

We propose an improved method for moving target localization with a noncoherent multiple-input multiple-output (MIMO) radar system having widely separated antennas. The method is based on the well-known two-stage weighted least squares (2SWLS) method, but in contrast to the recently proposed Group-2SWLS, it requires only one reference transmitter (or receiver) without grouping and combining. This change allows us to obtain a closed-form solution which is less likely to be degraded by bias. Furthermore, the proposed method can easily utilize not only time-of-arrival (TOA) and frequency-of-arrival (FOA) data but also time-difference-of-arrival (TDOA) and frequency-difference-of-arrival (FDOA) data. We also introduce new auxiliary variables for the purpose of numerical stability; our method using the auxiliary variables is shown to be numerically more stable than the Group-2SWLS, while attaining the CramérRao lower bound (CRLB) at higher noise levels. The adoption of auxiliary variables requires no additional computations in contrast to the adoption of the concept of Turbo-2SWLS for the same purpose.