Journal of Engineering and Applied Sciences 12 (15): 3957-3960, 2017
ISSN: 1816-949X

Nautical Chart Understanding for Autonomous Surface Ship Operations

R. Durga Singh
Department of GMDSS, AMET University, Chennai, India

Abstract: When a mariner navigates into an unfamiliar area, he/she uses a nautical chart to familiarize him/herself with the environment, determine the locations of hazards and decide upon a safe course of travel. An Autonomous Surface Vehicle (ASV) would gain a significant advantage if, like its human counterpart, it can learn to read and use the information from a nautical chart. Electronic Nautical Charts (ENCs) contain extensive information on an area, providing indications of rocks and other obstructions, navigational aids, water depths and shorelines. The goal of this research is to increase an ASV's autonomy by using ENCs to guide the helm when its predetermined path which may be dynamically changing is unsafe due to known hazards to navigation and context to its sensor measurements that are invariably subject to uncertainty. Identifying objects in a camera, sonar, LIDAR or other sensor's data can be a challenging endeavor in an ocean environment due to the variable sea state, the wind, fog, sea spray, sun glint from the sea surface and bubbles in the water column. Therefore, providing a prior probability distribution for the likely location of those objects in a sensor's field of view has the potential to enhance object detection processing significantly. Contextualizing sensor measurements dynamic identifies objects from the ENC in a sensor's field of view and provides that information to the sensor in real-time. It accomplishes these tasks, feature layers within a standard ENC must be translated to a spatial database. In this database, features are encoded with a "threat level" based on the feature type and the estimated depth of the object which is not always encoded within the ENC. Variations in the political tides as well as the vessel size and speed are also factors when deciding the threat level and the vehicle's appropriate course of action.

Key words: Obstacle avoidance, ENCs, ASV, MOOS-IVP, LIDAR, India

INTRODUCTION

The Center for Coastal and Ocean Mapping (CCOM) at the University of New Hampshire (UNH) is exploring the utilization of self-governing Surface Vehicles (ASVs) for bathymetric studies and sea life science because of their potential for drive duplication. Numerous economically accessible ASVs have restricted self-sufficiency in that their primary goal arrangements are frequently static with negligible attention to their condition. This reliance, alongside a static mission, arrange for that does not change without human intercession, prompts a serious work approach that does not scale to an administration of different vehicles.

Notwithstanding, dependable and vigorous sensor operation is trying in a maritime domain that every now and again darkens a sensor's field of view, requires a high unique range to counteract immersion or under-presentation, produces bounteous anomalies that are hard to perceive and fundamentally erodes segments prompts continuous sensor disappointment. To manage these conditions, human sailors enlarge their comprehension of their status with nautical graphs which give from the prior learning of their working condition, direction when the way is hazy and setting to sensor estimations that are liable to instability. In this manner, ASVs utilizing dynamic mission arranging can work to impressive preferred standpoint if they can figure out how to peruse and use nautical graphs like their human partners.

The objective of this examination is to utilize Electronic Nautical Charts (ENCs) and give an ASV information of its condition. Giving the ASV the capacity to powerfully respond to snags securely without the need to detect things that are now known and to offer to set to and modify certainty for sensor estimations that are perpetually subject to instability. Giving an ASV an all-encompassing comprehension of its condition with ENCs expands its self-governance and declines the administrator ASV communication by taking into consideration diagram mindful snag shirking, responsive mission arranging and expanded sensor heartiness and dependability.

In this study, the related articles are studied and expose their results, study of formazan derivative inhibitor used to prevent the mild steel material used in the construction of ship material (Anand *et al*., 2011) expressed the rate of citric acid corrosion affect ship metal. A soft computing approach on ship trajectory control for marine applications (Sethuramalingam and Nagaraj, 2015, 2016) reveals that the system compensates for coupling effects cause bandwidth characteristics which are dynamic composites. A proposed system of ship trajectory control using particle swarm optimization are referred in this study (Sethuramalingam and Nagaraj, 2015, 2016) discussed the operation of Particle Swarm Optimization (PSO) to optimize a Fuzzy Model Reference Learning Controller (FMRLC) for the ship.

MATERIALS AND METHODS

Earlier work: Extensive work has been distributed on protest evasion techniques in different fields of mechanical technology. This short audit is constrained to late work particular to marine vessels and the utilization of nautical outlines or comparable maps in their route. Methodologies are comparative and the work displayed here speaks to an answer created inside an interim programming, conduct based engineering.

Sauze and Neal (2010) built up a calculation to decide snag freeways utilizing beam throwing on an open street guide of the neighborhood. Sauze's count throws 150 m beams around the coveted heading for convergences with the land. If there is a convergence, the nearest clear way to the existing line with a 5-degree cushion is picked as the new coveted title. In this study, a conduct based, receptive mission organizer will supplant the beam throwing obstruction shirking (OA) technique and the potential snags will be extended by utilizing which will consider a more robust OA framework.

Larson *et al*. (2007) split OA into the "far-field" and "close field" administrations. In the far-field organizer, Larson utilized nautical graphs to decide stationary snags and AIS and automated radar plotting aid contacts for moving deterrents. Once the far-field risks were resolved, Larson made a coarse 2D obstruction delineate utilized the A* calculation to decide a sheltered way while keeping up nearness to the first arranged way.

RESULTS AND DISCUSSION

Implementation: The calculations for this study are executed utilizing a blend of MOOS (Newman, 2002) and the IvP Helm (Benjamin, 2004) as a busybody. In a meddler engineering, the gossip gives speed and making a beeline for the lower level controls who utilize these

Table 1: Description of water level effect attribute

Water level index	Minimum distance (m)
1	Partly submerged at high water
2	Always dry
3	Always underwater/submerged
4	Covers and uncovers
5	Awash
6	Subject to inundation or flooding
7	Floating

states to control the thrusters and control surfaces. Utilization of a busybody design permits usage in monetarily accessible ASVs (that bolster it), exploiting the makers bring down level controls while expanding the vehicle's more elevated amount self-sufficiency. MOOS is a middleware application for apply autonomy in which each procedure speaks with a focal database called the MOOSDB in a distribute/subscribe engineering and the IvP Helm is a MOOS system giving a conduct based design to shipping driving. The directions of the pinnacle estimation of the IVP work show the ideal choice for the given behavior for that emphasis. IvP capacities from every running conduct are submitted to the IvP Helm Solver on every cycle which decides the ideal craved speed, heading and perhaps profundity for all practices by a weighted aggregate (Casalino *et al*., 2009). Each actualizes nautical outline mindfulness, new MOOS applications and Helm practices were created.

A simplified design of the implementation is shown in Fig. 1. The red rectangles represent new MOOS applications and behaviors the blue shapes represent preexisting MOOS architecture, the purple rectangle represents a non-MOOS application the yellow cylinder represents a non-MOOS database and the green hexagon accounts for a database containing the raw ENCs.

To assess the threat that an obstacle poses to the vessel, one must know the hazards depth and not all objects in ENCs have recorded depths. For example in the ENC that encompasses the harbor for portsmouth, new Hampshire there are 201 recorded underwater rocks of which only 54 have recorded depths. Therefore, a "threat level" attribute was defined based on quantitative information when it is available and qualitative information such as the "water level effect" attribute when it is not (Benjamin *et al*., 2010; Anand *et al*., 2011; Sethuramalingam and Nagaraj, 2015, 2016). The water level effect describes the effect the varying tidal level has on an object (Table 1). From the qualitative and quantitative measurements of depth, along with the obstacle type and draft of the vessel, objects in the ENC_DB are labeled with a corresponding threat level that ranges from -1 to 5.

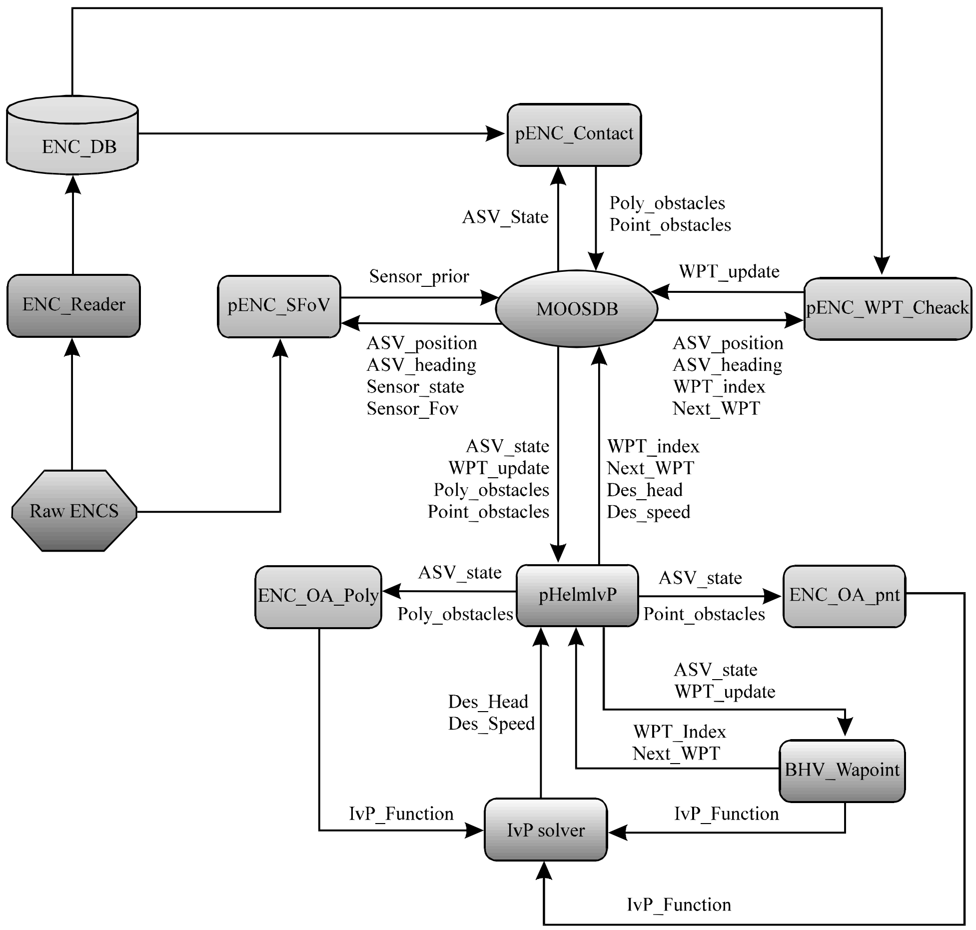

Fig. 1: Architecture for the MOOS implementation of nautical chart awareness

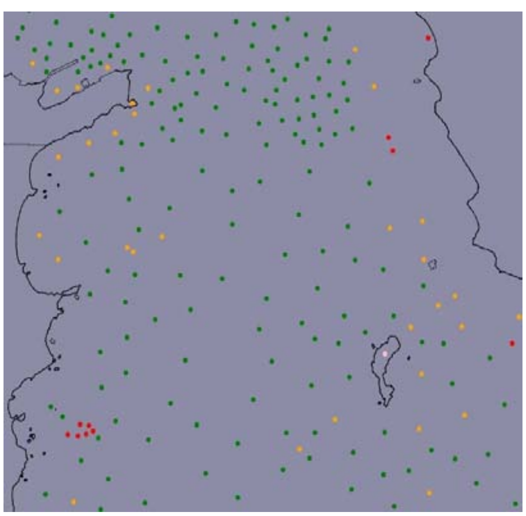

Fig. 2: Information from the ENC_DB for the area around UNH's Pier in portsmouth, NH showed using MOOS's p Marine Viewer

Table 2: Description of threat level

	Obstacle attributes	
Threat levels	General description	Colors
-1	Landmark	Violet
0	No threat	Green
1	Deep threat	Yellow-green
2	Little threat	Yellow
3	Medium threat	Orange
4	Significant threat	Red
5	Landmass	Black

The data preoccupied from the ENCs utilizing ENC_Reader is appeared in the MOOS reproduction Graphical UI (GUI), pMarineViewer in Fig. 2 where land is shown as dark lines and the hindrances are performed as either focuses or polygons relying upon their geometry and are shading coded in light of their danger level as portrayed in Table 2 (Sethuramalingam and Nagaraj, 2015). The territory appears in Fig. 2. Three is in the harbor of Portsmouth, NH where the UNH Pier appears in the upper left corner.

CONCLUSION

Static mission arranging extremely constrains the achievability of ASVs. Without a dynamic task organizer, a human administrator must direct the ASV and record for all deterrents in its condition. The capacity to comprehend and utilize ENCs gives the ASV an extraordinary preferred standpoint by permitting the ASV to progressively change its arranged way securely and offer to set to sensor estimations that are liable to instability.

Nautical diagrams as ENCs can build self-rule of ASVs. ENCs give data on an extensive variety of potential impediments from coastline to submerged rocks to floats and points of interest. The data is effectively gotten to and require not require sharp locally available sensor handling to stay away from these many known elements. Also, if ASVs are to be utilized as a part of the vast sea, they will be mindful (may be legitimately so) for what is now known and given to different sailors. Hence, a comprehension of ENCs is fundamental.

REFERENCES

Anand, B., M. Jayandran and V. Balasubramanian, 2011. Study of formazan derivative inhibitor used to prevent the mild steel material used in the construction of ship material. Asian J. Chem., 23: 2106-2108.

Benjamin, M.R., 2000. IHO Transfer Standard for Digital Hydrographic Data. Internation Hydrographic Bureau, Monaco,.

Benjamin, M.R., 2004. The interval programming model for multi-objective decision making. Master Thesis, MIT Computer Science and Artificial Intelligence Laboratory, Cambridge, Massachusetts.

Benjamin, M.R., H. Schmidt, P.M. Newman and J.J. Leonard, 2010. Nested autonomy for unmanned marine vehicles with MOOS-IvP. J. Field Rob., 27: 834-875.

Casalino, G., A. Turetta and E. Simetti, 2009. A three-layered architecture for real time path planning and obstacle avoidance for surveillance USVs operating in harbour fields. Proceedings of the IEEE International Conference on Oceans, May 11-14, 2009, IEEE, Bremen, Germany, ISBN:978-1-4244-2522-8, pp: 1-8.

Larson, J., M. Bruch, R. Halterman, J. Rogers and R. Webster, 2007. Advances in autonomous obstacle avoidance for unmanned surface vehicles. AUVSI Unmanned Systems North America, SPAWAR Systems Center Pacific, San Diego, California.

Newman, P., 2002. MOOS: A mission oriented operating suite. Master Thesis, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Sauze, C. and M. Neal, 2010. A raycast approach to collision avoidance in sailing robots. Proceedings of the International Conference on Robotic Sailing, June 7-10, 2010, Academic Publisher, Kingston, Ontario, pp: 26-33.

Sethuramalingam, T.K. and B. Nagaraj, 2015. A soft computing approach on ship trajectory control for marine applications. ARPN. J. Eng. Appl. Sci., 10: 4281-4286.

Sethuramalingam, T.K. and B. Nagaraj, 2016. A proposed system of ship trajectory control using particle swarm optimization. Procedia Comput. Sci., 87: 294-299.