ABSTRACT

A theoretical model for predicting the drift of persons-in-water wearing survival suits (PIW/SS) under time-varying and uncertain sea environment for search and rescue missions is presented in this work. This work focuses on uncertainty analysis which integrates an earlier report of theoretical, experimental, and field results and brings these results to the attention of wider community. The drift model is based on the laws of physics which govern the motion of a floating body in time-dependent wind and surface current fields. The nature of a sea environment is addressed through uncertainty analysis with interval mathematics and nonlinear programming. The drift velocity of the PIW/SS being searched for can be obtained numerically in terms of the empirical aerodynamic force coefficients of the PIW/SS obtained in a laboratory setting, external wind field, and current field. Field experiments previously performed are described, and nine sets of measured field data are selected to verify the presented model. Predictions of the presented theoretical model are compared with the measured field data. The result shows that the model predictions are in agreement with field test results and, with a prescribed uncertainty, the predicted path falls within the same range as the field test result. This illustrates that the presented models can provide reliable PIW/SS regions for search and rescue.

KEY WORDS: Search and rescue; PIW/SS; time dependent; field data; interval analysis; uncertainties.

INTRODUCTION

A valid theoretical framework is critical to a sound search-and-rescue plan. The ideal model should be correct in its physics, require minimal search target information, and rapidly provide search areas based on the given wind and surface current. Because of the vital importance of maritime search and rescue activities, there is continual progress and much effort focused on improving search area prediction. Many relevant works can be found in Breivik and Allen (2008), Allen and Plourde (1999), Nash and Willcox (1985, 1991), Anderson, Odulo and Spaulding (1998), Fitzgerald, Finlayson and Allen (1994), Allen (1996), Allen and Fitzgerald (1997), Allen and Plourde (1999), Allen, Robe and Morton (1999), Allen (2005), Kang (1999), and Su (1986) as well as in references cited within. Of particular relevance is the report by Su, Robe and Finlayson (1997), in which a combined theoretical, experimental, field approach was used to predict the leeway and drift of a survival suit clad person-in-water. The present understanding of PIW/SS drift at sea emerged over the years thanks to these works. The present paper extends the result of Su, Robe and Finlayson (1997) with uncertainty analysis to account for the uncertain sea environment. The description of theoretical modeling, laboratory testing and field test are based on Su, Robe and Finlayson (1997).

The search areas are based upon an evaluation of the last known position of the target, surface current, and leeway drift. Previous studies mainly focus on the concept of “leeway drift”—the movement of the leeway objects relative to the ocean’s surface caused by the wind. “Leeway” is defined as “the movement of an object through water caused by winds blowing against exposed surfaces. Thus, the “leeway velocity” $V_l$ is defined as $V_o - V_c$, the difference between drifting object velocity $V_o$ and the velocity of the surface current $V_c$. The studies of leeway drift based on statistical models mainly rely on field tests to obtain coefficients using linear regression analysis. A recent study (Breivik et al., 2011) continued the statistical-based approach with a new operational definition of the wind & wave-induced motion of a drifting object relative to the ambient current, known as the leeway of a drifting object. In our recent study, a theoretical drift prediction for boats based on the law of physics and non-probabilistic analysis of uncertainty is reported (Ni et al., 2010).

Persons-in-the-water clad in survival suits are the object of this study. There are three terms commonly used to describe flotation suits: exposure suits, immersion suits, and survival suits. The exposure suit is a work coverall generally made of nylon or other non-neoprene material. It is intended for working on deck in harsh weather and thus has no gloves or boots. It does, however, provide some flotation. The immersion suit and the survival suit are equivalent and are made of neoprene or other rubber-like material. They have integral gloves, boots, and hoods. Survival suits are designed to provide flotation and to retain body heat; an inflatable pillow is provided to keep a person’s head above the water surface. Survival suits are carried on many boats for use in “abandon ship” situations.

The PIW/SS will float in a horizontal position on the water surface rather than in an upright orientation. PIW/SS drift characteristics caused by wind loading and current drag are very different from those of a person not wearing a survival suit. A survival suit increases survival chances for a PIW/SS by reducing the effects of cold water on the victim. A better understanding of the drift characteristics of a

On Predicting the Drift of a Survival Suit Clad Person-in-Water Under Time-Varying and Uncertain Sea Environment

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