Paper Title*

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***Abstract*—This document is a model and instructions for LaTeX. This and the IEEEtran.cls file define the components of your paper [title, text, heads, etc.]. *CRITICAL: Do Not Use Symbols, Special Characters, Footnotes, or Math in Paper Title or Abstract.**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

This document is a model and instructions for LaTeX. Please observe the conference page limits.

II. Modelagem estatística para dados PolSAR

Os sistemas SAR totalmente polarimétricos transmitem pulsos de micro-ondas polarizados ortogonalmente e medem componentes ortogonais do sinal recebido. Para cada pixel, a medida resulta em uma matriz de coeficientes de espalhamento. Esses coeficientes são números complexos que descrevem no sistema SAR a transformação do campo eletromagnético transmitido para o campo eletromagnético recebido.

A transformação pode ser representada como

$$\begin{bmatrix} E_h^r \\ E_v^r \end{bmatrix} = \frac{e^{\hat{\imath}kr}}{r} \begin{bmatrix} S_{hh} & S_{hv} \\ S_{vh} & S_{vv} \end{bmatrix} \begin{bmatrix} E_h^t \\ E_v^t \end{bmatrix}, \tag{1}$$

onde k denota o número de onda, $\hat{\imath}$ é um número complexo e r é a distância entre o radar e o alvo. O campo eletromagnético com componentes E_i^j, o índice subscrito denota polarização horizontal (h) ou vertical (v), enquanto o índice sobrescrito indica a onda recebida (r) ou transmitida (t). Definindo $S_{i,j}$ como os coeficientes de espalhamento complexo, tal que o índice i e j são associados com o recebimento com a transmissão das ondas, por exemplo, o coeficiente de espalhamento S_{hv} está associado a onda transmitida na direção vertical (v) e recebida na direção horizontal (h).

Bolsista Capes.

Sendo conhecido cada um dos coeficientes, a matriz de espalhamento complexa $\mathbf{S}$ é definida por

$$\mathbf{S} = \begin{bmatrix} S_{hh} & S_{hv} \\ S_{vh} & S_{vv} \end{bmatrix}, \tag{2}$$

sendo o meio de propagação das ondas recíproco, podemos afirmar $S_{hv} = S_{vh}$ tornando a matriz hermitiana. Desta forma, a matriz pode ser escrita como um vetor

$$\mathbf{s} = \begin{bmatrix} S_{hh} \\ \sqrt{2}S_{vh} \\ S_{vv} \end{bmatrix}. \tag{3}$$

A função densidade de probabilidade (**pdf**) da distribuição gaussiana complexa m-variada é dada por

$$p(\mathbf{s}) = \frac{1}{\pi^m |\mathbf{\Sigma_s}|} \exp(-\mathbf{s}^H \mathbf{\Sigma_s^{-1}} \mathbf{s}), \tag{4}$$

sendo $|\cdot|$ o determinante de uma matriz ou o valor absoluto de um escalar, e $\mathbf{\Sigma_s}$ é a matriz de covariância associada a $\mathbf{s}$ definida por

$$\mathbf{\Sigma_s} = E[\mathbf{s}\mathbf{s}^H] = \begin{bmatrix} E[S_H \overline{S_H}] & E[S_H \overline{S_V}] \\ E[S_V \overline{S_H}] & E[S_V \overline{S_V}] \end{bmatrix} \tag{5}$$

talque, $E[\cdot]$ denota o valor esperado e $\bar{\cdot}$ denota o conjugado complexo.

Nas imagens PolSAR definimos o vetor $\mathbf{s}$ como na equação (3) e seu tranposto conjugado por $\mathbf{s} = [S_{hh}, S_{vh}, S_{vv}]^H$, isto é, a hermitiana do vetor,

$$\mathbf{s}\mathbf{s}^H = \begin{bmatrix} S_{hh}\overline{S_{hh}} & S_{hh}\overline{S_{vh}} & S_{hh}\overline{S_{vv}} \\ S_{vh}\overline{S_{hh}} & S_{vh}\overline{S_{vh}} & S_{vh}\overline{S_{vv}} \\ S_{vv}\overline{S_{hh}} & S_{vv}\overline{S_{vh}} & S_{vv}\overline{S_{vv}} \end{bmatrix}. \tag{6}$$

A matriz $\mathbf{\Sigma_s}$ tem dimensão 3×3, e pode ser definida como sendo a matriz de covariância associada a $\mathbf{s}$.

$$\mathbf{\Sigma_s} = \begin{bmatrix} E[S_{hh}\overline{S_{hh}}] & E[S_{hh}\overline{S_{vh}}] & E[S_{hh}\overline{S_{vv}}] \\ E[S_{vh}\overline{S_{hh}}] & E[S_{vh}\overline{S_{vh}}] & E[S_{vh}\overline{S_{vv}}] \\ E[S_{vv}\overline{S_{hh}}] & E[S_{vv}\overline{S_{vh}}] & E[S_{vv}\overline{S_{vv}}] \end{bmatrix}. \tag{7}$$

Dados polarimétricos são usualmente sujeitados a um processo de várias visadas com o intuito de melhorar a razão entre o sinal e o seu ruído. Para esse fim, matrizes positivas definidas hermitianas estimadas são obtidas computando a média de L visadas independentes de uma mesma cena. Resultando na matriz de covariância amostral estimada $\mathbf{Z}$ conforme [**?**], [**?**]

$$\mathbf{Z} \quad = \quad \tfrac{1}{L}\sum_{i=1}^{L} \mathbf{s}_i \mathbf{s}_i{}^H, \tag{8}$$

onde $\mathbf{s}_i$ com $i = 1, \ldots, L$ é uma amostra de L vetores complexos distribuídos como $\mathbf{s}$, assim a matriz de covariância amostral associada a $\mathbf{s}_i$, com $i = 1, \ldots, L$ denotam o espalhamento para cada visada L seguindo uma distribuição complexas de Wishart.

Sendo agora $\mathbf{\Sigma_s}$ e L parâmetros conhecidos a função densidade de probabilidade da distribuição Wishart por

$$f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma_s}, L) = \frac{L^{mL}|\mathbf{Z}|^{L-m}}{|\mathbf{\Sigma_s}|^L \Gamma_m(L)} \exp(-L \operatorname{tr}(\mathbf{\Sigma_s}^{-1}\mathbf{Z})), \tag{9}$$

onde, $\operatorname{tr}(\cdot)$ é o operador traço de uma matriz, $\Gamma_m(L)$ é uma função Gamma multivariada definida por

$$\Gamma_m(L) = \pi^{\frac{1}{2}m(m-1)} \prod_{i=0}^{m-1} \Gamma(L-i) \tag{10}$$

e $\Gamma(\cdot)$ é a função Gamma. Podemos afirmar que $\mathbf{Z}$ é distribuído como uma distribuição Wishart denotando por $\mathbf{Z} \sim W(\mathbf{\Sigma_s}, L)$ e satisfazendo $E[\mathbf{Z}] = \mathbf{\Sigma_s}$. Sem perda de generalidade para o texto vamos usar o simbolo $\mathbf{\Sigma}$ em detrimento a $\mathbf{\Sigma_s}$ para representar a matriz de covariância associada a $\mathbf{s}$.

Seja a função densidade de probabilidade da distribuição complexa Wishart (9) na qual vamos aplicar o logaritmo natural e suas propriedades com o intuito de reescrever a função na forma adequada para aplicar o método de estimativa de máxima verossimilhança. Assim,

$$\begin{aligned}
\ln f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L) &= \ln\left(\tfrac{L^{mL}|\mathbf{Z}|^{L-m}}{|\mathbf{\Sigma}|^L \Gamma_m(L)} \exp(-L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}))\right) \\
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= \ln\left(\tfrac{L^{mL}|\mathbf{Z}|^{L-m}}{|\mathbf{\Sigma}|^L \Gamma_m(L)}\right) + \ln\left(\exp(-L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}))\right) \\
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= \ln\left(L^{mL}|\mathbf{Z}|^{L-m}\right) - \ln\left(|\mathbf{\Sigma}|^L \Gamma_m(L)\right) - L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}) \\
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= mL \ln L + (L-m)\ln(|\mathbf{Z}|) - \ln\left(|\mathbf{\Sigma}|^L\right) - \ln\left(\Gamma_m(L)\right) - L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}) \\
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= mL \ln L + L\ln(|\mathbf{Z}|) - m\ln(|\mathbf{Z}|) - L\ln(|\mathbf{\Sigma}|) - \ln\left(\Gamma_m(L)\right) - L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z})
\end{aligned} \tag{11}$$

lembrando que a função Gamma multivariada é definida na equação (10) então, podemos rescrever a equação da seguinte forma

$$\begin{aligned}
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= mL \ln L + L\ln(|\mathbf{Z}|) - m\ln(|\mathbf{Z}|) - L\ln(|\mathbf{\Sigma}|) - \ln\left(\Gamma_m(L)\right) - L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}), \\
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= mL \ln L + L\ln(|\mathbf{Z}|) - m\ln(|\mathbf{Z}|) - L\ln(|\mathbf{\Sigma}|) \\
&- \ln\left(\pi^{\frac{1}{2}m(m-1)} \textstyle\prod_{i=0}^{m-1} \Gamma(L-i)\right) - L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}), \\
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= mL \ln L + L\ln(|\mathbf{Z}|) - m\ln(|\mathbf{Z}|) - L\ln(|\mathbf{\Sigma}|) \\
&- \ln\left(\pi^{\frac{1}{2}m(m-1)}\right) - \ln\left(\textstyle\prod_{i=0}^{m-1} \Gamma(L-i)\right) - L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}), \\
\ln\left(f_{\mathbf{Z}}(\mathbf{Z}; \mathbf{\Sigma}, L)\right) &= mL \ln L + L\ln(|\mathbf{Z}|) - m\ln(|\mathbf{Z}|) - L\ln(|\mathbf{\Sigma}|) \\
&- \tfrac{1}{2}m(m-1)\ln(\pi) - \textstyle\sum_{i=0}^{m-1} \ln\left(\Gamma(L-i)\right) - L \operatorname{tr}(\mathbf{\Sigma}^{-1}\mathbf{Z}),
\end{aligned} \tag{12}$$

equação equivalente pode ser encontrada em [**?**].

III. Ease of Use

A. Maintaining the Integrity of the Specifications

The IEEEtran class file is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

IV. Prepare Your Paper Before Styling

Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections IV-A–IV-E below for more information on proofreading, spelling and grammar.

Keep your text and graphic files separate until after the text has been formatted and styled. Do not number text heads—LaTeX will do that for you.

A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Units

- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as "3.5-inch disk drive".
- Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
- Do not mix complete spellings and abbreviations of units: "Wb/m^2" or "webers per square meter", not "webers/m^2". Spell out units when they appear in text: ". . . a few henries", not ". . . a few H".
- Use a zero before decimal points: "0.25", not ".25". Use "cm^3", not "cc".)

C. Equations

Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \tag{13}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(13)", not "Eq. (13)" or "equation (13)", except at the beginning of a sentence: "Equation (13) is . . ."

D. LaTeX-Specific Advice

Please use "soft" (e.g., `\eqref{Eq}`) cross references instead of "hard" references (e.g., `(1)`). That will make it possible to combine sections, add equations, or change the order of figures or citations without having to go through the file line by line.

Please don't use the `{eqnarray}` equation environment. Use `{align}` or `{IEEEeqnarray}` instead. The `{eqnarray}` environment leaves unsightly spaces around relation symbols.

Please note that the `{subequations}` environment in LaTeX will increment the main equation counter even when there are no equation numbers displayed. If you forget that, you might write an article in which the equation numbers skip from (17) to (20), causing the copy editors to wonder if you've discovered a new method of counting.

BibTeX does not work by magic. It doesn't get the bibliographic data from thin air but from .bib files. If you use BibTeX to produce a bibliography you must send the .bib files.

LaTeX can't read your mind. If you assign the same label to a subsubsection and a table, you might find that Table I has been cross referenced as Table IV-B3.

LaTeX does not have precognitive abilities. If you put a `\label` command before the command that updates the counter it's supposed to be using, the label will pick up the last counter to be cross referenced instead. In particular, a `\label` command should not go before the caption of a figure or a table.

Do not use `\nonumber` inside the `{array}` environment. It will not stop equation numbers inside `{array}` (there won't be any anyway) and it might stop a wanted equation number in the surrounding equation.

E. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum μ_0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an "inset", not an "insert". The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).
- Do not use the word "essentially" to mean "approximately" or "effectively".
- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
- Do not confuse "imply" and "infer".
- The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the "et" in the Latin abbreviation "et al.".
- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

An excellent style manual for science writers is [7].

F. Authors and Affiliations

The class file is designed for, but not limited to, six authors. A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

G. Identify the Headings

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is "Heading 5". Use "figure caption" for your Figure captions, and "table head" for your table title. Run-in heads, such as "Abstract", will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced.

H. Figures and Tables

a) Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert

TABLE I
TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	*Subhead*	*Subhead*
copy	More table copy[a]		

[a]Sample of a Table footnote.

Fig. 1. Example of a figure caption.

figures and tables after they are cited in the text. Use the abbreviation "Fig. 1", even at the beginning of a sentence.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K".

ACKNOWLEDGMENT

The preferred spelling of the word "acknowledgment" in America is without an "e" after the "g". Avoid the stilted expression "one of us (R. B. G.) thanks ...". Instead, try "R. B. G. thanks...". Put sponsor acknowledgments in the unnumbered footnote on the first page.

REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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