamat [1], Abdul Reizal Dim [1], and Andrew Ragai Henry Rigit [2]

[1] Faculty of Applied and Creative Arts, University Malaysia Sarawak
[2] Faculty of Engineering, University Malaysia Sarawak

Abstract

A micro-submarine (micro-sub) is a very small unmanned submarine, which is normally being deployed for various dangerous underwater tasks effectively with minimum cost and risks. The micro-sub design must be optimised in every aspect of its practicability and operation ability. A combination of industrial design and engineering method is used design the micro-sub. Industrial design method emphasis on application of design aspects that user experience, configuration of sensitive electronics and software unit compartment, and developing the body shell streamline. The final design concept is translated into computer aided design software, Autodesk 3D Max and Catia to generate a 3-D model of the micro-sub. Modifications of the model at this stage are now done virtually. The computer generated model data is then fed to rapid modelling software, 3-D Printer to produce a full scale rapid prototyping model. It is desirable to have a smoother as possible velocity profile around the micro-sub body in order to obtain a better stability and control of the micro-sub, application of engineering method such as flow visualisation is vital to determine the effects of fluid flow conditions around the micro-sub when it submerged in changing underwater current. The 3-D model data is also used to create a computer simulation of the micro-sub in actual underwater environment using a commercially available computational fluid dynamic (CFD) package, Star-CD. The effects of the micro-sub geometry on the velocity and pressure distributions on the micro-sub outer shell surface were tested and analysed for Re = 500,000 and 3,000,000. The analysis output is used to propose further enhancement of the micro-sub with a smoother velocity profile around the body shell. The final design is custom fabricated for field trials and evaluations.

Introduction

Optimisation of the micro-submarine (micro-sub) design is done through industrial design and engineering methodology. The concurrent applications of both methodologies enable designers and engineers to generate and develop the most practical micro-sub with improved performance and better value without engaging too many expensive technologies that will eventually increase the price of the product. The application of industrial design processes throughout the product design and development stages proved better techniques for stimulating creativity and generating innovative solutions to design problems, rather than placing industrial design at the ending stage of development after most of the engineering aspects have been completed. Typically, an engineering organisation developing a highly operator oriented product such as the micro-sub, the ‘creativity and innovative phase’ are considered as an external, extraneous process which is largely independent of the engineering design process itself thus allowing only limited combination between industrial design and engineering design (Goldenberg and Mazursky, 2002; Pahl and Beitz, 2006). Realising the significant of combining the processes, a research was conducted by a team of researchers from the Design Technology Department and Mechanical Engineering Department of