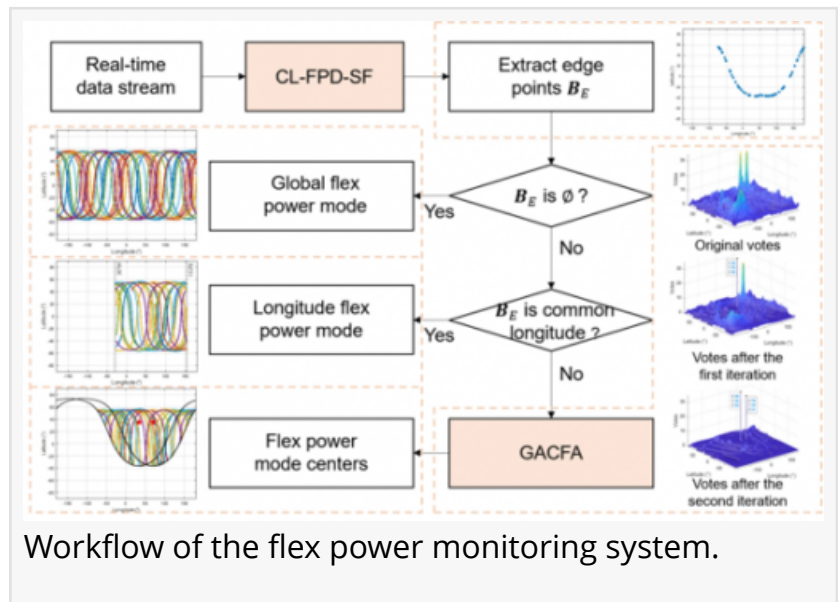


# How GPS “Flex Power” hides in plain sight – And why it matters for navigation

FAYETTEVILLE, GA, UNITED STATES, July 17, 2026 /EINPresswire.com/ -- [Global Positioning System \(GPS\)](#) satellites have a wartime secret: they can suddenly boost their signal power to punch through jamming. But these same power surges distort civilian navigation, introducing meter-level errors that degrade high-precision positioning, time transfer, and ionospheric modeling. Now, researchers have built the first fully automated framework that not only detects these power shifts in real time with near-perfect accuracy but also maps their geographic centers—replacing slow, error-prone manual methods with machine intelligence.



Workflow of the flex power monitoring system.

The U.S. military first tested Global Positioning System (GPS) “flex power” in 2010, enabling satellites to temporarily amplify specific signals without exceeding a strict –150 dBW ceiling to prevent interference. Since full deployment in 2018, flex power has been used tactically—during the 2018 Damascus airstrikes and amid rising tensions in Iran in 2019. Yet these power boosts introduce significant distortions in Differential Code Bias (DCB), causing uncalibrated ranging errors that undermine high-accuracy civilian services. Existing detection methods suffer from low-gain false alarms, transition-boundary delays, or scalability issues that require retraining for each new monitoring station. Due to these challenges, the need for robust, real-time monitoring and automated spatial mapping has become increasingly urgent.

Now, a team of researchers from China has published (DOI: [10.1186/s43020-026-00198-9](https://doi.org/10.1186/s43020-026-00198-9)) a comprehensive solution in [Satellite Navigation](#) (Volume 7, Article 14, June 23, 2026). Led by Chuhan Huang and colleagues, the study introduces an integrated framework that combines a novel detection algorithm with an autonomous center-fitting system—delivering what the authors describe as a major leap in space situational awareness for contested electromagnetic environments.

At the heart of the framework is the Closed-Loop Flex Power Detection with Sidereal Filtering (CL-FPD-SF) method. By exploiting the near-perfect repetition of satellite geometry each sidereal day—a 23-hour, 56-minute, and 4-second cycle—the algorithm constructs station-specific C/N<sub>0</sub> templates that effectively cancel out multipath interference. Instead of relying on lagged time windows, CL-FPD-SF computes epoch-specific residuals to detect power transitions the moment they occur. The results are striking: across five years of global data (2020–2025), the method achieved an average True Positive Rate (TPR) of 0.99997 and a False Positive Rate (FPR) of just  $3.6 \times 10^{-6}$ . That translates to near-perfect detection with virtually no false alarms—outperforming both machine learning-based approaches and linear correlation methods, particularly in low-gain flex power scenarios where existing techniques frequently fail. Complementing this, the Greedy-Strategy-Based Adaptive Centroid Fitting Algorithm (GACFA) automates spatial localization: it uses a grid-voting mechanism to map enhancement boundaries, replacing the inefficient manual fitting that has plagued the field. The framework successfully identified and tracked nine distinct flex power modes over the five-year period, including a previously undocumented Mode 9 that positioned centroids in the Southern Hemisphere for the first time—spanning Oceania and across the vast Pacific Ocean.

“Our framework fundamentally changes how we monitor GPS flex power,” the authors said. “Instead of chasing power shifts after they happen, we’re now able to detect them in real time and automatically identify the critical points of focus—all without human intervention. The CL-FPD-SF method essentially gives us a fingerprint of what ‘normal’ looks like for each satellite at each station, so any deviation immediately stands out. And GACFA takes the guesswork out of mapping these enhancement zones, which have historically been tied to regions of geopolitical instability. This isn’t just an incremental improvement—it’s a complete shift from reactive to proactive monitoring.”

The implications extend far beyond military applications. Flex power-induced DCB variations can introduce meter-level ranging errors that degrade high-precision positioning, satellite time transfer, and ionospheric modeling. By providing real-time detection and automated spatial mapping, the framework enables region-specific receiver calibration strategies, helping civilian users mitigate signal distortions without waiting for post-processing. The automated mapping of enhancement boundaries also establishes a critical mathematical baseline for the navigation community to develop targeted correction models. Looking ahead, the research team plans to extend their algorithms to multi-constellation Global Navigation Satellite Systems (GNSS) and integrate real-time detection into unmanned systems—a step toward comprehensively enhancing navigational resilience and anti-jamming performance in increasingly contested environments.

## References

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