OPERATIONAL ASPECTS OF IMAGING RADAR SYSTEMS IN MARITIME RECONNAISSANCE AIRCRAFT

David P. Galligan and Michael K. Lauren[1]

Abstract: The interception of a surface vessel is an important function of a nation's maritime military capability. Here we explore a scenario where a reconnaissance aircraft is used to cue a surface naval vessel to intercept a suspect vessel amongst a number of non-target vessels. The effect of upgrading the aircraft's radar suite from non-imaging to imaging-capable is examined. Substantial savings of up to 11% in flight time and 16% in fuel consumption are found when the latter is used. Greater savings are generally found for larger (in radar cross-section) target vessels and these savings increase with the number of non-targets vessels present—12, 24 and 36 vessels are tested here. The situation is found to worsen significantly if sufficient standby aircraft are not available to maintain target surveillance during refuelling times. Therefore, acquisition of expensive technology must be accompanied by appropriate platform maintenance and operating policies.

INTRODUCTION

When considering the future sensor requirements for a nation's military reconnaissance aircraft it is important to provide a scientific background to decisions that are made.

Here we present a study of a particular scenario that an air force may be expected to deal with—the detection of a target vessel in a large oceanic area with a number of non-target vessels complicating the search. We are interested in the effect the replacement of a non-imaging radar system with an imaging capable (SAR/ ISAR) system would have on the cost and efficiency of search operations.

The MANA Model

The MANA model [1,2] is used for this study. MANA is a cellular automata model where each automaton is endowed with a particular character that shapes its interactions with its neighbours. Each decision made by the model is based upon a set of pseudo-random numbers weighted according to the characters of the participating entities. In the current study these are a maritime patrol aircraft and a number of surface vessels. Following the Monte Carlo approach, a large number of model runs are computed in order to obtain representative values for parameters of interest.

Interception Scenario

Here we use a New Zealand scenario as a hypothetical example.

New Zealand authorities have been alerted to the imminent arrival of a vessel of interest (target vessel) within 500 nautical miles (nmi) of the country. Broadly speaking, this target could represent any number of vessels of a high level of political importance passing near to New Zealand. For example, it could contain terrorists, a significant drug haul, a large group of illegal immigrants, or nuclear waste. While each of these variations would play out slightly differently, the basic capabilities required to intercept each are the same. For the sake of this study, we assume that the target vessel is believed to be intending to either enter New Zealand or pass near enough to cause some significant threat, but it is not known where or when the vessel intends to do so.

Figure 1 shows a screen shot of the scenario. Clearly, a single naval vessel is unable to position itself at a given entry point without an indication of the direction the target vessel is heading. Intelligence is therefore required from a reconnaissance asset.

In a typical run of the model, the search aircraft leaves Auckland and attempts to find the target vessel. Once it has recognised the target it guides the naval vessel to intercept it. Note that this is not supposed to represent that the naval ship "boards" the target at that point; rather, it positions itself to shadow the vessel so that it may take action if necessary. The number of non-target vessels is varied from 12 to 36 to study the effect of the background population upon the ability to detect the target.

It is assumed that the aircraft and ship must both detect and recognise possible targets. So, in the case of the aircraft, it may detect the presence of a vessel on its radar, then fly towards it. A vessel is only recognised as the target when the patrol aircraft is close enough to do so.

Figure 1. Screen image of MANA model for the scenario considered. Black arrows have been added to illustrate possible entry points for the target vessel (shown here in the upper right corner).

[1] Both authors are with the Defence Technology Agency (DTA), Naval Base, Private Bag 32901, Devonport, Auckland, New Zealand.

1440-5113