Maritime Surveillance Sensor Information Fusion for Improved Decision Making for Sri Lanka Navy

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Abstract— **This paper presents an ongoing research on generic sensor fusion architecture and its applications in maritime surveillance systems. The importance of information fusion in the single sensor type and collectively for different multiple sensor types is also discussed. In sensor data fusion, centralized versus decentralized refers to where the fusion of the data occurs. In centralized fusion, the clients simply forward all the data to a central location and a specific entity at the central location is responsible for correlating and fusing data. Our research intends to correlate multiple maritime sensors such as RADAR (Radio Detection and Ranging), AIS (Automatic Identification System) and other electronic object detection systems. Sri Lanka Navy has a number of surveillance information sources such as AIS, RADAR, SONAR (Sound Navigation And Ranging), MSTT (Maritime Small Target Tracker), HFSWR (High Frequency Surveillance Wave Radar), AVLS (Automatic Vessel Locating System), Radio Communication, Intelligence Data etc. It is clear that information fusion methodology is needed to harness the effectiveness of multiple sensor information. An object identification pipeline is conceptualized in such a way that an unknown object in the maritime domain is detected, reducing the uncertainty of information obtained. The radical new virtual reality application has been developed to visualize the information fused from sensors and discussed in depth. In addition to this, the fusion process is introduced. The technologies used in developing the virtual world and incorporating the real time information into the virtual world are presented in simplified models to ensure that it is better understood. Further design aspects involved and some experimental analysis of research and a developed project conducted at the Sri Lanka Navy are discussed in depth. It is to be noted that these fusion technologies are presented in a real time virtual environment and are currently used by SL Navy.**

1. Introduction

Advances in technology have led to the creation of many sensory information sources, overwhelming the receiver with an information overload. The sheer volume of information available today has given rise to a burgeoning field of computer science known as information fusion. This is needed to reduce the uncertainty associated with each sensor. The objective of the fusion process is to provide the user with an abstract layer of information derived from basic sensors, thus eliminating unnecessary information [1],[2].

To reach the required level of quality in maritime surveillance, it is necessary to use a heterogeneous network of sensors and large scale multi-sensor tracking and fusion architecture capable of processing data. There are various technologies for detection and identification of objects (Radar, Day-night cameras, AIS, etc), but every sensor technology has its own limitations i.e. in range, detection, recognition and coverage. Fusion of data extracted from these different complex scenarios will greatly help overcome this problem and further improve the reliability.

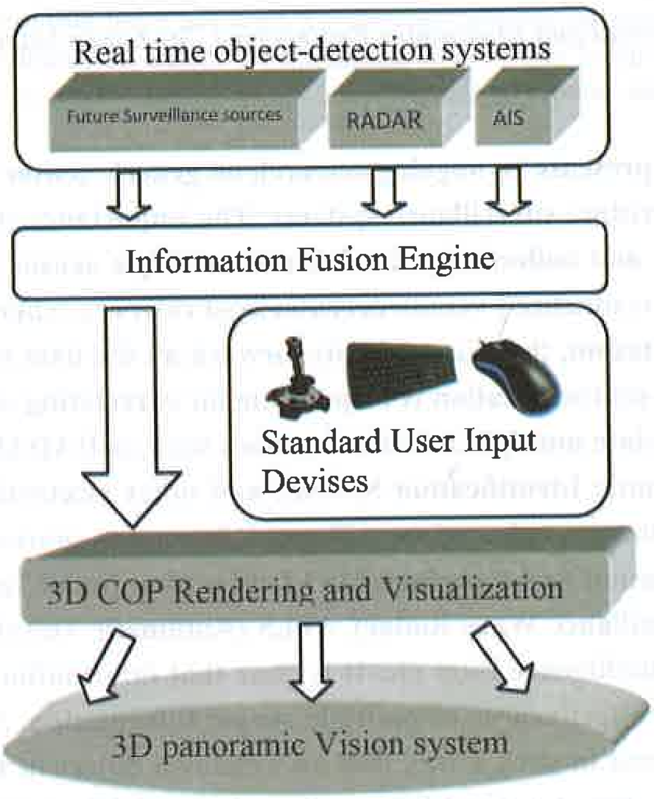

Fig 1. Fusion architecture and output to 3D virtual environment

2. System architecture

In this section of the paper, a brief description of the system architecture is presented in an abstract view and a few of the sensor types are described.

a. *System Description*

The system consists of a remote sensing network distributed over a large area covering a major economical busy maritime domain. It consists of information fusion engine, data disseminating interface, 3D panoramic display, 2D display, mobile platform and a human computer interface. A secured wide area network is used to connect the sensors distributed over the large maritime area such as AIS, RADAR and other distant object detection systems. In addition to that, informal means of data gathering such as SMS can be used. Internet sources are also planned to be incorporated. The intended system is an abstract layer for intelligence information and response guidance.

b. Automatic Identification System (AIS)

The Automatic Identification System is an automatic tracking system used by ships and vessel traffic services (VTS) for identifying and locating vessels by electronically exchanging data with other nearby ships and AIS base stations. AIS information supplements marine radar, which continues to be the primary method of collision avoidance for water transport. The following diagram illustrates the AIS object detection system's overview as seen by the developer. Every ship sailing in commercial maritime waters should carry an AIS transponder enouncing its static and dynamic data. The AIS base station at the harbor picks up the AIS signal and registers the ship in the database. The ship then acts as a sensor of its own, transmitting dynamic data such as GPS coordinates, COG, SOG etc [4].

Fig. 2 is the abstract view of the AIS systems as seen from the fusion engine. AIS base stations are connected through a wide area network to a centralized fusion centre.

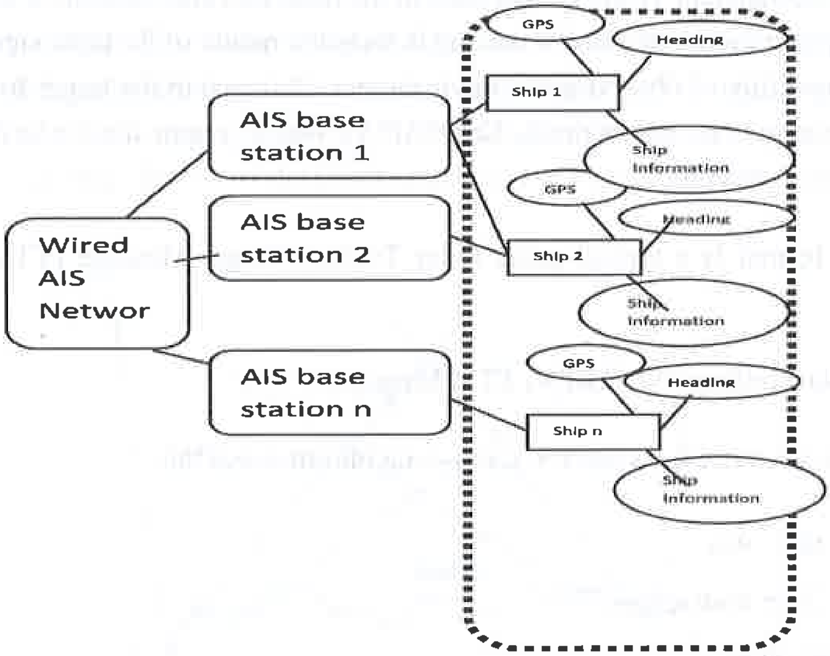

Fig 2. AIS object detection system

The following is a format of a sample sentence of an AIS output interface statement.

!aaccc, x1, x2, x3, c—c, x4*hh<CR><LF>

Among the sentence, "c—c" is a data field of "6 bit" binary encapsulated data and the example of the interface statement is shown as follows.

!AIVDM,1,1,B,**F0WDBv22N2P3D73EB6>6bT20000**, 0*76

!AIVDM,2,2,3,B,1@0000000000000,2*55