HARDWARE DESIGN AND SIMULATION FOR DIGITAL ADAPTIVE BEAMFORMER

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ABSTRACT

THE PURPOSE OF ADAPTIVE BEAMFORMING IS TO USE ARRAY SENSORS TO PICK UP SIGNALS ARRIVED FROM VARIOUS DIRECTIONS. THE DIRECTION OF ARRIVALS (DOA) OF DIFFERENT SIGNALS IS THEN DETERMINED. BY CONCENTRATING PROCESSING AT CERTAIN ANGLES OF INTERESTING, THE SYSTEM EFFICIENCY CAN BE GREATLY IMPROVED. THE APPLICATIONS OF BEAMFORMING INCLUDE RADAR, SONAR, SPEECH AND WIRELESS COMMUNICATION. ONE OF THE MOST POPULAR APPROACHES IS OF MVDR WHICH IS BASED ON OPTIMUM FILTERING AND SPECTRUM ANALYSIS. A COST FUNCTION IS FIRST DEFINED AND MINIMIZED IN ORDER TO FIND THE OPTIMAL CONNECTION WEIGHTS BETWEEN THE INPUT SIGNAL FROM THE ANTENNA ARRAY AND BEAMFORMER OUTPUT. THE COMPUTATION OF THE INVERSE CORRELATION MATRIX AND ITS MULTIPLICATION WITH STEERING VECTOR ARE THE MOST IMPORTANT PARTS IN THIS PROCESSES. IN A SYSTEM THAT REQUIRES HIGH-SPEED COMPUTATION, MATRIX INVERSION IS AMONG THE MOST TIME-CONSUMING PROCESSES, ESPECIALLY WHEN THE DIMENSIONALITY IS HIGH AND MATRIX IS CLOSE TO SINGULAR. FORTUNATELY, ADAPTIVE ALGORITHMS ARE AVAILABLE SO THAT THE PROCESS CAN BE PERFORMED EFFICIENTLY IN A RECURSIVE WAY. THIS PAPER WILL DERIVE A FAST ALGORITHM FOR COMPUTING INVERSE CORRELATION MATRIX IN DIGITAL BEAMFORMING USING THE FAMOUS MATRIX INVERSION LEMMA. WE WILL DEMONSTRATE IN THE SIMULATION THAT DOA CAN BE EFFICIENTLY DETECTED USING THIS APPROACH. IN HARDWARE DESIGN, WE USE THE TMS320C6X DIGITAL SIGNAL PROCESSOR FROM TEXAS INSTRUMENT (TI) TO APPLY THE ADAPTIVE BEAMFORMING IN THE DEVELOPMENT OF DSP HARDWARE. THIS IS WILL FACILITATE THE TECHNIQUE OF ADAPTIVE BEAMFORMING IN WIRELESS COMMUNICATION.

Keywords: LINEAR ARRAY CIRCULAR ARRAY MVDR LCMV CORRELATION MATRIX RLS DIGITAL SIGNAL PROCESSOR.

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