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ANALYSIS OF RTK GNSS PARAMETER REQUIRED FOR ACCURATE POSITION ESTIMATION

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ABSTRACT

In modern applications like autonomous systems and wearables, centimeter-level positioning is vital, and RTK GNSS is widely used for this purpose. However, sudden accelerations often degrade its accuracy, yet the underlying causes are not fully understood. This project investigates these issues using the OHCOACH Cell Y device, focusing on UBX-NAV-SAT parameters such as signal quality and real-time-correction signal. By analysing dynamic motion scenarios, key conditions for RTK degradation were identified, and their impact on positioning accuracy was assessed.

KEYWORD

RTK GNSS, High accuracy position estimation, Rapid acceleration, IMU, Sensor fusing, Correction signal

INTRODUCTION

In recent years, the demand for high-precision positioning has grown rapidly across fields such as autonomous driving, unmanned robotics, agricultural automation, wearable devices, and defense systems. Among the available solutions, Real-Time Kinematic (RTK) GNSS stands out for providing centimeter-level accuracy in real time, making it well-suited for dynamic applications where low-latency and high mobility are required.

Despite its advantages, RTK GNSS faces critical challenges under dynamic conditions. Rapid accelerations and sudden motion changes—common in sports like football—often lead to temporary loss of Fix status, causing positioning accuracy to degrade from centimeter-level (Fix) to decimeter (Float) or meter-level (GNSS Only). Maintaining a stable Fix state is essential for applications such as athlete performance monitoring, where real-time, precise tracking enables data-driven training, recovery, and scouting.

This project investigates these challenges using the OHCOACH Cell Y device, a lightweight wearable tracker developed by Fitogether Inc., recognized by FIFA for its player tracking technology. The focus is on understanding how key GNSS parameters behave under high-intensity motion. Unlike static or average-case analyses, this work targets real-time parameter fluctuations—such as carrier-to-noise ratio (C/N_0), correction signal usage, and ephemeris data—based on the UBX-NAV-SAT message structure from the u-blox ZED-F9P receiver.

Through controlled experiments simulating rapid player movements and systematic data collection, the study quantitatively assesses how these parameters contribute to Fix state loss and recovery time. By combining statistical analysis and machine learning, the findings aim to identify the conditions that most critically affect RTK GNSS stability. Ultimately, this lays the groundwork for more robust wearable tracking systems, with the potential for advanced GNSS/IMU sensor fusion to further enhance accuracy under challenging dynamic environments.

MATERIAL AND METHODOLOGY

The experiment was conducted using equipment provided by Fitogether. The devices were classified into two categories: one cell remained stationary to serve as a base reference, while the other was shaken to induce state changes. By calculating the ratio between these two conditions, this study analyzes which GNSS parameters have the greatest impact on maintaining the Fix state and enabling rapid recovery under dynamic conditions.

RESULT AND DISCUSSION

Analysis of the experimental data showed that various GNSS parameters exhibited a downward trend. This pattern is considered reasonable because as recovery time increases—that is, as the cell experiences acceleration, transitions from the Fix state to the Float state, and then returns to Fix—the GNSS signal reception tends to decrease over time. Among the parameters examined, crCorrUsed showed the widest distribution ratio, suggesting that this variable may play a critical role in maintaining or regaining the Fix state.

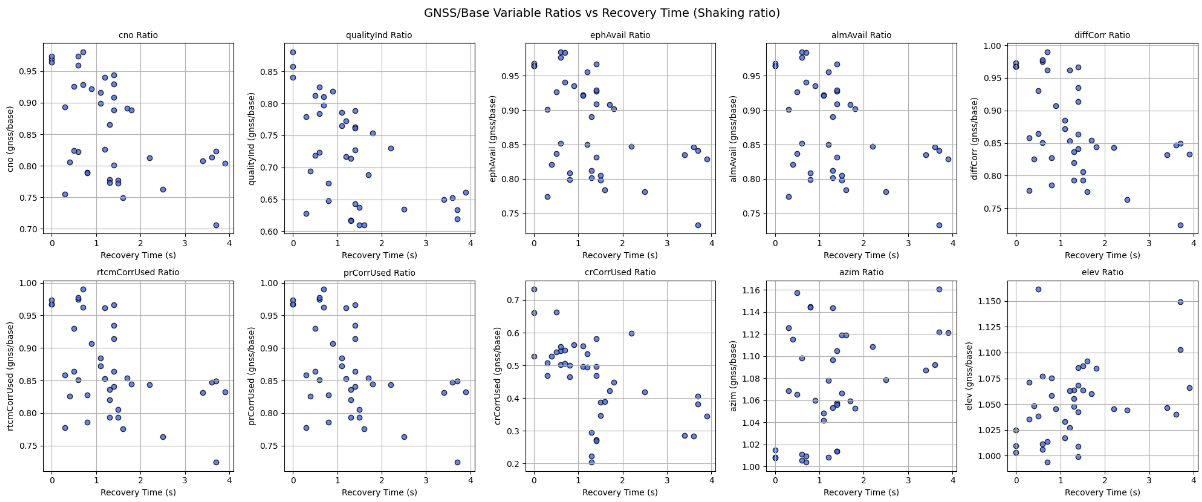

Figure 1: Scattering data of all GNSS parameters.

However, recovery time is affected by multiple GNSS parameters in a complex manner, making it difficult to identify clear relationships through simple observation alone. Therefore, quantitative analysis using machine learning is necessary to evaluate the contribution of each parameter more precisely. Ultimately, it is expected that integrating IMU sensor fusion with GNSS signals could enable the development of a wearable device capable of providing consistently accurate positioning, even in scenarios where GNSS signals alone are insufficient.

CONCLUSION

This study identified key GNSS parameters affecting Fix state stability under dynamic motion, with crCorrUsed showing critical influence. The results confirm that recovery time is impacted by multiple variables, requiring machine learning for precise quantification.

Importantly, this work serves as a first step toward developing robust GNSS + IMU sensor fusion, aiming to enable consistent high-precision positioning even when GNSS signals degrade.

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