MULTISENSORY FUSION FOR UNDERWATER ROBOT LOCALIZATION AND EXPLORATION

BY

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1 Description of Research Work

Pakistan has 1000 km long coast from sir creek to Jiwani in the middle of Indian Occean so this littoral state carries out 95% of its trade through the sea and 40% of its industry is situated near the coast (Ghazala Jalil, 2018). In march 2015 Pakistan successfully achieved 50000 square kilometers of seabed territory with which, other than 200 nautical Miles (NM) of Exclusive Economic Zone(EEZ), Pakistan gained the rights to explore and to use marine resources including energy production from the area of additional 150 NM of Continental Shelf(sajjad syed, 2015). World is aware that trade balance of future is in favour of china and 60% of population lives in Asia that mean China Pakistan Economic Corridor (CPEC) is going to be the future due to its geological position(Abid & Ashfaq, 2015). With these benefits there are also some challenges specially for Pakistan Navy because of huge seabed area. This situation encourages the researcher to explore for resources underwater and establish smart defensive systems across the seabed boundaries.

Underwater localization, exploration and target tracking is very important research question due to unstructured and dynamic nature of sea water. There is high possibility of error because of unmodeled noise(Chame, Dos Santos, & da Costa Botelho, 2018). Multiple sensors are combined together for best possible results. For Multisensory fusion Kalman Filters are commonly used and these filters usually reduce Gaussian type of noise(Potyagaylo, Constantinou, Georgiades, & Loizou, 2015). In Underwater environment Kalman filter perform poorly because they are not very good in dealing with unmodeled noise. Some parametric Algorithms produce global estimates from different types of hypothesis which can handle unmodeled noise but they are computationally very expensive. We need an algorithm which can deal unmodeled noise as well as it should be computationally efficient. It has been seen for last few years that neural networks are very optimum and efficient for approximation and classification. PC/BC-DIM algorithm can perform optimal cue integration with a non-flat prior and its response is optimal even when the input distributions are noisy(Spratling, 2016). So there is need to implement such PC/BC-DIM type neural algorithms for accurate localization, exploration and target tracking which response optimally even in the presence of unstructured noise.

2 Need and Significance of the Research

In subsections of problem statement and objectives the significance and need of research is described.

2.1 Problem Statement

Available techniques for multisensory fusion under unstructured environment are either inefficient to deal unmodeled noise of sea or have expensive computational cost so there is need to propose neural network based algorithm which can efficiently fuse data of sensors and accurately eliminate unstructured noise for best possible estimates.

2.2 Objectives

Objectives of the research are as follows

1. To develop a technique of multisensory fusion for dynamic environment of water
2. To Implement proposed technique for localization of vessel under seabed conditions
3. To explore underwater resources using proposed technique

3 Review of Literature

To Perform reliable localization and navigation under unstructured noise is a difficult task because of dunamic nature of water(Corke et al., 2007). There are mostly two types of vehicles used underwater. First is Remotely operated vehicle (ROV) which is connected through wire and has the basic working of seabed inspection, maintenance and repair operations(Grøtli, Tjønnås, Azpiazu, Transeth, & Ludvigsen, 2016). Second is Autonomous underwater vehicle (AUV) which is self driving vehicle with no directly connected wire. AUV is now being used for a variety of tasks, including oceanographic surveys, demining for resource inspection and bathymetric data collection in marine and riverine environments. Accurate localization and navigation is essential to ensure the accuracy of the gathered data for these applications which is possible using optimal techniques(Paull, Saeedi, Seto, & Li, 2014). A number of techniques are proposed to estimate the motion of vessel which can be categorized as either acoustic based technique or visual(Corke et al., 2007).

For underwater tracking generally three types of methods are used which are instrument-assisted method, active and passive mode based method and tracking optimization method. According to the tracking instrument and tracking mode, researchers have proposed numerous algorithms to improve the tracking accuracy and stability. However, other optimization methods have been investigated for further improvements(Paull et al., 2014).

Acoustic systems are better approach for underwater tracking, exploration and localization. Acoustic imaging systems are more accurate to provide observation and inspection data rather than optical systems(Sutton, 1979). For localization different geo-reffered techniques are used like Global positioning system (GPS) but RF signals cannot be received directly by the AUV

when underwater, hence we have to rely on acoustic positioning systems like ultrashort baseline sensors (Khan, Taher, & Hover, 2010). Such positioning systems consists on different positioning and inertial sensors. choosing a convenient and optimal fusion technique which would have low computation cost and which would be able to eliminate underwater noise to provide accurate results is in open research question(Chame et al., 2018). Adaptable fusion of sensors is possible using conventional Kalman filters. In (Drolet, Michaud, & Côté, 2000) an algorithm can handle any number of redundant sensors by using multi-filter fusion and can work asynchronously with different sensor data rates through a filter switching process. But Kalman filters performs poorly under presence of unstructured noise. Particle filter are good known filters which can perform finely under un-modeled noise but they are slow responsive with very high computational cost.For optimum and efficient computation there is need of a choosing a convenient fusion policy which can perform accurately even in presence of unstructured noise. It has been seen for last few years that neural networks are very optimum and efficient for approximation and classification. PC/BC-DIM can also perform optimal cue integration even when the input distributions are noisy(Spratling, 2016). So there is need to implement such PC/BC-DIM type neural algorithm to describe accurate location of acoustic source and underwater exploration which can perform multi-sensory fusion optimally even in the presence of unstructured noise.

4 Methodology of Research

For successful completion of research work it is required to deeply analyse available techniques of multisensory fusion. Mathematical modeling and algorithm of currently available techniques have to be practiced in MATLAB. The proposed method is based on artificial neural network so its deep concepts and applications should be understand. After proposing a optimal solution finally all previous techniques will be compared with proposed technique through the results.

5 Implications of Research

This project is directly beneficial for Pakistan seabed territory. It would be used for localization, exploration and target tracking. Other benefits are described below

1. Scientific Exploration
2. Underwater surveys
3. Localization of living and non living objects
4. Unmanned defensive robot of sea boundary
5. Discovery of new species and resources

6. Sea food diversity
7. Detection of unusual activity(spy)

6 Comprehensive Tentative Budget Required for Conducting Research

Financial aspects are buying registered software for simulation work. For review of literature some papers are needed which has to be purchased. If the system is performed on hardware after successful simulations then cost of buying AUV module, sensors and controller to burn proposed algorithm.

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APPENDIX-01

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