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Three Element Beam forming Algorithm with Reduced Interference Effect in Signal Direction

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ABSTRACT: *The beam forming algorithm simulated in this project is motivated by analyzing a low-cost radar system that provides wide spatial coverage and very rapid target detection as well as tracking.Desigining towards these goals, a reasonable and mostly generic receiver would employ a three-antenna receiver. Because the minimum number of sensing elements needed to determine two dimensional angles is three the system cost has been mostly minimized.*

In this project 1 consider the problem of using our low cost system to detect and estimate the direction of arrival (DOA) of a desired signal in the presence of a dominant interference signal.

Unlike most direction of arrival (DOA) estimation algorithms, the proposed algorithm does not use grid search. Instead the estimates result from a closed-form solution, a great advantage in time-sensitive applications. Additionally, we carry out numerical simulations and results will be analyzed to demonstrate that our algorithm is capable of achieving more reliable DOA estimates than those found with the well-known multiple signal classification algorithm. Finally, a complete radar signal processing example will be presented.

MATLAB/GNU OCTAVE simulation tool will be used for simulation. The simulation results, applications, merits and demerits of proposed approach will be analyzed and will be documented.

Keywords: *Three antenna receiver, direction of arrival*

I. INTRODUCTION

A conventional technique of processing temporal sensor array measurements for signal estimation ,interference suppression, or source direction and spectrum estimation is beam forming [1-3].It has been exploited in numerous applications (e.g.,radar,sonar,wireless communications, speech processing, medical imaging, radio astronomy).

The beam forming algorithm presented in this paper is motivated by analyzing low –cost radar system that provides wide spatial coverage and very rapid target detection as well as tracking. Designing towards these goals, reasonable and mostly generic receiver would employ a three antenna receiver. because the minimum number of sensing elements needed to determine two dimensional angles is three, the system cost has been mostly minimised..we now consider the problem of using our low cost system to detect and estimate the direction of arrival of a desired signal in the presence of dominant interfering signal.

The rest of the paper is organized as follows. In section1,first,we give a full description of our algorithm ,starting with the system model and continuing with a tabular list of algorithm steps .Next we proceed with the system model and continuing with a tabular list of algorithm steps .Next ,we proceed with a detailed description on our methodology for interference cancellation ,target detection ,and phase angle estimation. Afterwards, we analytically identify the spatial scenarios of a jammer and target in which the proposed technique will reliably estimate a target's DOA. Next, in section 3 the stastical performance of the algorithm is explained through a collection of simulations..Finally; section5 contains the conclusions of this work.

II. SYSTEM MODEL

Three antennas in an arbitrary geometry make up our receiver structure. The received signal at the *i*th element at time n,is denoted by $x_i(n)$ and is formed from the coherent condition of the target signal $t_i(n)$,the jammer signal $u_i(n)$,and the noice $v_i(n)$.Therefore

$$x_i(n) = t_i(n) + u_i(n) + v_i(n) \qquad i=1,2,3. \qquad (1)$$

Assuming point sources and equal gains for the three receivers, the target and interfering signal at each sensor will be phased replicas [10].We also assume sensor will be phased replicas [10].We also assume narrow band signals, which means that relative phases of the received signal s will be constant across the entire band.the target signals are modelled as

$$t_2(n) = t_1(n)e^{j\theta}$$
$$t_3(n) = t_1(n)e^{j\delta} \qquad (2)$$

Where

$$t_1(n) = \alpha(n)e^{j\phi(n)} \qquad (3)$$

And the interfering signals are

$$u_2(n) = u_1(n)e^{j\epsilon}$$
$$u_3(n) = u_1(n)e^{j\eta} \qquad (4)$$

Where

$$u_1(n) = \beta(n)e^{j\lambda(n)} \qquad (5)$$

The variables α(n) and ϕ(n) respectively denote the amplitude and the time varying phase of the target at antenna 1,while θ and δ denote the relative phase angles at antenna 2 and 3.In a similar manner ,the parameters $\beta(n)$, $\lambda(n), \epsilon,$ and η denote the amplitude ,time varying phase ,and electrical phase angles of the jamming signal .The noise ,$v_i(n)$ is a white zero –mean complex random variable with variance σ^2 and is uncorrelated with $v_m(n)$ for $i \neq m.$ All greek letter variables represent real numbers.

We now give an overview of our algorithm which does not fit either of the paradigms introduced above, i.e. we do not scan a narrow beam nor do we use a parametric method to estimate the steering vectors of all present source signals.Throughout the rest of this paper, we refer to the desired signal as the target signal because this approach has been motivated from the signal processing needs of a radar system.we have also choosen to use a noise jammer for the interference source because of the ease at which one can be simulated, but application need not be limited to this case.the algorithm steps are enumerated in table I.Like [11] instead of using beam forming is used to null a jamming signal. Nulling the jammer enables a reduced –complexity mathematical technique for estimating target signal parameters. Unlike [11], we employ phase interferometery and require one less receiver channel. Adapting a beam based solely on information about an processing techniques that attempt to reduce computational complexity.

Table1

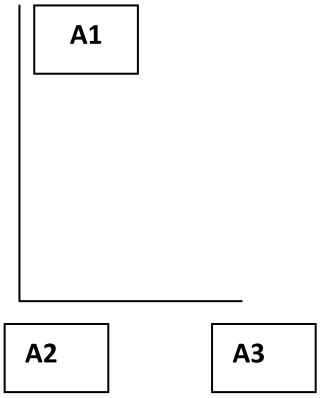
Algorithm overview
Step 1: Find beam forming weights that minimize the jammer's power.
Step 2: Apply threshold detection to the Beam former outputs of each range - Doppler bin of interest.
Step 2a: If a target is detected, record its range and Doppler and proceed to step 3.
Step 2b: If no target is detected, start over with the next coherent processing interval.
Step 3: Estimate relative phase information for each detected target.
Step 4: Calculate DOAs from the phase information.

III. METHODOLOGY DESCRIPTION-STEPS

I. Interference Cancellation

If a weighted sum of the received signals is formed, it is possible to choose non-zero, equal magnitude weights that completely cancel, or null the jammer signals. The importance of the weights being non-zero is obvious because we still desire to detect the target.A L shaped is assumed with 3 antennas located at (0,5) ,(0,0) and (5,0) . A jammer signal is assumed to be located to predefined coordinates. The jammer signal is a cosine wave with random noise added to it. The goal is to null of the three antennas due to the jammer signal. We calculate each of the antenna's net output due to the jammer signal by taking relative delays (time taken for the signal to reach the antenna) into consideration. The phase weights of each of 3 antennas are calculated using the below formulas

Antennas(1,2) = X1 + X2 * e^(jwt)
Antennas(1,3) = X1 + X3 * e^(jwt)



The phase weights are calculated by varying the value of pi from -180 to 180 in steps of 0.0001.We find minimum value value occurs and consider the pi value to be the corresponding phase weight value.After obtaining the phase weight values, we multiply the respective phase weight with the antenna output the compare the results.

II. Target Detection and Range estimation

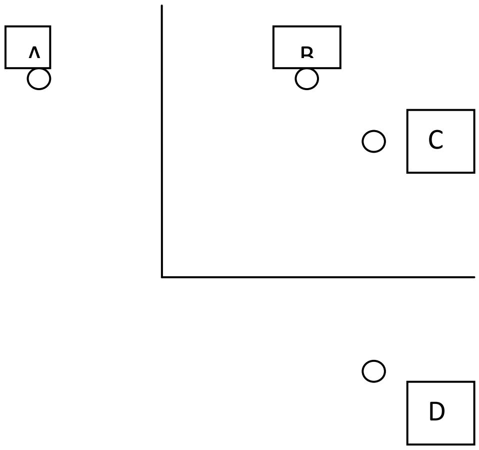
We assume the target coordinates and calculate the Radar signal for 3 pulses. We then observe the output when the radar emits the signal, how it is reflected from the receiver and how it is received back by the transmitter. The total output will be the sum of the radar signal due to target and the jammer signal. A threshold value is computed based on the assumed noise power. The complete antenna output is compared with this threshold value. If a match is found, the corresponding index is noted and the round trip time and the range of the target are both calculated. If no match is found the entire process is repeated with another set of radar pulse signals.

III. Angle of arrival (AOA)

The Angle of arrival is calculated building the look up table for sample delays between antenna outputs to DOA of signal.The angles are measured considering the line joining antenna 2 and 3 as initial line where the location of antenna 2 is the origin.All angles are measured in anti clock wise direction.For example if the target is on the line joing the 1 and 2 antennas then it will be reported as 90 degrees. We first calculate maximum delays corresponding to Antenna pairs(1,2) and (2,3).Taking a loop from min to max value we calculate all the angles possible to the antenna pairs (1,2) and (2,3) by using the below formulae

Theta (1,2,1) = (180/ π) * sind(dd12/d12)
dd12: Additional distance travelled by the signal
d12: Distance between Antennas 1 and 2 Theta(1,2,2) = - Theta(1,2,1)
Theta(2,3,1) = (180/ π) * cosd(dd23/d23)
dd23: Additional distance travelled by the signal d23 : Distance between Antennas 1 and 2 Theta(2,3,2) = - Theta(2,3,1)

After building the look up table we now calculate cross correlation between Antenna 1 and 2 outputs, Antenna 2 and 3 outputs. The maximum peak from the cross correlation outputs is found for the 2 antenna pairs. Based on the maximum peak index the corresponding angles from the look up table are extracted for the Antenna pairs (1, 2) and (2,3).Therefore 4 angles are obtained A and B for the first antenna pair, C and D for the second antenna pair. The angle of arrival is then found by taking the differences of the angles (A,C), (A,D), (B,C) and (B,D). Wherever the least difference is obtained, angle of arrival is found by averaging the 2 angles where the minimum difference was obtained. For



Ex:
Angles due to Antenna pair (1,2) is A,B
Angles due to Antenna pair (2,3) is C,D
Taking all the differences, minimum difference is obtained from B and C.
Therefore angle of arrival = (B+C)/2.

IV. SIMULATION RESULTS

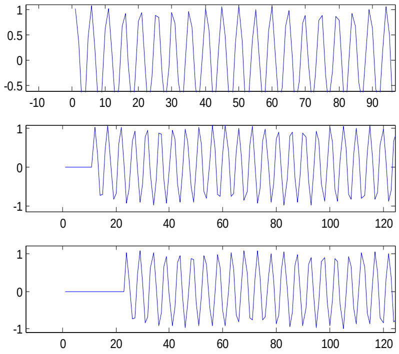


Fig.1.Data generation

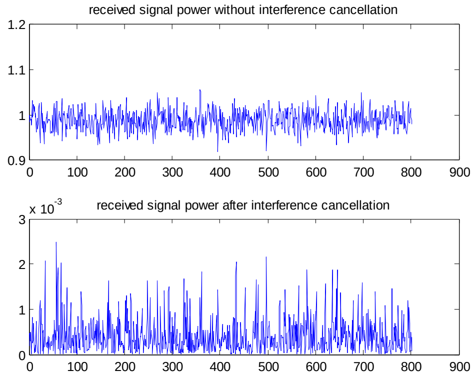


Fig.2. Interference cancellation

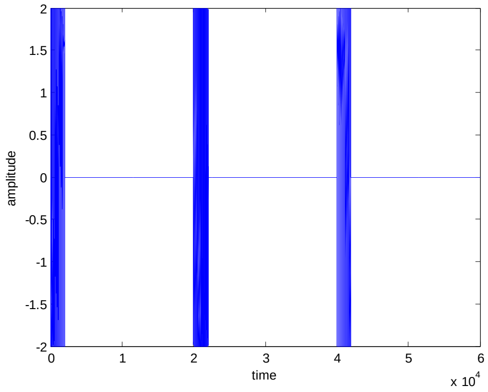


Fig.3. Radar Signal Generation

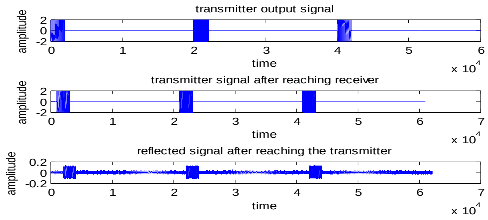


Fig.4. Phase Angle Estimation

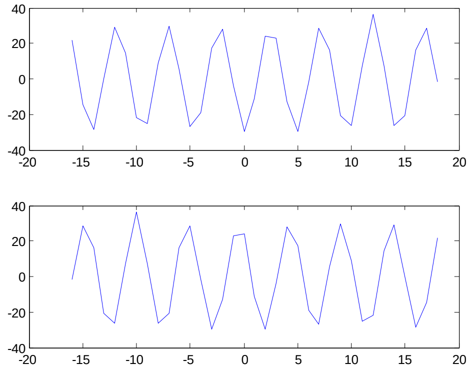


Fig. 5. Obtaining Angle of Arrival of Desired Signal

V. CONCLUSION

While in the presence of a dominant interference source, our proposed algorithm yields unbiased target DOA estimates from a low-cost, three-element receiver. We also mathematically identified the spatial scenarios where those estimates will have low variances. Unlike most DOA estimation methods, our estimates are found from closed-form expressions. In contrast to MUSIC, our algorithm performs well even when the number of target-containing snapshots available is small. This property makes it attractive for use in post-Doppler processing where it is common for a target signal to straddle only a few range-Doppler bins. Te DOAs of multiple targets can be estimated from one CPI as long as those target signals are resolvable in range or Doppler.

REFERENCES

[1] Krim,H.Viberg,M. Two decades of array signal processing researh:The parametric approach. IEEE signal processing Magazine,13(July 1996),67-94.

[2] Van veen, B.D.andBuckley,K.M. Beamforming:A Versatile approach to spatial filtering. IEEE signal processing Magazine,5(Apr 1988),4-24.

[3] Van Trees, H. L.Optimal Array Processing (Detection, Estimation, andModulation Theory, Part IV).New York: Wiley-Interscience, 2002.

[4] Capon, J.High resolution frequency-wavenumber spectrumanalysis. Proceedings of the IEEE, **57**, 8 (Aug. 1969), 1408—1418.

[5] Schmidt, R. O. Multiple emitter location and signal parameter estimation. IEEE Transactions on Antennas Propagation, **AP-34**, 3 (Mar. 1986), 276—280.