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## Velocity Filtering

Velocity filtering is a technique used in Trimble Mapping & GIS products to improve position accuracy. It removes “spikes” and outliers in GPS data collected in poor GPS environments.

This document describes how velocity filtering works, and provides information on when to use it.

### How does velocity filtering work?

The quality of a GPS position can be degraded by a number of error sources, including multipath. Multipath occurs when GPS signals reflect off buildings, tree canopy, or other obstructions before they reach the GPS receiver. To calculate a GPS position, a receiver measures the range to each satellite, based on the time it takes for the GPS signal to arrive. When a signal is reflected, it takes longer to arrive, so a range measurement using a reflected signal is incorrect.

As well as calculating its position, a GPS receiver can also determine its velocity by measuring the Doppler shift: the difference between the expected frequency of the satellite signal and the actual frequency of the incoming signal. This is similar to the way a police radar gun works. Multipath does not affect velocity measurements as much as it affects GPS positions.

A velocity measurement shows not only your speed, but also your direction of movement. You can use these values (the velocity vector) to predict where you will be after a specified time, relative to your current position. The accuracy of this predicted position is affected by the accuracy of your current position.

Velocity filtering calculates a filtered position for each epoch. The filtered position is a weighted average of the predicted position (derived from the velocity measurement) and the actual GPS position, and is more accurate than either.

The first predicted position is based on the previous GPS position, so its accuracy depends on the accuracy of the GPS position. However, each subsequent prediction is based on the previous filtered position, which is more accurate than the GPS position for that epoch. This means that the predicted positions become more accurate the longer the filter is used. As time passes, the calculations for the filtered position are weighted more heavily toward the predicted position.

The following diagram illustrates this process for a GPS receiver that is traveling in a straight line. The dots (●) are the predicted positions, and the arrows are the velocity vectors. Note that with each epoch, the filtered position (★) gets closer to the predicted position than the GPS position (■), as the accuracy of the predictions improves and the filter weighting changes.

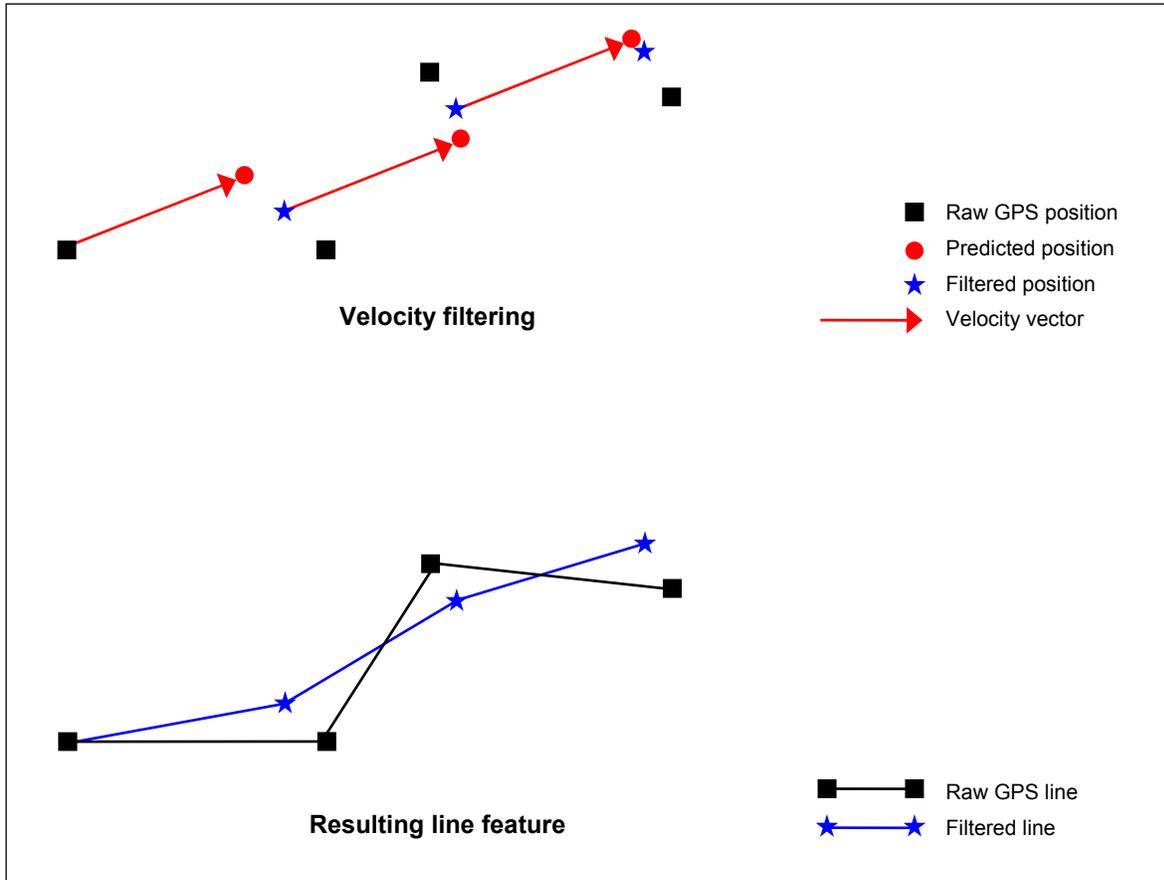
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## When should velocity filtering be applied?

Velocity filtering works best if:

- you are collecting data in a poor GPS environment (for example, under trees)
- the receiver dynamics are consistent, with no sudden changes in speed or direction
- the receiver is using a fast logging rate (one second or higher)

Velocity filtering is not recommended for good GPS environments, where GPS positions are relatively accurate.

**Warning:** When used in good GPS conditions, velocity filtering may decrease position accuracy.

If you have access to base station data for differential correction, you can apply velocity filtering during differential correction in the GPS Pathfinder® Office software. This gives you the flexibility to process your data with and without velocity filtering, and then choose the best result.

## How do I use velocity filtering?

You can apply velocity filtering:

- in real time in your Trimble Mapping & GIS field software.

If you apply velocity filtering in the field, Trimble recommends that you also enable SuperCorrect™ logging. If you log SuperCorrect records, you can remove the effects of velocity filtering when you reprocess your data in the GPS Pathfinder Office software.

- when you postprocess your data in the GPS Pathfinder Office software's Differential Correction utility.

GPS Pathfinder Office can only apply velocity filtering to your data if you have enabled the logging of velocity records or SuperCorrect records in the field software.

For detailed information on enabling real-time velocity filtering, SuperCorrect logging, or velocity record logging, refer to the documentation for your Trimble Mapping & GIS field software. For detailed information on applying velocity filtering during postprocessing, refer to the GPS Pathfinder Office Help.