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Ontology Alignment in Geographical Hard-Soft Information Fusion System

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ABSTRACT
This paper describes the advantages and use of both physical as well as semantic markup in a geographical information system(GIS). In this paper, we explore about the Issues of the of fusing hard-soft data as related to ontology alignment. The geographical information system is tool that is commonly used to by any computer system to manipulate the geographical data. GIS consist of data inputs, data reporting (retrieval, presentation, analysis etc.), data management (data manipulation, exchange, changing etc.). A maritime domain awareness example is shown to explain the need for ontology alignment to assist users for pragmatic surveillance.

Keywords:- Geographical information system (GIS), Ontology alignment, Maritime Domain, Hard-Soft fusion

I. INTRODUCTION

The goal of the paper is to put forth the problem with the semantic and ontology alignment in geographical information system. The basic issues that arise will fusing the hard data (physical imagery product) and Soft data (semantic markup) are (1) Ontology Standardization- A situation where multiple labels are pointing towards a single problem, (2) Ontology Alignment- When there is a shared vocabulary lining is required, (3) Ontology Analysis- When the same reference is given to multiple problems.

Geographical information system (GIS) is a special computer based tool that is used to collect, retrieve and to display spatial data for real GIS world. GIS not only create geographical maps but it also analyzes the data as well.

The spatial data represent phenomena from the real world in terms of their position with respect to a known coordinate system, their attributes that are unrelated to position (such as color, pH, incidence of disease, etc.) and their spatial interrelations with each other.
GIS also a decision-making tool that allows user to combine spatial data and databases containing attribute and other kind of data (images or graph).

APPLICATION OF GIS

In most of the organization GIS is used for one or more of the following core functionalities: transaction processing, operations, planning and decision making, inventory management, and internal management and control.

Geographical information provides a variety of qualities and characteristics to a geographical location. These qualities can be physical parameters such as ground elevation, soil moisture, atmospheric temperature, or classifications according to type of vegetation, ownership of land, zoning, floods, environmental accidents, water sources, wastewater, storm water, air quality, etc.
Beside the core functionalities of GIS there are some practical applications of GIS that are used in industries these days.

Surveying and Mapping is the first application that is commonly being used in the industries now days. Surveying and mapping is also known as automated mapping (AM). Automated mapping allows organizations to generate spatial data in-house.

The second GIS application is logistics and transport problems. Logistic problems usually involve spatial, so GIS can be used in this context as platform for decision modeling and also displaying the result of analysis.

The third GIS application is public safety systems such as computer aided dispatch and emergency 911 dispatch are greatly enhanced by GIS in foreign countries. By utilizing up-to-date street maps, ortho imagery, and address matching capabilities, GIS applications augment and improve critical response times.

II. HOW ONTOLOGY ALIGNMENT HELP IN GIS

ONTOLOGY ALIGNMENT

Ontology is defining the types, properties, and interrelationships between entities on the basis of their physical and fundamental existence in the domain.

Ontology alignment or ontology matching is the process of finding a physical connection between the factors defining data in ontologies.

There are two sub research technology have emerged in recent years, first is the monolingual ontology mapping and the second is the cross-lingual ontology mapping.

Monolingual ontology mapping that refers to the ontology mapping in same natural language and the Cross-lingual ontology mapping refer to the process of establishing relationships among ontological resources from two or more independent ontologies where each ontology is labeled in a different natural language.

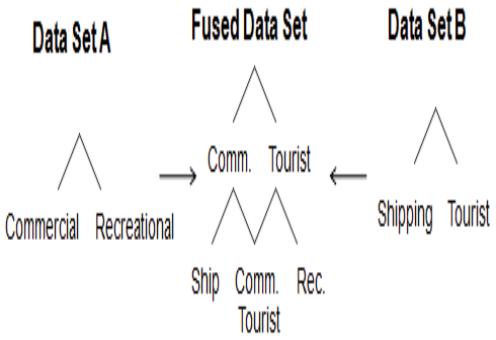

Figure: process of ontology alignment

Ontology for Surveillance Research

With the many web services and users available, there is alot of development in field of surveillance. Roy [7] has been developing methods for knowledge-based systems for **maritime awareness**. These kind of technology is developed to solve issues like tracking, situation analysis, and threat assessment. Examples include anomaly detection and alerting.Other developments include net-centric warfare for **enterprise** systems that include intelligence and
surveillance data as well as cyber information.

GEOSPATIAL ONTOLOGY

Ontologies have been developed for web-service products. Bellow Figure showsan example of high-level fusion needs as the user has many databases available. Determining the need of user is very important and also how user interpret that information to improve quality.

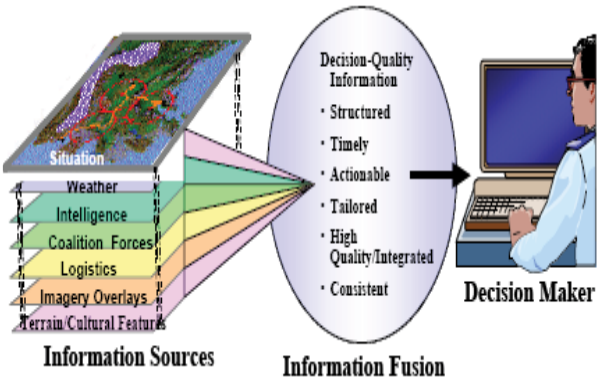

Figure : Information Fusion Decision Quality

In a typical ***harbor scenario***, images are taken and the regions are labelled. The quality of data representation can vary from system to system. For example, the coastline can never be defined preciously as the change in tidal nature can't be predicted.The data collected by sensor can also vary time to time, altering the segmentation or producing uncertainty in the labeling.
Geo-pragmaticsimprove the chance for user to establish the command over the data and reason every information. From the GIS point-of-view, there are many are where the information fusion can improve the working of a system like in image registration, image estimation and data management; however, when labels are created using class structures, both syntactic as well as semantic ontology alignment is considered.

HARD-SOFT FUSION SYSTEM

In hard-soft fusion system the spatial data indexing is mapped to a semantic feature representation. Semantic labeling of databases is important for compact storage, process efficiency, and timely and useful information retrieval.

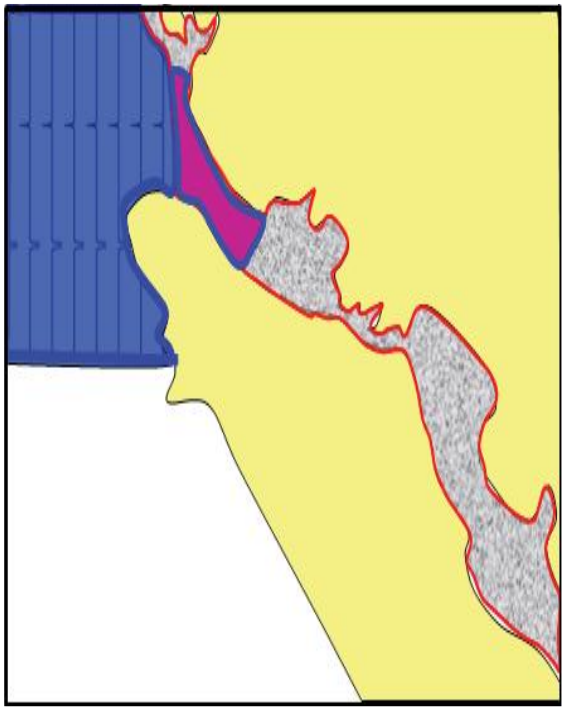

Figure: Geographical Fusion Modeling

There are basically three type of Hard and soft geographical data fusion being used now days (1) fusion hard-to-soft product,(2) fusion hard data with soft data extraction from the image set and, (3) hard imagery data fusion combined with soft ontological data fusion.

Usually the sensors and the system collecting data both are designed by the same company, which forces the system to integrate a hard-soft product alignment over ontologies.

While the listing of ontologies could be differently, they are example of hard-soft ontologies. Two most relevant example of this is geographic and traffic routes:

- Geography ontology: geography ontology includes a wide range of components including terrain features, transport routes, rivers, shorelines, terrain elevation
- Transportation ontologies: the transportation ontology is same as the geography ontology but the difference is in transportation ontology the transportation routes is also considered as element of geography.

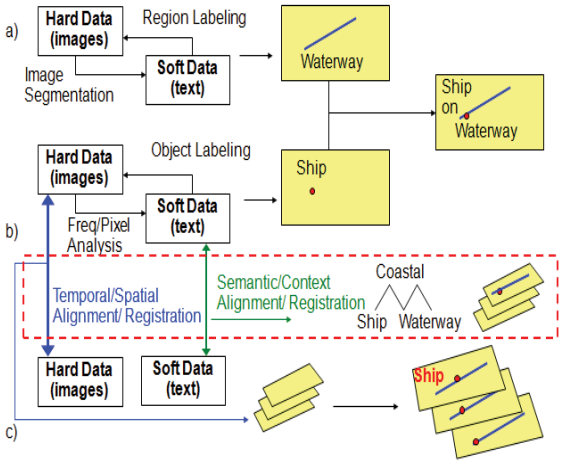

Figure. Hard-Soft Ontology Fusion.
(a) Fusion over Hard-to-soft products,
(b) Imagery and Ontology Fusion and Alignment,
(c) Aligned imagery with single soft data extraction

Maritime domain:

The maritime domain is defined as the entire region as well as beings connected to each other by any relation and all the maritime activities i.e. infrastructure, cargoes, conveyances etc.

Maritime domain awareness (MDA) is defined by the international maritime organization.

Some basic issues that concern with the maritime domain are tracking, situation analysis, and threat assessment.

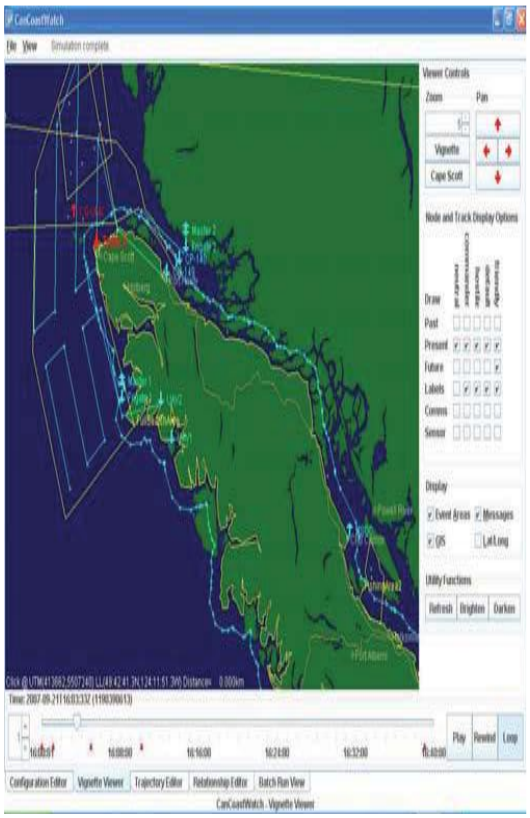

Figure: Example of Maritime Domain awareness

HARD-SOFT ONTOLOGY EXAMPLE

1. **Collision avoidance**

Automated identification system is developed by IMO to avoid collision between large ships or cargo vessels that are not in range to be guided by shore based system. The technology creates an individual physical identity of every vessel by putting its physical coordinate, average speed and the route to the destination in a database connected to the system (AIS). The AIS provide to basic and important functionality like Closest point of Approach(CPA) and collision alarm that inform the authority when the two vessels are on verge of collision. AIS are not a commonly used technology and are used in conjunction with radar. When a ship is navigating at sea, the speed at which the vessel is moving and location of nearby vessels are the two most critical constraints of data that is required to make decisions to avoid collision with other ships and dangers (shoal or rocks). Mechanisms like night vision, audio exchange and Automatic radar plotting Aid is used at night time to avoid Collision. But these mechanisms also have their own limitations i.e. time delay in system, short range radar system, miscalculations and display malfunctions. AIS only required to display very basic text information the data obtained can be integrated with a radar display, providing all the information required by the system on a single display.

2. **Fishing Fleet Monitoring and Control**
AIS are widely used by national authorities to track and monitor the activities of their national fishing fleets. AIS provide authorities with the reliable information that help reducing the cost of monitoring fishing vessels activities along their coast line.

III. CONCLUSION

In the paper, we discussed how to implement the hard-soft fusion system in a geographical information system using ontology alignment. But the few question are still unsolved that

(1) How to deal with the mismatch and mapping uncertainty in ontologies,
(2) coordinates between different standards for interoperability, and
(3) How to fuse ontologies from both hard and soft data.

In this paper, we simply put the advantages of the ontology alignment in a geographical information system and the use of higher concept of GIS i.e. Automatic identification system and automated mapping.

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