AUTHOR KIT INSTRUCTIONS AND MASTER CHECKLIST

UNCLASSIFIED TECHNICAL PROGRAM

Instructions

This kit supplies instructions and necessary forms for submitting final manuscripts for the MILCOM 2002 Unclassified Technical Program. Three copies of final, camera-ready and electronic manuscripts, following the Electronic Manuscript Submittal Instructions, are due no later than **July 1, 2002**. Please read the instructions carefully and submit all Mandatory and appropriate Optional forms with the final paper copies.

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1 Upload an electronic copy of manuscript by no later than **July 1, 2002:**

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- ❑ IEEE Copyright Form
- ❑ Approval Endorsement Forms (Choose applicable)
  - US Authors (Except US Government Employees) Endorsement Form A
  - US Government Employee Authors Endorsement Form B
  - Foreign Nationals (Non-US Authors) Endorsement Form C
- ❑ Speaker s Breakfast/Audiovisual/Media Interview Form

Optional Forms

- ❑ Student Travel Support Application Form

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- Hotel Reservation Information
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- General Speaker Instructions
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- Text font is 11 point Times Roman, single space
- Position figure numbers and title below each figure; treat tables as figures
- Imbed all tables, charts, scans of photos and artwork within the text
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- The first paragraph must be the abstract in 11 pt. Times Roman Italic
- See figure at right for sample layout

A NULLING ALGORITHM FOR MULTI-APERTURE MULTIPLE BEAM ANTENNAS

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ABSTRACT

Several multi-aperture multiple beam antennas (MA-MBA) designs have been proposed for future military communications satellites to satisfy demands for increased nulling resolution against jammers. However, overall network performance can be severely degraded because of spurious nulls that are associated with MA-MBA antennas. In this paper, we propose and analyze a nulling algorithm that improves overall network performance by reducing potential performance degradation caused by MA-MBA antenna spurious nulls while providing high jamming resolution. This algorithm also provides wide are coverage for network users near a jammer in support of tactical scenarios. We show that optimized beam weights are a function of individual user optimum beam weights along with proper phase rotation for each beam. Computer simulated results are then provided illustrating performance of this proposed technique versus another nulling algorithm developed for Defense Satellite Communication System (DSCS) Super High Frequency (SHF) satellites.

INTRODUCTION

Multiple beam antennas (MBA) are frequently used on military communications satellites especially to receive the uplink signal so that good gain patterns can be developed in the direction of user terminals while simultaneously providing nulls in the direction of uplink jammers. Recently, the use of additional apertures has been investigated as a means of improving the jammer nulling resolution of these MBAs. In addition to improving nulling resolution, the rapidly changing phase gradients across the field of view of these multi-aperture MBA(MA-MBA) can also provide spurious nulls in the gain pattern. These spurious can seriously degrade the overall gain pattern of these antennas especially for scenarios where a number of desired user terminals are in close proximity to the jammer.

Antenna gain patterns for MBAs, in general, are determined by the complex valued multiplication factors, called beam weights, applied to each beam. Many algorithms have been developed for determining these beams weights. These algorithm attempt to achieve good gain toward desired terminals while simultaneously providing nulls in the direction of jammer terminals. Unfortunately, many of these algorithms do not adequately address the problem of spurious nulls with the result that some user terminals may have lower gain then desire.

This paper presents a new algorithm for determining beam weights. This algorithm is especially well suited for MA-MBA designs since it uses a phase rotation technique which compensates for the large phase difference among individual beams resulting from these beam existing in different apertures. The next section provides an overview of the methodology. Next, the mathematics of the algorithm are presented. Finally, the performance of the new algorithm is evaluated for a particular scenario in comparison with another algorithm.

METHODOLOGY

Good antenna gain patterns must provide gain toward desired terminals while simultaneously exhibiting nulls in the direction of jammers. This later requirement can be considered a constraint on the beam weight vector and this constraint can be imposed simply by working in the null space of the antennas response to the jammer or jammers. Consequently the dimensionality of the problem is reduced and gains are determined while ensuring the jammers are null. The problem is further constrained such that the norm of the beam weight vector in unity. By appropriate normalization of the basis vectors for the null space, this unity norm constraint applies in both the null space and in the full beam weight space. The remaining problem is to find beam weights in the null space which provide good gains toward the desired user terminals.

The need for beam weight phase rotation can best be understood by first considering the special case of real beam weights and then extending the problem to include complex valued beam weights. Consider a two dimensional problem without a jammer as shown in Figure 1.

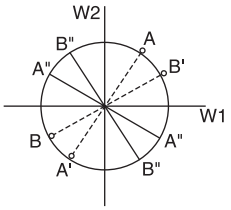

Figure 1. Two dimension Example with Real Weights

As shown if Figure 1, two weights must be selected, W1 and W2. Because there is a constraint on the norm of the

Examples

Follow these examples for Paper, Title with Multiple Authors, and Artwork.

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The Boeing Company
Phantom Works
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Jae H. Kim
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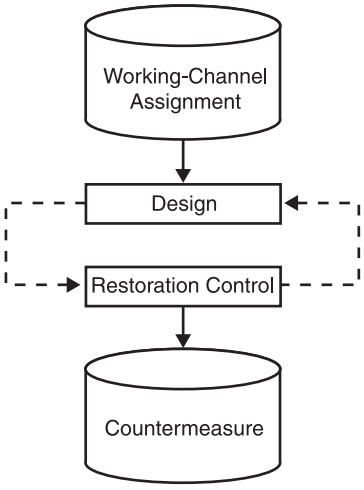

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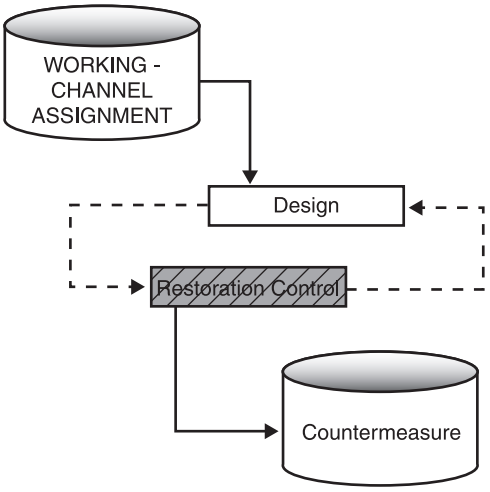

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- PostScript (Level I, II) (.PS)

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1. Select File /Print
2. Under Printer Name select the Acrobat PDF Writer driver
3. Click Properties button to the right of the Printer Name text box
4. Click Compression
5. Under the Compatibility drop-down list, choose Acrobat 3.0 or higher
6. Click OK
7. Click Fonts
8. Check the Embed All Fonts option in the upper left corner, or check the Always Embed List option and add all fonts used in your paper to the list (you may opt to embed only those fonts that are not base fonts)
9. Deselect any subsetting options (IMPORTANT)
10. Click OK twice, then either click Close to complete the configuration, or OK to create the PDF.

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- Times-Bold Italic
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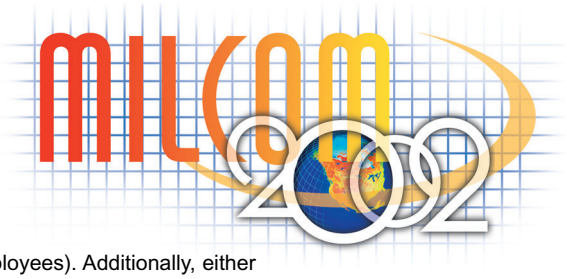

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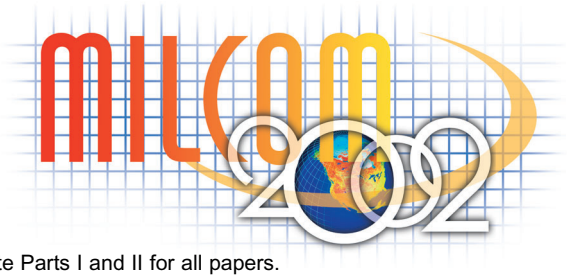

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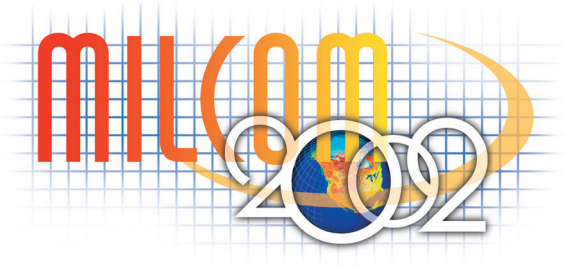

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  I will attend the Speaker s Breakfast ❑ Yes ❑ No

Audiovisual Equipment Reservation

A computer with a multimedia projector and an overhead transparency projector will be provided. Please bring your presentation on a laptop computer, floppy disk, Zip disk, or CD. Please bring your presentation on printed overhead transparencies as a backup.

Presentations may be sent electronically in advance to: mark.muto@boeing.com. Deadline for advance submission is Monday, September 11, 2002. No presentation will be accepted via email after that date.

Additional audio/visual equipment i.e., speakers, monitors, etc., can be made available at cost. To place an order for additional audio/visual equipment, please contact Mark Muto: (714) 762-5887. Orders must be received by Monday, September 16, 2002.

I need the following audio/visual equipment: (Please be specific).

_____

_____

_____

_____

Media Interview Availability

Journalists from the general news media and trade press will be invited to attend all unclassified sessions at MILCOM 2002. They may report anything said or shown at these open sessions. Your presentations and artwork must be planned and cleared accordingly. If your presentation generates media interest, will you be available for an interview? ❑ Yes ❑ No

MILCOM s publicity committee will handle arrangements for media requests. The interview can be conducted in the hotel s media center, if you desire. Interviewees and their companies or organizations are solely responsible for the following:

- The decision to be interviewed
- The interview s content
- All security and media relations aspects connected with the information released

We recommend that you coordinate your actions with the public relations or public affairs function within your company or organization. If you have any questions call **MILCOM 2002 Communications Chair:**
Felicia A. Cambell (562) 797-4303, or felicia.a.cambell@boeing.com

Please send this form to Unclassified Technical Program

STUDENT TRAVEL SUPPORT APPLICATION REGISTRATION ADDITIONAL FORM (IF APPLICABLE)

UNCLASSIFIED TECHNICAL PROGRAM

Applicability

Travel grants are intended to provide partial reimbursement of travel costs for full-time students attending MILCOM 2002 and making technical presentations based on research conducted as part of graduate-level university degree program in engineering or science. Although the primary goal is to provide partial or full reimbursement of transportation costs, the MILCOM 2002 Conference Board does not wish to rule out the reimbursement of hotel, registration, or other expenses in certain instances.

Student Name: Last | First | Middle Initial

Student IEEE Number | Student SSN

University

University Address

City, State, Zip

Advisor s Name | Advisor s Phone

Title of Paper | Paper Tracking No.

Student Signature: I am a full-time student at the university listed above

Advisor s Signature: I confirm the above information and verify that alternate travel support for this student does not exist

Guidelines for MILCOM 2002 Graduate Student Travel Grants

The guidelines provide some degree of uniformity in the selection of MILCOM Student Travel Grant recipients from year to year. However, these are guidelines, not restrictions. The final authority in awarding travel grants lies with the Technical Program Chair.

Eligibility Guidelines

- Eligibility is limited to full-time university students who are enrolled in a graduate program and are making satisfactory progress toward a graduate-level engineering or science degree, as certified by the student s graduate thesis advisor.
- The student must be the author or a coauthor of a technical paper that has been accepted for presentation at MILCOM 2002. The paper must be based on the student s graduate research, as certified by the student s thesis advisor.
- The student must submit this completed application form, the copy of the camera-ready manuscript, and a copy of the appropriate MILCOM 2002 approval form indicating that the paper has been approved for release and publication in the MILCOM 2002 Conference Proceedings. The student s university affiliation must be displayed on the paper, and no company affiliations may be given.
- The student must be a member or student member of IEEE.

Grant Awards

All recipients of a Student Travel Grant will receive a Grant Award Letter from the Technical Program Chair specifying the amount of the award.

Grant Reimbursement

After the paper is presented, the student should contact the MILCOM 2002 Registration Supervisor to receive the grant award.
The student must present a copy of the Grant Award Letter signed by the Technical Program Chair and a photo ID.

Please send this form to Unclassified Technical Program