SIGNAL PROCESSING TECHNIQUES FOR ANTI-JAMMING GPS

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The GPS uses a direct sequence spread spectrum (DSSS) signal that is highly susceptible to interference. There are both intentional and non-intentional forms of interference. The primary area of concern in both commercial and military applications is intentional interferers. Development of techniques for protection of GPS from interference and jamming is an area of active research.

GPS signals have some degree of jamming protection built in to the signal structure itself; however, due to the fact that the GPS signal originates in a half-geosynchronous orbit, it is relatively weak when it reaches the earth. The weak signal strength of the GPS signal makes it easy for an intentional interference to overcome the inherent jamming protection of the DSSS signal. Depending on the GPS receiver, the interference-to-signal ratio of greater than 40 to 50dB will prevent the GPS receiver from being able to obtain a position.

There are several approaches to mitigating this susceptibility including frequency-domain techniques, time-domain techniques, space-time processing and adaptive antennas. Frequency- and time-domain techniques are only effective against partial band interference. Further, neither of these techniques is capable of effectively incorporating the suddenly- changing or evolutionary rapidly time-varying nature of the frequency characteristics of the interference. In both techniques, there is a lack of intelligence about interference behavior in the joint time-frequency domain, rendering them limited in results and applicability.

Our research broadly considers space-time processing as well as multiuser detection methods, applied in wireless communications, for GPS interference suppression. The current focus of research is applying signal processing techniques, based on joint time, frequency, and space variables, to effectively mitigate the interferers (jammers) with a minimum distortion of the desired signal. In particular, we consider the mitigation of frequency modulated (FM) interference in GPS receivers. In difference to commonly assumed wideband and narrowband interferers, the FM interferers are wideband, but instantaneously narrowband, and as such, have clear time-frequency signatures that are distinct from the GPS spread spectrum code. In the proposed approach, the estimate of the FM interference instantaneous frequency (IF) and the interference spatial signature are used to construct the spatio-temporal interference subspace. The IF estimates can be provided using existing effective linear or bilinear t-f methods. The undesired signal arrival is suppressed by projecting the input data on the interference orthogonal subspace. With a multi-sensor receiver, the distinctions in both the spatial and time-frequency signatures of signal arrivals allow effective interference suppressions.