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| **Title: Underwater SLAM with ICP Localization and Neural Network Objects Classification** | |
| **Introduction** | SLAM in underwater using acoustic sensors,  Regression NN and iterative closest point(ICP) algorithms are used to process SONAR data without using any dynamic model,  . |
| **Application** | ICP: used for displacement estimation and localization.  KF : kalman filter is used for map building  RNN: Object classification |
| **Limitation**  **and accuracy** | Proposed technique gives satisfactory results in only **structured environment**,  **Recognition of objects** is required for Agent Location estimation,  **20 cm** horizontal error possible for location estimation between object and agent |
| **reference** | Conte, G., Scaradozzi, D., Zanoli, S. M., Gambella, L., & Marani, G. (2008, January). Underwater SLAM with ICP Localization and Neural Network Objects Classification. In *The Eighteenth International Offshore and Polar Engineering Conference*. International Society of Offshore and Polar Engineers. |

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| **Title: AUV Dead-Reckoning Navigation Based On Neural Network Using a Single Accelerometer** | |
| **Introduction** | Ocean currents wrongly measure gyroscope angle so neural network are used on only a single accelerometer to predict the position more accurately.  (\*\*\*Theta is required to measure angular position that is why we used equations to get odometry value) |
| **Application** | Pitch angle and distance travelled estimation using a single 3D accelerometer using Trained neural network. |
| **Limitation**  **and accuracy** | In Dead reckoning error accumulates over time  Plots are showing the results are accumulating method is used(Deadreckoning) |
| **reference** | Xie, Y. X., Liu, J., Hu, C. Q., Cui, J. H., & Xu, H. (2016, October). AUV dead-reckoning navigation based on neural network using a single accelerometer. In *Proceedings of the 11th ACM International Conference on Underwater Networks & Systems* (pp. 1-5). |

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| **Title: An USBL-Aided Multisensor Navigation System for Field AUVs** | |
| **Method Used** | EKF is used for collecting   1. Continuous odometry data 2. Absolute positioning measurment |
| **Application** | RAW usbl data imporved and odometry data also got support from USBL data,  Plots showing affective reduction of trajectory error,  . |
| **Limitation**  **and accuracy** | Random high noise can not overcome (like our pcbc eliminate beyond range values)  No statistical error comparison only plots are showing comparisons. |
| **reference** | Guerrero-Font, E., Massot-Campos, M., Negre, P. L., Bonin-Font, F., & Codina, G. O. (2016, September). An USBL-aided multisensor navigation system for field AUVs. In *2016 IEEE International Conference on Multisensor Fusion and Integration for Intelligent Systems (MFI)* (pp. 430-435). IEEE. |

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| **Title: USBL Integrationand Assessment in a Multisensor Navigation Approach for AUVs** | |
| **Method Used** | Two parallel extended kalman filters  One for integrating IMU, DVL and pressure sensor  Other for integrating USBL and GPS  For position estimation. |
| **Application** | Slow usbl values are supported by odometry data to get more reliable location. |
| **Limitation**  **and accuracy** | When distance increases the usbl measurement produces more delay and odometry data is always produces increasing trajectory error  extended kalman filter can not model usbl delay   1. Stardard deviation 0.45m in 100m trajectory for USBL 2. using an stereo SLAM approach as a GT, shows a trajectory error bounded in the range of [0, 1.7]m in a route of 270m   The mean and standard deviation of trajectory error for the ekf odom andof the ekf map turned out to be µodom = 3.4m, σodom = 1.3m, µmap = 0.89m and σmap = 0.48m |
| **reference** | Font, E. G., Bonin-Font, F., Negre, P. L., Massot, M., & Oliver, G. (2017). USBL integration and assessment in a multisensor navigation approach for AUVs. *IFAC-PapersOnLine*, *50*(1), 7905-7910. |

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| **Title: Comparison of Kalman Filter and Particle Filter Used for Localization of an Underwater Vehicle** | |
| **Method Used** | It is comparison of KF and PF and other methods wrt old methods of localization. |
| **Application** | KF and PF givers better results and PF gives more better and smoother trajectory wrt to trilateration, triangulation, and least squares method |
| **Limitation and accuracy** | The Kalman filter method requires computation time of 7.956×10-5sec while the particle filter requires 4.445×10-2sec on average with the number of particles 15,000. |
| **reference** | Ko, N. Y., & Kim, T. G. (2012, November). Comparison of Kalman filter and particle filter used for localization of an underwater vehicle. In *2012 9th international conference on ubiquitous robots and ambient intelligence (URAI)* (pp. 350-352). IEEE. |

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| **Title: Monte carlo localization of underwater robot using internal and external information** | |
| **Method Used** | Monte carlo particle filter for localization of underwater vehicle.  The Monte Carlo Localization(MCL) combines both of the deadreckoning and acoustic beacon based method in probabilistic manner. |
| **Application** | The MCL consists of two stages as the usual Bayes filters. The first stage predicts the location of the robot using internal information, that is, by deadreckoning. The second stage corrects the predicted location using the external information.  The results show that it is possible to estimate the robot location in 3 dimensional space using only two beacons.  the result shows the method improves the localization performance. |
| **Limitation**  **And accuracy** | Method is compared only with DeadReckoning which we all know that DR is always diverging in error.  No statistical comparison is given only waveform is showing the difference of DR and MC (particle) method. |
| **reference** | Ko, N. Y., Kim, T. G., & Noh, S. W. (2011, December). Monte carlo localization of underwater robot using internal and external information. In *2011 IEEE Asia-Pacific Services Computing Conference* (pp. 410-415). IEEE. |

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| **Title: Synchronous and asynchronous application of a filtering method for underwater robot localization** | |
| **Method Used** | This paper reports a method that fuses multiple sensor measurements for location estimation of an underwater robot |
| **Application** | The paper contributes to derivation of an EKF approach for sensor fusion for underwater localization. Moreover, proposal and test of various application methods to deal with AS measurements enhances the EKF approach to fully utilize all the available measurements.  The test tank has 14 m width, 20 m length, and 2 m depth. |
| **Limitation and accuracy** | Simulations:    Experiment:  The vehicle is controlled to move from (1.6, 7.0, 0.3) to (14.0, 7.5, 0.3) straight using remote controller. Though, the **reference trajectory is not able to be detected in the experiment**, it is examined that the result of SC and SI is feasible for location estimation of an underwater vehicle |
| **reference** | Ko, N. Y., Kim, T. G., & Choi, H. T. (2016). Synchronous and asynchronous application of a filtering method for underwater robot localization. *International Journal of Humanoid Robotics*, *13*(02), 1550038. |

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| **Title: Camera-IMU-based Underwater Localization** | |
| **Method Used** | Based on these four key information extracted from the camera and IMU, a Monte Carlo Localization(MCL) algorithm is established to localize the robotic fish online  Through the image processing algorithm, the distance and angle between the robot and landmark are calculated.  An odometry is generated for the robot based on the data of IMU. |
| **Application** | From the experimental results, we can see that the proposed localization approach is able to localize the robotic fish quickly and accurately (the plots) |
| **Limitation and accuracy** | Predefined objects are required  2D localization only  The convergence results of the MCL algorithm are shown in plots not statistical. The times are sequentially 0 ms, 90 ms, 270 ms, 480 ms, 673 ms, 860 ms, 1063 ms, 1250 ms, 1453 ms |
| **reference** | Zhang, J., Wang, W., Xie, G., & Shi, H. (2014, July). Camera-IMU-based underwater localization. In *Proceedings of the 33rd Chinese Control Conference* (pp. 8589-8594). IEEE. |

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| **Title: Improving Localization Accuracy for an Underwater Robot With a Slow-Sampling Sonar Through Graph Optimization** | |
| **Method Used** | Graph Slam. |
| **Application** | The algorithm is verified with both the ROS based simulation and the home-made AUV platform. Experimental results clearly show that the proposed algorithm outperforms other two traditional algorithms such as dead reckoning and uspIC in terms of both localization and mapping accuracy. |
| **Limitation and accuracy** | Simulations:  The average distance errors for dead reckoning, uspIC and GraphSLAM are 6.09m, 2.53m and 0.67m, respectively.  Experiment:  The testing site is a 33m × 13m rectangular pond in Woodbridge. It is clear that the pose difference with the dead reckoning is the largest one, i.e. 7.77m, and the proposed GraphSLAM has the smallest pose difference at 1.08m. The pose difference with uspIC is 4.37m. |
| **reference** | Chen, L., Wang, S., Hu, H., Gu, D., & Liao, L. (2015). Improving localization accuracy for an underwater robot with a slow-sampling sonar through graph optimization. *IEEE Sensors Journal*, *15*(9), 5024-5035. |

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| **Title: USBL/DVL navigation through delayed position fixes** | |
| **Method Used** | position fixes are fed back to the AUV through an acoustic modem. An Extended Kalman Filter (EKF) is used for the Multi Sensor Data Fusion (MSDF) |
| **Application** | In this paper an integrated method for USBL/DVL navigation has been presented.  Results show a significant navigation error reduction when the delay is taken into account |
| **Limitation and accuracy** | Not statistical comparison only plot comparison |
| **reference** | Ridao, P., Ribas, D., Hernandez, E., & Rusu, A. (2011, May). USBL/DVL navigation through delayed position fixes. In *2011 IEEE International Conference on Robotics and Automation* (pp. 2344-2349). IEEE. |

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| **Title: Position and Velocity USBL/IMU Sensor-based Navigation Filter** |

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