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AN ANTENNA ARRAY-BASED RADIO NAVIGATION SIGNAL'S DIFFERENTIAL CARRIER TRACKING ALGORITHM

Abstract

By using an antenna array, the navigation signal's direction of arrival(DOA) can be estimated, and the DOA information can be used for beam-formingattitude fix, spoof detecting, so the capability of estimation DOA is a key technology for the advanced navigation system. A common feature of the radio navigation systems used by aerospace vehicle, such as GNSS and the relative position system implemented by broadcasting a low energy navigation signal component through the communication link, is the signal strength is very weak and buried under thermal noise. So the traditional DOA estimation algorithm, such as the spatial spectrum analysis algorithm, which have not use the spread spectrum gain cannot be used to solve the DOA of navigation signal. In consideration of that carrier phase difference measurements for the same navigation signal at each antenna array elements can be used to solve its DOA, tracking the same signal at each antenna element is feasible to estimate the DOA. Howevertraditional tracking algorithms can only adopt separate tracking loops for each separate antenna element when moderate weak signal condition is present; these algorithms cannot obtain precise measurements and frequently become lose of lockAim to solve these problemsan antenna array-based differential carrier tracking algorithm which decomposed each element' s carrier phase to the common average part and the low dynamic residual differential part was proposedFor the average carrier phaseas it is commonly shared by each array elementits tracking stability can be improved by combining all the observation values of the whole array elementsFor the residual differential carrier phaseits tracking accuracy can be improved by reducing the loop noise bandwidthFurthermore, for the modern GNSS signal with a pilot component, a FLL is adopted to track the common dynamics and a high sensitivity PLL with long coherent integration time is adopted to track the differential dynamics. Theoretical analysis and numerical simulation show that the algorithm can significantly improve the measurement accuracy of carrier phase difference between elements needed by DOA estimation and tracking sensitivityThe tracking sensitivity of a 4 element antenna array with typical application conditions improves 4dB and the carrier phase difference measurement accuracy of it increases 3 times under the same carrier noise ratio, and stable DOA estimation can be obtained at the low C/N0 of 25 dBHz.