Ved Prakash Dubey

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Research Interests

- Multi-sensor tracking systems
- Sensor management
- Nonlinear estimation
- Underwater and aerospace tracking
- Data fusion

Education

Cont. **Ph.D. in Electrical Engineering**
Indian Institute of Technology
Patna, Bihar, India

2018. **M. Tech in Instrumentation & Control**
Aligarh Muslim University
Aligarh, Uttar Pradesh, India

2016. **B. Tech in Electrical Engineering**
Dr. A.P.J. Abdul Kalam Technical University
Lucknow, Uttar Pradesh, India

Achivements

- **Senior Research Fellowship (SRF)** at IIT Patna from the Ministry of Education, Govt. of India.
- Three-year four months **Senior Research Fellowship (SRF)** at IIT Patna from Naval Research Board (NRB) of Defence Research and Development Organization (DRDO), India.
- Received **Master of Technology Degree with Honours**.
- **Scholarship grant** from Ministry of Education, Govt. of India to pursue M. Tech.
- **Graduate Aptitude Test in Engineering (GATE)** 2016, 2017, 2018 qualified.
- Received **Bachelor of Technology Degree with Honours**.
- Full **tuition fee waived off** pursuing Bachelor degree sponsored by Government of Uttar Pradesh under Tuition Fee Waiver (TFW) scheme.

Doctoral Research Accomplishments

Supervisor: Dr. Shovan Bhaumik (Jan 2019 - Present)

The followings are the accomplishments during the research journey.

- The initial research work was focused on sensor selection in sensor management for a centralized tracking in multi-sensor systems.
- Developed different cost functions for sensor selection in underwater target tracking application for tracking a two or/and three dimensional target.
- Developed a noval local search algorithm based on binary search optimization technique for above mentioned cost functions.
- Nonlinear estimators are combined with the devolaped sensor selection technique to track an underwater suspected target.
- Explored and implemented different continuous-discrete (CD) filters for tracking problems.

Experiences

Ph.D. research scholar at IIT Patna (Cont.)

Teaching Assistant at IIT Patna

- Control & Instrumentation Lab
- Control System Classes
- Basic Electronics Classes

Teaching Assistant at ZHCET Aligarh

- Instrumentation Laboratory
- Control Laboratory
- Basic Electrical Laboratory

Skills

- MATLAB/Simulink®
- Python
- C languages
- LaTeX, Microsoft Office and Visio

Languages

Hindi ●●●●● English ●●●●●

References

Dr. Shovan Bhaumik

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Dr. M. Rihan

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- I designed a decentralized tracking algorithm, sensor selection techniques, and a consensus method to combine estimates from multiple trackers and estimators and analyzed the results.
- developed CD consensus filters for the above-mentioned decentralized underwater tracking problems.
- An extended Kalman filter, deterministic sample point filters (DSPFs), and a shifted Rayleigh filter are designed to deal with the problem of sensor position uncertainty.
- In subsequent works, the algorithm is also designed for one-step randomly delayed measurements.
- Developed a method to generate pseudo-random samples for a uniform distribution for various two-dimensional geometries.
- Different fusion schemes are analyzed for track-to-track data association between trackers.
- Geometric mean density fusion techniques have been formed using various cost measures, and their effectiveness has been evaluated.
- "Two international journals" are communicated as a result of these works, and one project of the Naval Research Board (NRB), DRDO, India, is successfully completed.

Academic Project/Seminar/Workshop

- I worked on a project titled “Decentralized Consensus Filtering for Underwater Target Motion Analysis” Naval Research Board (NRB) of Defense Research and Development Organization (DRDO) 2^{nd} January 2019 - 30^{th} April 2022.
- I participated in a five-day certified education planner (CEP) course on “Nonlinear Estimation for Engineers” organized by IIT Patna, held from 1^{st}- 5^{th} February 2020.
- M.Tech Project on “Distributed power system state estimation using micro phasor measurement units (PMUs).”

Publications

Journals

[1] **Ved Prakash Dubey**, Joydeb Saha, Shovan Bhaumik, and Arito Dey, “Tracking an Underwater Target in a Large Surveillance Region with Sensor Location Uncertainty", ***IEEE Access* 2023**

[2] **Ved Prakash Dubey**, and Shovan Bhaumik, “Distributed Consensus Tracking in Randomly Delayed Environments using Harmonic Mean Density Fusion and Optimal Sensor Selection”, ***IEEE Oceanic Engineering*** (Under Review)

Conferences

[4] **Ved Prakash Dubey**, Ranjeet Kumar Tiwari, and Shovan Bhaumik,“Selection of Sensors During Tracking a Submarine", ***IEEE OCEANS Conference and Symposium 2021***, San Diego-Porto, pp. 1-6.

[4] **Ved Prakash Dubey**, Rohit Kumar Singh, and Shovan Bhaumik,“Target Motion Analysis with Dynamic Sensor Selection in Multi-sensor Environment", ***IEEE Mechatronics and Electrical Engineering (MEEE) 2023***, Abu Dhabi, UAE.

Research Statement

In the era of advancing sensor technology, the widespread adoption of multi-sensor systems has become pivotal across various applications. These systems integrate many sensors, collaborating seamlessly to deliver tracking information of superior accuracy and reliability compared to their single-sensor counterparts. The inherent advantages of multi-sensor systems include heightened precision, redundancy, expanded coverage, and the capability to amalgamate data from diverse sensors, yielding a holistic understanding of the environment and tracked objects. Despite these merits, challenges accompany implementing multi-sensor systems, encompassing complexity, sensor compatibility, synchronization, and data fusion intricacies. Designing, implementing, and maintaining such systems entail significant costs and complexities. However, the potential benefits, particularly in tracking applications, often outweigh these challenges. This proposal aims to devise and implement a filtering strategy to address these challenges, facilitating the effective deployment of multi-sensor systems in tracking scenarios.

In underwater applications, continuous-discrete filters are indispensable due to their unique ability to balance the benefits of continuous and discrete filters. These filters handle underwater environments’ prevalent uncertainties and non-linearities, thereby furnishing robust and accurate state estimates of objects. Specifically in tracking applications, the continuous-discrete filter emerges as a potent method for state estimation in dynamic systems, seamlessly integrating the continuous-time dynamics of the system with discrete-time measurements. Widely adopted across diverse fields such as navigation, control systems, and signal processing, the continuous-discrete filter enhances estimation performance and demonstrates robustness in the face of measurement noise, making it a valuable asset for underwater tracking scenarios.

In tracking applications, the assumption of a known motion model for an unknown object is often impractical in real-world scenarios. A viable alternative is using a multiple-model system, a multi-sensor setup employing various models to track objects or estimate their state. This approach brings several advantages, including robustness to environmental changes, adaptability to diverse scenarios, and enhanced accuracy through model fusion. It effectively manages uncertainty by representing different hypotheses, handles multiple objects by assigning distinct models, and addresses non-linearity in object motion. The multiple model system emerges as a robust and accurate solution for tracking applications, capable of handling complex and dynamic scenarios.

Multiple underwater target tracking is a challenging task due to several factors such as acoustic noise, limited sensor range, target occlusion, target maneuverability, environmental factors, data association, and computational complexity. The underwater environment is noisy, which can make it difficult to detect and track targets. The limited range of underwater sensors can make it difficult to detect targets at a distance. Target occlusion can occur when targets are obscured by other objects in the water, making it difficult to detect and track them. Target maneuverability can also present a challenge, as targets can move quickly and unpredictably, making it difficult to maintain accurate tracking. Environmental factors such as currents, tides, and water temperature can also affect the movement of targets and make tracking more difficult. The data association problem determining which measurements correspond to which target is a big challenge in multiple target tracking. Finally, as the number of targets increases, the computational complexity of the tracking algorithm increases, which can make it difficult to maintain real-time performance.

Anticipated Outcomes

Upon joining the research position, the expected outcomes of the proposal can be outlined below.

- Designed a centralized sensor selection based tracking algorithm to track an underwater suspected target.
- Designed a distributed consensus algorithm for track to track fusion schemes in randomly delayed measurements.
- To design a sensor management based continuous -discrete filters for tracking to improve the further tracking accuracy.
- To design a model adaptive filtering technique for racking application to track a suspected target in which target model is not known to the tracker.
- To design a multiple target tracking algorithm to meet the challenges like limited range sensor detection, clutter in measurement and measurement signal absorption when propagates in underwater medium.