Study on Direction of Arrival Estimation Method with Automatic Calibration System for Solar Power Station/Satellite

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In Solar Power Station/Satellite (SPS), it is necessary to transmit microwave power generated in space to a rectenna site on Earth correctly by a beam control. The difference of characteristics in each pilot signal receiver, however, causes a serious error for the accurate detection of Direction of Arrival (DOA). Piece-to-piece variations of devices, secular changes, and failure of equipments are cited as main causes of the difference. We have been studying a method of estimating DOA with a self-calibration function, and it has turned out that DOA estimation is affected badly when the mean of phase errors which are added in passing through the receivers is not zero. In the present research, we have developed a DOA estimation method which is not influenced by such errors.

We study a DOA estimation method with an automatic phase calibration system for linear equispaced arrays, named PCLE method (Phase Calibration method for Linear Equispaced arrays). This method assumes that the sum of the differences of characteristics in receivers approaches 0.We show through numerical simulations that the PCLE method causes errors in estimation of the DOA if the sum is not 0 although this errors become negligible with data received by a lot of antennas.

Then, we have developed a new method, named PCLE-WS method (Phase Calibration method for Linear Equispaced arrays with double (W) pilot Signals). The PCLE-WS method is not necessary to assume that the sum of the phase differences from characteristics is 0. We show that PCLE-WS method well estimates the true DOA with data received by any number of antennas by both numerical simulations and demonstration experiments. Fig.2 shows experimental setup and experimental result of PCLE method. The α that leads true DOA physically is different from ideal parameter.

Finally, we suggest how we should apply these methods to SPS. We propose that the PCLE-WS method should be used for experimental types of SPS and the PCLE should be used for commercial types of SPS from a view point of the number of antennas.

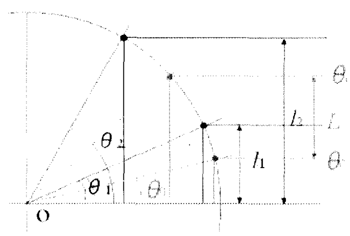

Fig. 1. There is a unique θ_0 which satisfy, $\sin\theta_1 - \sin\theta_2 = \sin(\theta_0 + \alpha) - \sin\theta_0$. α is assumed correct.

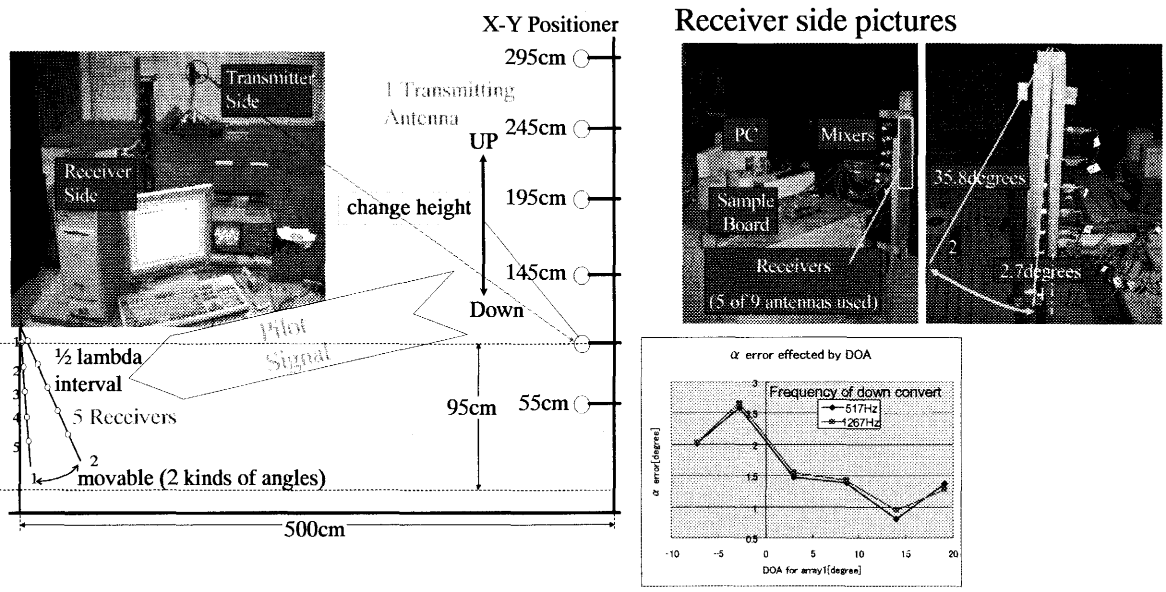

Fig.2 Experimental Setup and Experimental Result of PCLE method