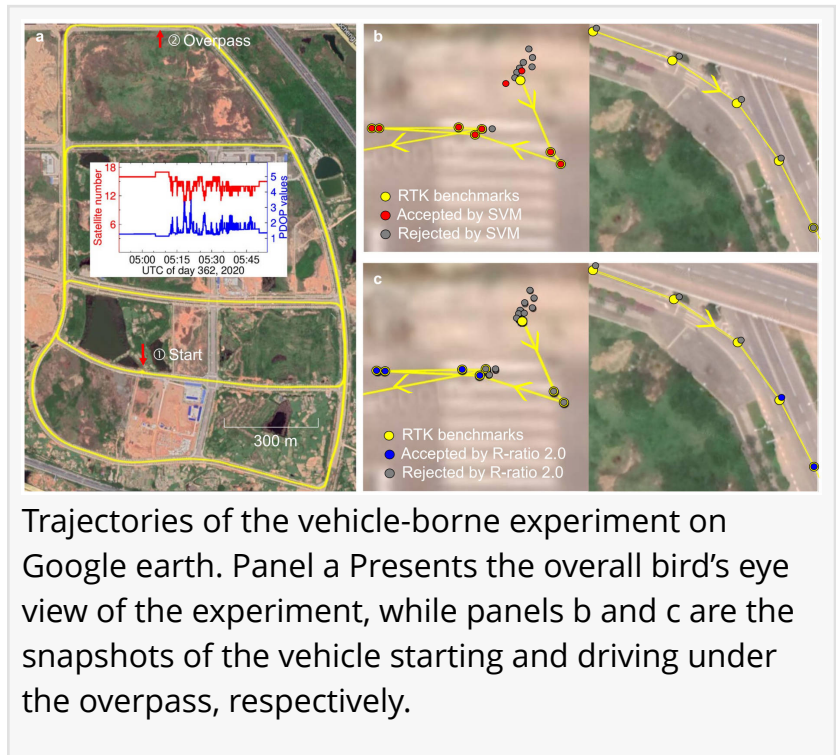


Machine learning boosts GPS precision: new method enhances ambiguity resolution

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/EINPresswire.com/ -- A new study has introduced a machine learning-based approach to improve the reliability of Global Navigation Satellite System (GNSS) ambiguity resolution, a critical step for achieving high-precision positioning. By integrating multiple diagnostic metrics into a Support Vector Machine (SVM) model, the method significantly enhances the success rate of ambiguity validation compared to traditional empirical tests. The results demonstrate an 83% success rate in independent testing and a notable reduction in convergence time prediction errors, paving the way for more accurate real-time navigation and monitoring applications.



Trajectories of the vehicle-borne experiment on Google earth. Panel a Presents the overall bird's eye view of the experiment, while panels b and c are the snapshots of the vehicle starting and driving under the overpass, respectively.

High-precision Global Navigation Satellite System (GNSS) applications, such as real-time displacement monitoring and vehicle navigation, rely heavily on resolving carrier-phase ambiguities. However, traditional methods like the R-ratio and W-ratio tests often use empirical thresholds, which can lead to unreliable results due to biases and environmental variability. These limitations hinder the efficiency of Precise Point Positioning Ambiguity Resolution (PPP-AR), especially in dynamic or challenging conditions. Based on these challenges, there is a pressing need to develop more robust and adaptive techniques for ambiguity validation.

Published (DOI: [10.1186/s43020-025-00167-8](https://doi.org/10.1186/s43020-025-00167-8)) on June 9, 2025, in Satellite Navigation, researchers from the Royal Observatory of Belgium and the State Key Laboratory of Precision Geodesy in China unveiled a novel Support Vector Machine (SVM) -based method for GNSS ambiguity validation. The study leverages machine learning to combine multiple diagnostic metrics, achieving higher accuracy and reliability than conventional approaches. The model was trained on extensive datasets and validated through real-world experiments, showcasing its

potential to transform high-precision positioning.

The study's key innovation lies in its integration of seven diagnostic metrics—including R-ratio, ADOP, and ambiguity dimension—into an SVM model. This approach addresses the limitations of traditional methods, which often rely on single thresholds and fail to account for complex dependencies among variables. The SVM model achieved an 92% success rate in ambiguity validation, outperforming the R-ratio test's 82% in kinematic scenarios. Notably, the model reduced convergence time prediction errors to just 1.0 minute, compared to 5.0 minutes for conventional methods.

Highlights of the research include:

Enhanced Reliability: The SVM model's ability to adaptively weigh multiple metrics ensures more consistent ambiguity resolution.

Real-World Validation: A vehicle-borne experiment demonstrated a 92% success rate, proving the method's practicality in dynamic environments.

Scalability: The framework is adaptable to both single- and multi-constellation GNSS systems, broadening its applicability.

Despite its advancements, the study acknowledges a 5% error rate in unresolved ambiguities, pointing to future research directions, such as incorporating variance-covariance data for further refinement.

Dr. Jianghui Geng, co-author of the study, emphasized, "Our SVM model represents a paradigm shift in ambiguity validation. By harnessing machine learning, we've not only improved accuracy but also provided a scalable solution for diverse GNSS applications, from autonomous vehicles to geodetic monitoring."

The SVM-based method holds significant promise for industries requiring ultra-precise positioning, such as autonomous navigation, aerospace, and infrastructure monitoring. Its ability to shorten convergence times and enhance reliability could revolutionize real-time GNSS applications, particularly in urban or obstructed environments where signal interruptions are common. Future iterations of the model, incorporating additional data layers, could further bridge the gap between theoretical precision and real-world performance, setting a new standard for GNSS technology.

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