DP-filter Performance Analysis in Dynamic Scene for GM Smart Receiver

INTRODUCTION

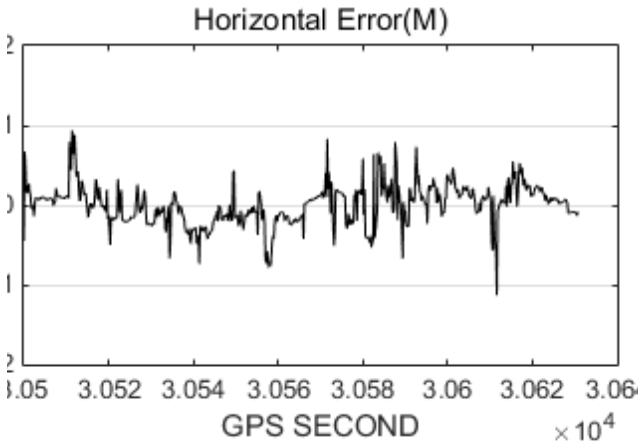


Fig. D-1 Autonomous

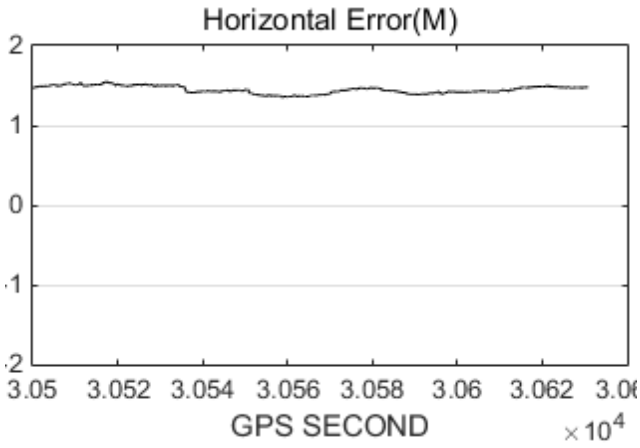


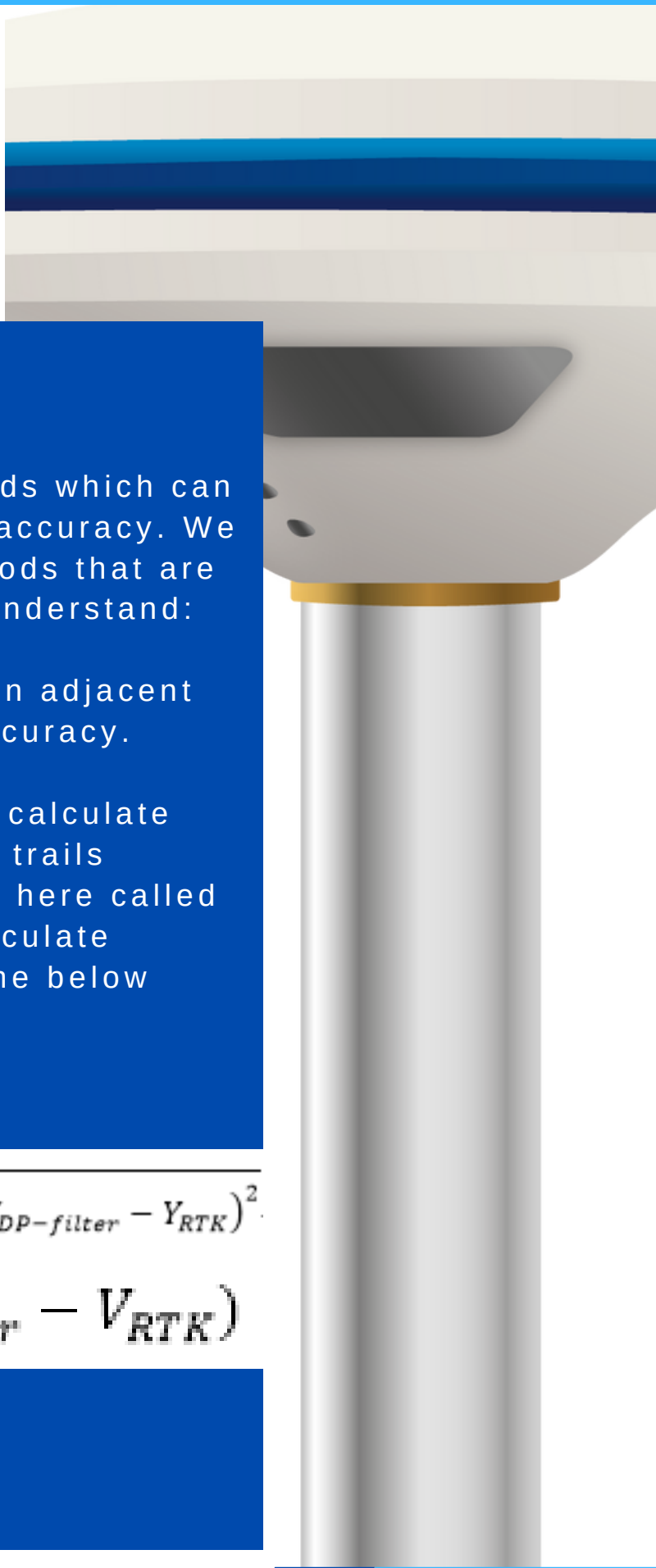
Fig. D-2 DP-Filter

In the single point (autonomous) positioning mode, the GNSS receiver provides around 1.5 meter absolute accuracy in horizontal, it can be significant drift in position due to pseudorange accuracy and no corrections input during positioning calculation.

For some positioning applications, such as guidance system in agriculture, absolute accuracy is not essential, but the relative position precision of continuous epochs and adjacent path is critical, even a small number of discontinuities point cause serious problems for users.

GM Smart Receiver DP-filter, the advanced smoothing filter algorithm, comprehensively implements carrier phase, delta-carrier phase, pseudorange and Doppler observation. Carrier phase is more accurate, less noisy and much resistant to multipath effect. From the merits of the carrier phase, the smooth positioning method improves relative positioning precision and creates a robust smooth solution, immunize from pseudorange inaccuracy. With DP-filter, the consistency of position Error will be involved to the positioning result, but smooth (pass to pass) accuracy will be insured in sub-meter to centimeter level. The following two figures show the different performance between autonomous with DP-filter mode.

SMOOTH (PASS TO PASS) ACCURACY



There are several different methods which can be used to quantify pass to pass accuracy. We adopt the following analysis methods that are straight forward to compute and understand:

a) Compare the difference between adjacent paths to evaluate pass to pass accuracy.

b) Set RTK result as a reference, calculate real-time coordinate difference of trails between DP-filter and RTK result, here called dynamic difference value, and calculate standard deviation according to the below formula.

$$H\_RMS = STD(\sqrt{(X_{DP-filter} - X_{RTK})^2 + (Y_{DP-filter} - Y_{RTK})^2})$$

$$V\_RMS = STD(V_{DP-filter} - V_{RTK})$$

TESTING PROCEDURE

Fig.1-1 Testing environment

In this paper, we test DP-filter performance to check the DP-filter performance in different environment, constellation and frequency configuration.

Scenario

The test is to compare smoothing function of GM Smart Receiver with one of competitors N. Setting RTK solution as the reference, one GM Smart Receiver and one competitor's were setup in parallel with one GM Smart antenna mounted on a trolley. The testing trolley was traveling at speeds of 7-10 km/h through a playground. In this scenario, all OEM boards tracks GPS, GLONASS and BeiDou constellations. This test was conducted on a playground with open sky view on one side, and tree canopy environment on another side.

TESTING PROCEDURE

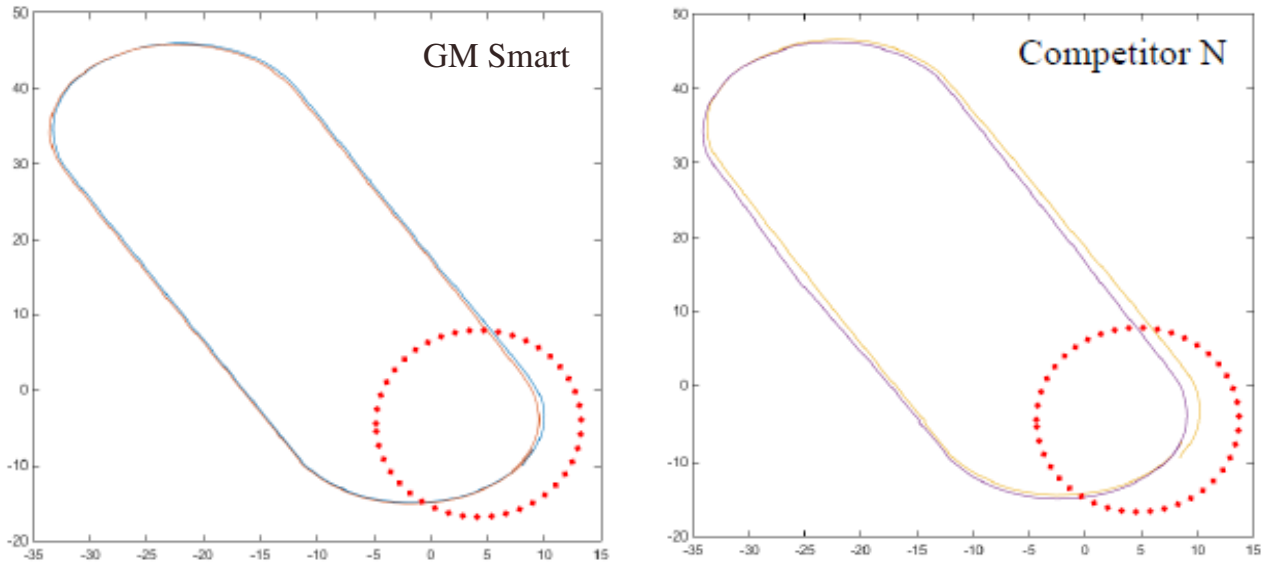


Fig.1-2 Smooth performance (2 loops) of GM Smart and Competitor N

The Fig.1-2 show smoothing path of GM Smart and Competitor's horizontally. The GM Smart acquires a closed loop; however, the competitor's receiver gets drift at the end of path.

We compare the difference between two adjacent paths first. The following Fig.1-3 and Fig.1-4 show the adjacent path performance.

We separately compare the difference in open environment and one half shelter environment. In open environment, they do not have the obvious difference, both of them can get less than 20 cm pass to pass accuracy.

In shelter environment, the GM Smart receiver show the advantage, it get closer between two paths. From the enlarged view, we can see the distance of GM Smart's two path is around 0.4m, competitor N is 1.2m.

TESTING PROCEDURE

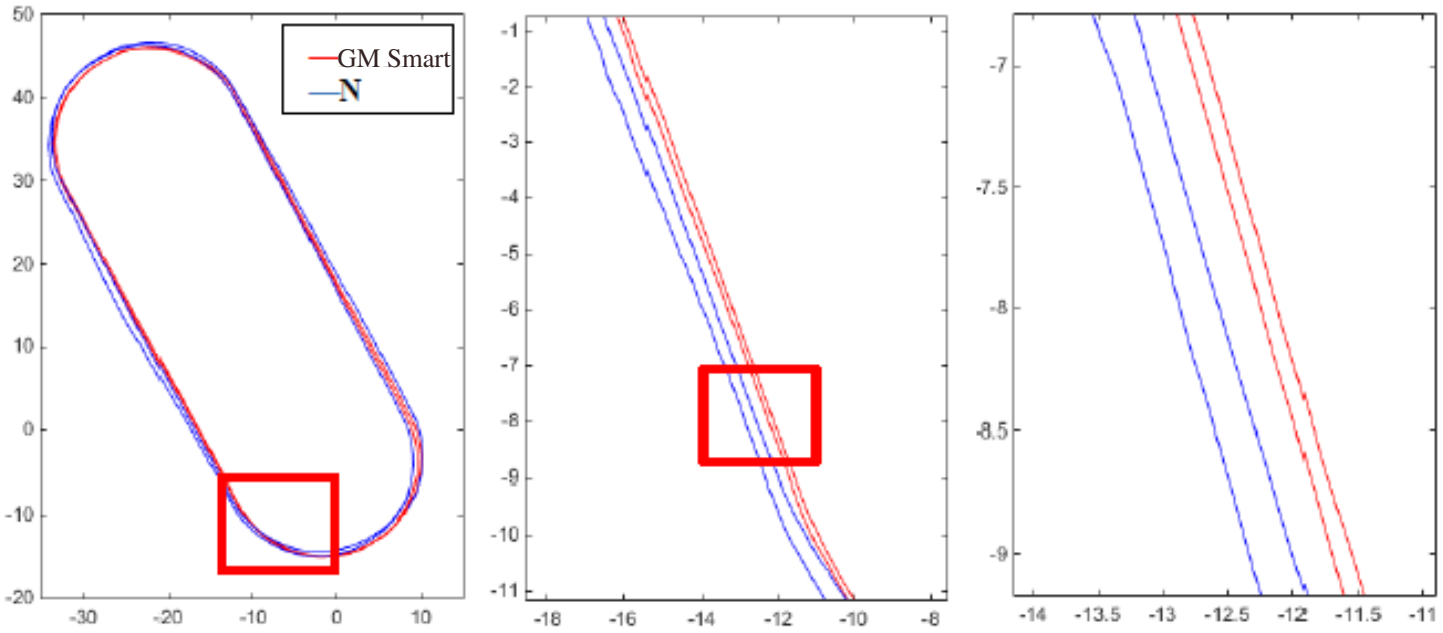


Fig.1-3 Comparison of GM Smart and competitor N in open environment (left side of the path)

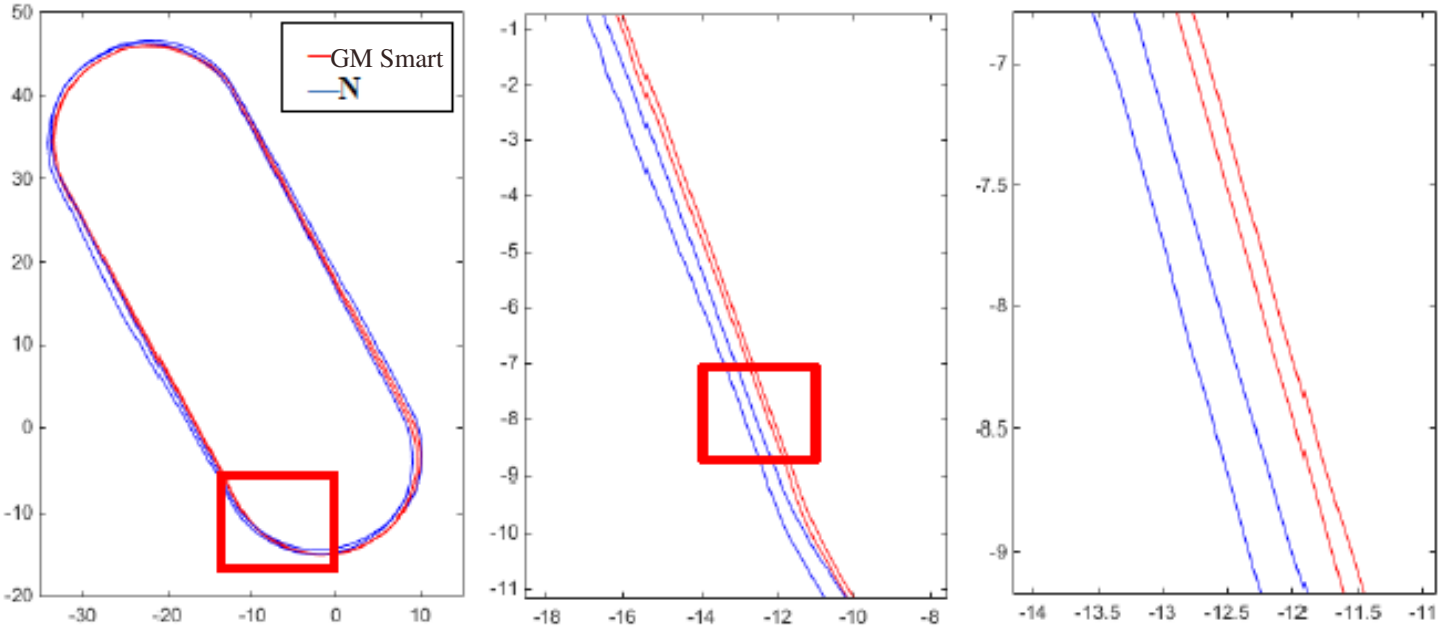


Fig.1-4 Comparison of GM Smart and competitor N in one half shelter environment (right side of the path)

TESTING PROCEDURE

We add the RTK solution as reference, make the mathematical statistics to calculate standard deviation (RMS). The following figure show the result.

In statistics, we separately analyze the left red box of upper figure which is half-shelter environment and the right green box which is in open environment. We can see from the Tab.1-1, the H-RMS of GM Smart is 0.12 meter in shelter environment and 0.07 meter in open environment. It shows the better performance than competitor N, no matter in open environment or shelter environment.

Tab.1-1 Real-time dynamic difference value RMS (m)

Receiver type	H-RMS	V-RMS
GM Smart (right red box)	0.12	0.18
N (right red box)	0.42	0.63
GM Smart (left green box)	0.07	0.16
N (left green box)	0.22	0.25

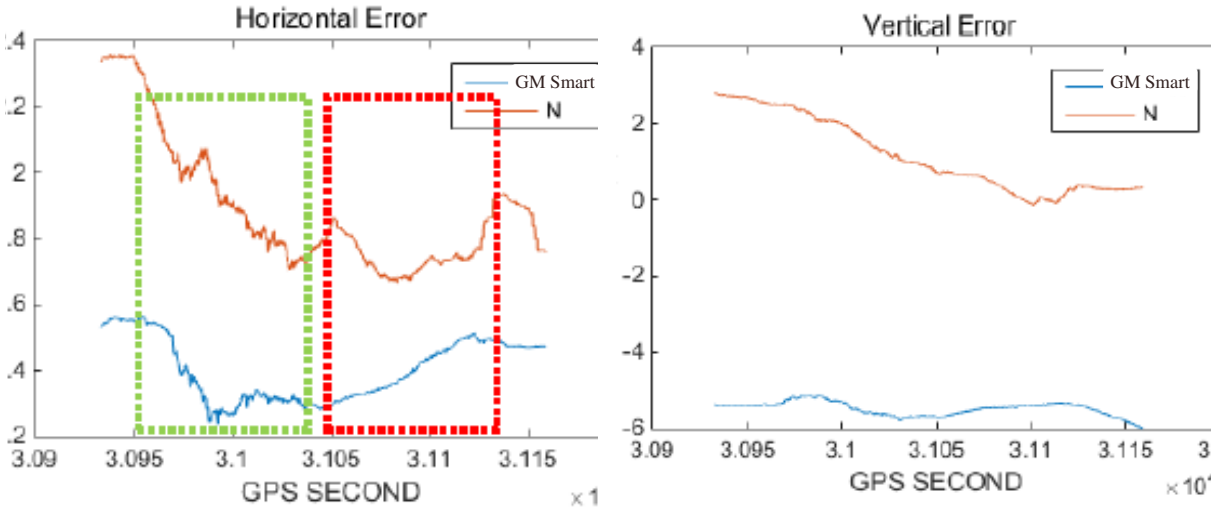


Fig.1-5 Real-time position difference of trails compare with RTK result in three constellations

CONCLUSION

DP-filter performance of GM Smart Receiver can reach under 20cm pass-to-pass accuracy and good smooth performance in open environment. This can meet the requirement of some projects which needs high relative position precision and smooth performance, such as guidance system in agriculture.

DP-filter can also get the better smooth performance than the competitor in shelter environment, shows the advantage for resisting shelter environment.