Beyond CORS: A Self-Organizing Collaborative Positioning for Real-Time High-Precision GNSS Applications

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SUMMARY

A Collaborative Positioning (CP) that integrates Precise Point Positioning with Ambiguity Resolution (PPP-AR) and Real-Time Kinematic (RTK) techniques to overcome the fundamental limitations of each method when used independently, are introduced in the study. While PPP-AR enables global high-precision positioning, it suffers from slow convergence; RTK delivers rapid centimetre-level accuracy but is constrained by baseline distance and dependence on static reference infrastructure. The proposed CP approach eliminates these trade-offs by establishing a dynamic, user-driven ground-based infrastructure in which GNSS receivers assume roles autonomously — Rover, Candidate, or Base Station — based on real-time positioning quality and user consent. This self-organizing network leverages cloud-based coordination and real-time State-Space Representation (SSR) corrections from services to enable scalable, high-accuracy positioning without reliance on permanent CORS stations. Pseudo-kinematic experiments across baselines of 79, 125, and 317 km demonstrate that the CP achieves consistent real-time accuracy of 10-20 cm per coordinate component, with ambiguity resolution success rates exceeding 74%. This significantly outperforms standalone PPP-AR and rivals RTK performance even at extended distances. It is necessary to mention that the CP is adaptable to harness the growing capabilities of mass-market dual-frequency smartphones. Modern smartphones equipped with multi-constellation GNSS chipsets are no longer limited to metre-level navigation; now they can provide phase and code measurements suitable for high-precision applications. Within the CP ecosystem, these devices become key nodes, simultaneously benefiting from and reinforcing the collaborative network. Their ubiquity, connectivity, and decreasing hardware costs enable a scalable, crowdsourced infrastructure that transcends the limitations of traditional geodetic networks. Thus, the proposed system represents a paradigm shift toward decentralized, user-centric GNSS positioning. By unifying global coverage with rapid convergence and leveraging consumer-grade hardware as active participants, the CP paves the way for real-time high-precision positioning in

diverse applications, ranging from the precise navigation of robots to new mass-market positioning-based applications.