Angle-of-arrival determination using pre-calculated phase differences

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A method has been developed to determine the angle-of-arrival (AoA) of incident radio waves using simple interferometer arrays. This technique compares the phase differences of all unique antenna pairs simultaneously to produce a map of probabilities of all possible AoAs. Given a pair of antennas, the angle between the propagation vector of a radio wave and an antenna pair baseline can be inferred from the phase difference between the antennas. Antenna pairs separated by more than half a wavelength will have more than one valid AoA for a particular phase, but larger spacings are preferable to reduce coupling between antennas and to increase angular precision. Current methods rely on collinear pairs separated by half a wavelength to de-alias individual phase differences for collinear antenna pairs. Our method starts by calculating the theoretical phase difference for all antenna pairs across all possible AoAs. For a particular set of antenna phase differences, we construct regions of possible AoAs for all unique antenna pairs, which are added to produce a probability map that has a maximum values at the true value of AoA. Numerical simulations and comparison with meteor radar data confirm the validity of this approach, which will provide more flexibility in the design and placement of low-cost interferometer arrays. This includes array designs that provide more accurate and reliable measurements of the direction to echoes, as well as the opportunity to construct three dimensional interferometer arrays.