

# Preparation of Papers for IEEE Transactions and Journals (June 2023)

First A. Author, *Fellow, IEEE*, Second B. Author, and Third C. Author Jr., *Member, IEEE*

**Abstract**—These instructions give you guidelines for preparing papers for IEEE Transactions and Journals. Use this document as a template if you are using L<sup>A</sup>T<sub>E</sub>X. Otherwise, use this document as an instruction set. The electronic file of your paper will be formatted further at IEEE. Paper titles should be written in uppercase and lowercase letters, not all uppercase. Avoid writing long formulas with subscripts in the title; short formulas that identify the elements are fine (e.g., “Nd–Fe–B”). Do not write “(Invited)” in the title. Full names of authors are preferred in the author field, but are not required. Put a space between authors’ initials. The abstract must be a concise yet comprehensive reflection of what is in your article. In particular, the abstract must be self-contained, without abbreviations, footnotes, or references. It should be a microcosm of the full article. The abstract must be between 150–250 words. Be sure that you adhere to these limits; otherwise, you will need to edit your abstract accordingly. The abstract must be written as one paragraph, and should not contain displayed mathematical equations or tabular material. The abstract should include three or four different keywords or phrases, as this will help readers to find it. It is important to avoid over-repetition of such phrases as this can result in a page being rejected by search engines. Ensure that your abstract reads well and is grammatically correct.

**Index Terms**—Enter key words or phrases in alphabetical order, separated by commas. Using the IEEE Thesaurus can help you find the best standardized keywords to fit your article. Use the thesaurus access request form for free access to the IEEE Thesaurus: <https://www.ieee.org/publications/services/thesaurus-access-page.com>.

## I. INTRODUCTION

THIS document is a template for L<sup>A</sup>T<sub>E</sub>X. If you are reading a paper or PDF version of this document, please download the template from the IEEE Web site at

This paragraph of the first footnote will contain the date on which you submitted your paper for review. It will also contain support information, including sponsor and financial support acknowledgment. For example, “This work was supported in part by the U.S. Department of Commerce under Grant 123456.”

The next few paragraphs should contain the authors’ current affiliations, including current address and e-mail. For example, First A. Author is with the National Institute of Standards and Technology, Boulder, CO 80305 USA (e-mail: [author@boulder.nist.gov](mailto:author@boulder.nist.gov)).

Second B. Author Jr. was with Rice University, Houston, TX 77005 USA. He is now with the Department of Physics, Colorado State University, Fort Collins, CO 80523 USA (e-mail: [author@lamar.colostate.edu](mailto:author@lamar.colostate.edu)).

Third C. Author is with the Electrical Engineering Department, University of Colorado, Boulder, CO 80309 USA, on leave from the National Research Institute for Metals, Tsukuba, Japan (e-mail: [author@nrim.go.jp](mailto:author@nrim.go.jp)).

<http://ieeeauthorcenter.ieee.org/create-your-ieee-article/use-authoring-tools-and-ieee-article-templates/ieee-article-templates/> so you can use it to prepare your manuscript. If you would prefer to use L<sup>A</sup>T<sub>E</sub>X, download IEEE’s L<sup>A</sup>T<sub>E</sub>Xstyle and sample files from the same Web page. You can also explore using the Overleaf editor at <https://www.overleaf.com/blog/278-how-to-use-overleaf-with-ieee-collabratec-your-quick-guide-to-getting-started#xsVp6tpPkrKM9>.

If your paper is intended for a conference, please contact your conference editor concerning acceptable word processor formats for your particular conference.

IEEE will do the final formatting of your paper. If your paper is intended for a conference, please observe the conference page limits.

## A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have already been defined in the abstract. Abbreviations such as IEEE, SI, ac, and dc do not have to be defined. Abbreviations that incorporate periods should not have spaces: write “C.N.R.S.,” not “C. N. R. S.” Do not use abbreviations in the title unless they are unavoidable (for example, “IEEE” in the title of this article).

## B. Other Recommendations

Use one space after periods and colons. Hyphenate complex modifiers: “zero-field-cooled magnetization.” Avoid dangling participles, such as, “Using (1), the potential was calculated.” [It is not clear who or what used (1).] Write instead, “The potential was calculated by using (1),” or “Using (1), we calculated the potential.”

Use a zero before decimal points: “0.25,” not “.25.” Use “cm<sup>3</sup>,” not “cc.” Indicate sample dimensions as “0.1 cm × 0.2 cm,” not “0.1 × 0.2 cm<sup>2</sup>.” The abbreviation for “seconds” is “s,” not “sec.” Use “Wb/m<sup>2</sup>” or “webers per square meter,” not “webers/m<sup>2</sup>.” When expressing a range of values, write “7 to 9” or “7–9,” not “7~9.”

A parenthetical statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.) In American English, periods and commas are within quotation marks, like “this period.” Other punctuation is “outside”! Avoid contractions; for example, write “do not” instead of “don’t.” The serial comma is preferred: “A, B, and C” instead of “A, B and C.”

If you wish, you may write in the first person singular or plural and use the active voice (“I observed that . . .” or “We observed that . . .” instead of “It was observed that . . .”). Remember to check spelling.

Try not to use too many typefaces in the same article. Please remember that MathJax cannot handle nonstandard typefaces.

### C. Equations

Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). To make your equations more compact, you may use the solidus ( $/$ ), the exp function, or appropriate exponents. Use parentheses to avoid ambiguities in denominators. Punctuate equations when they are part of a sentence, as in

$$E = mc^2. \quad (1)$$

Be sure that the symbols in your equation have been defined before the equation appears or immediately following. Italicize symbols ( $T$  might refer to temperature, but  $T$  is the unit tesla). Refer to “(1),” not “Eq. (1)” or “equation (1),” except at the beginning of a sentence: “Equation (1) is . . . .”

### D. Algorithms

Algorithms should be numbered and include a short title. They are set off from the text with rules above and below the title and after the last line.

---

#### Algorithm 1 Weighted Tanimoto ELM.

---

```

TRAIN( $\mathbf{X}, \mathbf{T}$ )
  select randomly  $W \subset \mathbf{X}$ 
   $N_t \leftarrow |\{i : \mathbf{t}_i = \mathbf{t}\}|$  for  $\mathbf{t} = -1, +1$ 
   $B_i \leftarrow \sqrt{\text{MAX}(N_{-1}, N_{+1}) / N_{\mathbf{t}_i}}$  for  $i = 1, \dots, N$ 
   $\hat{\mathbf{H}} \leftarrow B \cdot (\mathbf{X}^T \mathbf{W}) / (\|\mathbf{X}\| + \|\mathbf{W}\| - \mathbf{X}^T \mathbf{W})$ 
   $\beta \leftarrow (I/C + \hat{\mathbf{H}}^T \hat{\mathbf{H}})^{-1} (\hat{\mathbf{H}}^T B \cdot \mathbf{T})$ 
  return  $\mathbf{W}, \beta$ 

PREDICT( $\mathbf{X}$ )
   $\mathbf{H} \leftarrow (\mathbf{X}^T \mathbf{W}) / (\|\mathbf{X}\| + \|\mathbf{W}\| - \mathbf{X}^T \mathbf{W})$ 
  return  $\text{SIGN}(\mathbf{H}\beta)$ 

```

---

### E. $\text{\LaTeX}$ -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  $\text{\LaTeX}$  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.

$\text{\LaTeX}$  gets the bibliographic data from .bib files. If you use  $\text{\LaTeX}$  to produce a bibliography you must send the .bib files.

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.

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.

If you are submitting your paper to a colorized journal, you can use the following two lines at the start of the article to ensure its appearance resembles the final copy:

```

\documentclass[journal,twoside,web]{ieeecolor}
\usepackage{Journal_Name}

```

## II. UNITS

Use either SI (MKS) or CGS as primary units. (SI units are strongly encouraged.) English units may be used as secondary units (in parentheses). This applies to papers in data storage. For example, write “15 Gb/cm<sup>2</sup> (100 Gb/in<sup>2</sup>).” An exception is when English units are used as identifiers in trade, such as “3½-in 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 in an equation.

The SI unit for magnetic field strength  $H$  is A/m. However, if you wish to use units of T, either refer to magnetic flux density  $B$  or magnetic field strength symbolized as  $\mu_0 H$ . Use the center dot to separate compound units, e.g., “A·m<sup>2</sup>.”

## III. SOME COMMON MISTAKES

The word “data” is plural, not singular. The subscript for the permeability of vacuum  $\mu_0$  is zero, not a lowercase letter “o.” The term for residual magnetization is “remanence”; the adjective is “remanent”; do not write “remnance” or “remnant.” Use the word “micrometer” instead of “micron.” 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). Use the word “whereas” instead of “while” (unless you are referring to simultaneous events). Do not use the word “essentially” to mean “approximately” or “effectively.” Do not use the word “issue” as a euphemism for “problem.” When compositions are not specified, separate chemical symbols by en-dashes; for example, “NiMn” indicates the intermetallic compound Ni<sub>0.5</sub>Mn<sub>0.5</sub> whereas “Ni–Mn” indicates an alloy of some composition Ni<sub>*x*</sub>Mn<sub>1–*x*</sub>.

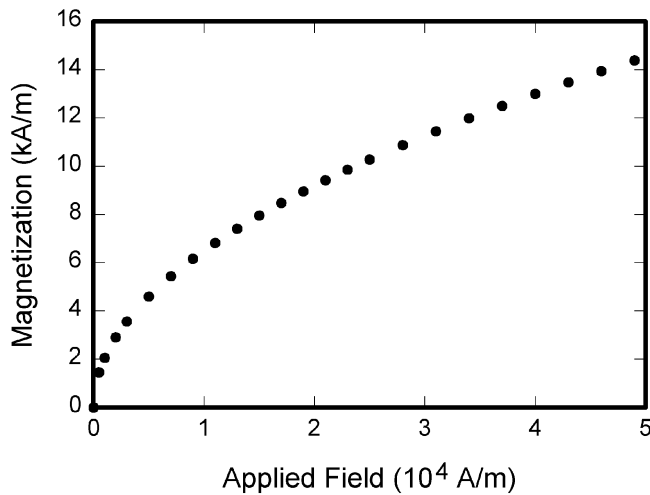


Fig. 1. Magnetization as a function of applied field. It is good practice to explain the significance of the figure in the caption.

Be aware of the different meanings of the homophones “affect” (usually a verb) and “effect” (usually a noun), “complement” and “compliment,” “discreet” and “discrete,” “principal” (e.g., “principal investigator”) and “principle” (e.g., “principle of measurement”). Do not confuse “imply” and “infer.”

Prefixes such as “non,” “sub,” “micro,” “multi,” and “ultra” are not independent words; they should be joined to the words they modify, usually without a hyphen. There is no period after the “et” in the Latin abbreviation “*et al.*” (it is also italicized). The abbreviation “i.e.,” means “that is,” and the abbreviation “e.g.,” means “for example” (these abbreviations are not italicized).

IEEE styleguides are available at <https://journals.ieeeauthorcenter.ieee.org/create-your-ieee-journal-article/create-the-text-of-your-article/ieee-editorial-style-manual/>.

#### IV. GUIDELINES FOR GRAPHICS PREPARATION AND SUBMISSION

##### A. Types of Graphics

The following list outlines the different types of graphics published in IEEE journals. They are categorized based on their construction, and use of color/shades of gray:

1) **Color/Grayscale figures:** Figures that are meant to appear in color, or shades of black/gray. Such figures may include photographs, illustrations, multicolor graphs, and flowcharts.

2) **Line Art figures:** Figures that are composed of only black lines and shapes. These figures should have no shades or half-tones of gray, only black and white.

3) **Author photos:** Head and shoulders shots of authors that appear at the end of our papers.

4) **Tables:** Data charts which are typically black and white, but sometimes include color.

##### B. Multipart figures

Figures compiled of more than one sub-figure presented side-by-side, or stacked. If a multipart figure is made up of multiple figure types (one part is lineart, and another

TABLE I  
UNITS FOR MAGNETIC PROPERTIES

Symbol	Quantity	Conversion from Gaussian and CGS EMU to SI <sup>a</sup>
$\Phi$	magnetic flux	1 Mx $\rightarrow 10^{-8}$ Wb = $10^{-8}$ V·s
$B$	magnetic flux density, magnetic induction	1 G $\rightarrow 10^{-4}$ T = $10^{-4}$ Wb/m <sup>2</sup>
$H$	magnetic field strength	1 Oe $\rightarrow 10^3/(4\pi)$ A/m
$m$	magnetic moment	1 erg/G = 1 emu $\rightarrow 10^{-3}$ A·m <sup>2</sup> = $10^{-3}$ J/T
$M$	magnetization	1 erg/(G·cm <sup>3</sup> ) = 1 emu/cm <sup>3</sup> $\rightarrow 10^3$ A/m
$4\pi M$	magnetization	1 G $\rightarrow 10^3/(4\pi)$ A/m
$\sigma$	specific magnetization	1 erg/(G·g) = 1 emu/g $\rightarrow 1$ A·m <sup>2</sup> /kg
$j$	magnetic dipole moment	1 erg/G = 1 emu $\rightarrow 4\pi \times 10^{-10}$ Wb·m
$J$	magnetic polarization	1 erg/(G·cm <sup>3</sup> ) = 1 emu/cm <sup>3</sup> $\rightarrow 4\pi \times 10^{-4}$ T
$\chi, \kappa$	susceptibility	1 $\rightarrow 4\pi$
$\chi\rho$	mass susceptibility	1 cm <sup>3</sup> /g $\rightarrow 4\pi \times 10^{-3}$ m <sup>3</sup> /kg
$\mu$	permeability	1 $\rightarrow 4\pi \times 10^{-7}$ H/m = $4\pi \times 10^{-7}$ Wb/(A·m)
$\mu_r$	relative permeability	$\mu \rightarrow \mu_r$
$w, W$	energy density	1 erg/cm <sup>3</sup> $\rightarrow 10^{-1}$ J/m <sup>3</sup>
$N, D$	demagnetizing factor	1 $\rightarrow 1/(4\pi)$

Vertical lines are optional in tables. Statements that serve as captions for the entire table do not need footnote letters.

<sup>a</sup>Gaussian units are the same as cg emu for magnetostatics; Mx = maxwell, G = gauss, Oe = oersted; Wb = weber, V = volt, s = second, T = tesla, m = meter, A = ampere, J = joule, kg = kilogram, H = henry.

is grayscale or color) the figure should meet the stricter guidelines.

##### C. File Formats For Graphics

Format and save your graphics using a suitable graphics processing program that will allow you to create the images as PostScript (PS), Encapsulated PostScript (.EPS), Tagged Image File Format (.TIFF), Portable Document Format (.PDF), Portable Network Graphics (.PNG), or Metapost (.MPS), sizes them, and adjusts the resolution settings. When submitting your final paper, your graphics should all be submitted individually in one of these formats along with the manuscript.

##### D. Sizing of Graphics

Most charts, graphs, and tables are one column wide (3.5 inches/88 millimeters/21 picas) or page wide (7.16 inches/181 millimeters/43 picas). The maximum depth a graphic can be is 8.5 inches (216 millimeters/54 picas). When choosing the depth of a graphic, please allow space for a caption. Figures can be sized between column and page widths if the author chooses, however it is recommended that figures are not sized less than column width unless when necessary.

There is currently one publication with column measurements that do not coincide with those listed above. Proceedings of the IEEE has a column measurement of 3.25 inches (82.5 millimeters/19.5 picas).

The final printed size of author photographs is exactly 1 inch wide by 1.25 inches tall (25.4 millimeters  $\times$  31.75 millimeters/6 picas  $\times$  7.5 picas). Author photos printed in editorials measure 1.59 inches wide by 2 inches tall (40 millimeters  $\times$  50 millimeters/9.5 picas  $\times$  12 picas).

### E. Resolution

The proper resolution of your figures will depend on the type of figure it is as defined in the “Types of Figures” section. Author photographs, color, and grayscale figures should be at least 300dpi. Line art, including tables should be a minimum of 600dpi.

### F. Vector Art

In order to preserve the figures’ integrity across multiple computer platforms, we accept files in the following formats: .EPS/.PDF/.PS. All fonts must be embedded or text converted to outlines in order to achieve the best-quality results.

### G. Color Space

The term color space refers to the entire sum of colors that can be represented within the said medium. For our purposes, the three main color spaces are Grayscale, RGB (red/green/blue) and CMYK (cyan/magenta/yellow/black). RGB is generally used with on-screen graphics, whereas CMYK is used for printing purposes.

All color figures should be generated in RGB or CMYK color space. Grayscale images should be submitted in Grayscale color space. Line art may be provided in grayscale OR bitmap colorspace. Note that “bitmap colorspace” and “bitmap file format” are not the same thing. When bitmap color space is selected, .TIF/.TIFF/.PNG are the recommended file formats.

### H. Accepted Fonts Within Figures

When preparing your graphics IEEE suggests that you use of one of the following Open Type fonts: Times New Roman, Helvetica, Arial, Cambria, and Symbol. If you are supplying EPS, PS, or PDF files all fonts must be embedded. Some fonts may only be native to your operating system; without the fonts embedded, parts of the graphic may be distorted or missing.

A safe option when finalizing your figures is to strip out the fonts before you save the files, creating “outline” type. This converts fonts to artwork what will appear uniformly on any screen.

### I. Using Labels Within Figures

**1) Figure Axis labels :** Figure axis labels are often a source of confusion. Use words rather than symbols. As an example, write the quantity “Magnetization,” or “Magnetization M,” not just “M.” Put units in parentheses. Do not label axes only with units. As in Fig. 1, for example, write “Magnetization (A/m)” or “Magnetization ( $A \cdot m^{-1}$ ),” not just “A/m.” Do not label axes with a ratio of quantities and units. For example, write “Temperature (K),” not “Temperature/K.”

Multipliers can be especially confusing. Write “Magnetization (kA/m)” or “Magnetization ( $10^3$  A/m).” Do not write “Magnetization (A/m)  $\times$  1000” because the reader would not know whether the top axis label in Fig. 1 meant 16000 A/m or 0.016 A/m. Figure labels should be legible, approximately 8 to 10 point type.

**2) Subfigure Labels in Multipart Figures and Tables:** Multipart figures should be combined and labeled before final submission. Labels should appear centered below each subfigure in 8 point Times New Roman font in the format of (a) (b) (c).

### J. File Naming

Figures (line artwork or photographs) should be named starting with the first 5 letters of the author’s last name. The next characters in the filename should be the number that represents the sequential location of this image in your article. For example, in author “Anderson’s” paper, the first three figures would be named ander1.tif, ander2.tif, and ander3.ps.

Tables should contain only the body of the table (not the caption) and should be named similarly to figures, except that ‘.t’ is inserted in-between the author’s name and the table number. For example, author Anderson’s first three tables would be named ander.t1.tif, ander.t2.ps, ander.t3.eps.

Author photographs should be named using the first five characters of the pictured author’s last name. For example, four author photographs for a paper may be named: oppen.ps, moshc.tif, chen.eps, and duran.pdf.

If two authors or more have the same last name, their first initial(s) can be substituted for the fifth, fourth, third... letters of their surname until the degree where there is differentiation. For example, two authors Michael and Monica Oppenheimer’s photos would be named oppmi.tif, and oppmo.eps.

### K. Referencing a Figure or Table Within Your Paper

When referencing your figures and tables within your paper, use the abbreviation “Fig.” even at the beginning of a sentence. Do not abbreviate “Table.” Tables should be numbered with Roman Numerals.

### L. Submitting Your Graphics

Because IEEE will do the final formatting of your paper, you do not need to position figures and tables at the top and bottom of each column. In fact, all figures, figure captions, and tables can be placed at the end of your paper. In addition to, or even in lieu of submitting figures within your final manuscript, figures should be submitted individually, separate from the manuscript in one of the file formats listed above in Section IV-C. Place figure captions below the figures; place table titles above the tables. Please do not include captions as part of the figures, or put them in “text boxes” linked to the figures. Also, do not place borders around the outside of your figures.

### M. Color Processing/Printing in IEEE Journals

All IEEE Transactions, Journals, and Letters allow an author to publish color figures on IEEE Xplore at no charge, and automatically convert them to grayscale for print versions. In most journals, figures and tables may alternatively be printed in color if an author chooses to do so. Please note that this service comes at an extra expense to the author. If you intend to have print color graphics, you will have the opportunity to indicate this in the Author Gateway and will be contacted by PubOps to confirm the charges. Online-only journals will have their figures appear in color, free of charge



## V. CONCLUSION

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

Appendixes, if needed, appear before the acknowledgment.

## REFERENCES AND FOOTNOTES

### A. References

References need not be cited in text. When they are, they appear on the line, in square brackets, inside the punctuation. Multiple references are each numbered with separate brackets. When citing a section in a book, please give the relevant page numbers. In text, refer simply to the reference number. Do not use “Ref.” or “reference” except at the beginning of a sentence: “Reference [3] shows ...” Please do not use automatic endnotes in *Word*, rather, type the reference list at the end of the paper using the “References” style.

Reference numbers are set flush left and form a column of their own, hanging out beyond the body of the reference. The reference numbers are on the line, enclosed in square brackets. In all references, the given name of the author or editor is abbreviated to the initial only and precedes the last name. Use them all; use *et al.* only if names are not given. Abbreviate conference titles. When citing IEEE Transactions, provide the issue number, page range, volume number, year, and/or month if available. When referencing a patent, provide the day and the month of issue, or application. References may not include all information; please obtain and include relevant information. Do not combine references. There must be only one reference with each number. If there is a URL included with the print reference, it can be included at the end of the reference.

Other than books, 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. See the end of this document for formats and examples of common references. For a complete discussion of references and their formats, see the IEEE style manual at <https://journals.ieeeauthorcenter.ieee.org/create-your-ieee-journal-article/create-the-text-of-your-article/ieee-editorial-style-manual/>.

### B. Footnotes

Number footnotes separately in superscript numbers.<sup>1</sup> Place the actual footnote at the bottom of the column in which it is cited; do not put footnotes in the reference list (endnotes). Use letters for table footnotes (see Table I).

<sup>1</sup>It is recommended that footnotes be avoided (except for the unnumbered footnote with the receipt date on the first page). Instead, try to integrate the footnote information into the text.

## SUBMITTING YOUR PAPER FOR REVIEW

### C. Review Stage Using IEEE ScholarOne Manuscripts

Contributions to the Transactions, Journals, and Letters may be submitted electronically on IEEE ScholarOne Manuscripts. You can get help choosing the correct publication for your manuscript as well as find their corresponding peer review site using the tools listed at [http://www.ieee.org/publications\\_standards/publications/authors/authors\\_submission.html](http://www.ieee.org/publications_standards/publications/authors/authors_submission.html). Once you have chosen your publication and navigated to the IEEE ScholarOne Manuscripts site, you may log in with your IEEE web account. If there is none, please create a new account. After logging in, go to your Author Center and click “Start New Submission.”

Along with other information, you will be asked to select the manuscript type from the journal’s pre-determined list of options. Depending on the journal, there are various steps to the submission process; please make sure to carefully answer all of the submission questions presented to you. At the end of each step you must click “Save and Continue”; just uploading the paper is not sufficient. After the last step, you should see a confirmation that the submission is complete. You should also receive an e-mail confirmation. For inquiries regarding the submission of your paper on IEEE ScholarOne Manuscripts, please contact [oprs-support@ieee.org](mailto:oprs-support@ieee.org) or call +1 732 465 5861.

IEEE ScholarOne Manuscripts will accept files for review in various formats. There is a “Journal Home” link on the log-in page of each IEEE ScholarOne Manuscripts site that will bring you to the journal’s homepage with their detailed requirements; please check these guidelines for your particular journal before you submit.

### D. Final Stage Using IEEE ScholarOne Manuscripts

Upon acceptance, you will receive an email with specific instructions regarding the submission of your final files. To avoid any delays in publication, please be sure to follow these instructions. Most journals require that final submissions be uploaded through IEEE ScholarOne Manuscripts, although some may still accept final submissions via email. Final submissions should include source files of your accepted manuscript, high quality graphic files, and a formatted pdf file. If you have any questions regarding the final submission process, please contact the administrative contact for the journal.

In addition to this, upload a file with complete contact information for all authors. Include full mailing addresses, telephone numbers, fax numbers, and e-mail addresses. Designate the author who submitted the manuscript on IEEE ScholarOne Manuscripts as the “corresponding author.” This is the only author to whom proofs of the paper will be sent.

### E. Copyright Form

Authors must submit an electronic IEEE Copyright Form (eCF) upon submitting their final manuscript files. You can access the eCF system through your manuscript submission system or through the Author Gateway. You are responsible for

obtaining any necessary approvals and/or security clearances. For additional information on intellectual property rights, visit the IEEE Intellectual Property Rights department web page at [http://www.ieee.org/publications\\_standards/publications/rights/index.html](http://www.ieee.org/publications_standards/publications/rights/index.html).

### IEEE PUBLISHING POLICY

The general IEEE policy requires that authors should only submit original work that has neither appeared elsewhere for publication, nor is under review for another refereed publication. The submitting author must disclose all prior publication(s) and current submissions when submitting a manuscript. Do not publish “preliminary” data or results. The submitting author is responsible for obtaining agreement of all coauthors and any consent required from employers or sponsors before submitting an article. The IEEE Transactions and Journals Department strongly discourages courtesy authorship; it is the obligation of the authors to cite only relevant prior work.

The IEEE Transactions and Journals Department does not publish conference records or proceedings, but can publish articles related to conferences that have undergone rigorous peer review. Minimally, two reviews are required for every article submitted for peer review.

### ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments. Avoid expressions such as “One of us (S.B.A.) would like to thank . . . .” Instead, write “F. A. Author thanks . . . .” In most cases, sponsor and financial support acknowledgments are placed in the unnumbered footnote on the first page, not here.

### REFERENCES

#### Basic format for books:

J. K. Author, “Title of chapter in the book,” in *Title of His Published Book*, *x*th ed. City of Publisher, (only U.S. State), Country: Abbrev. of Publisher, year, ch. *x*, sec. *x*, pp. xxx–xxx.

#### Examples:

- [1] G. O. Young, “Synthetic structure of industrial plastics,” in *Plastics*, 2<sup>nd</sup> ed., vol. 3, J. Peters, Ed. New York, NY, USA: McGraw-Hill, 1964, pp. 15–64.
- [2] W.-K. Chen, *Linear Networks and Systems*. Belmont, CA, USA: Wadsworth, 1993, pp. 123–135.

#### Basic format for periodicals:

J. K. Author, “Name of paper,” *Abbrev. Title of Periodical*, vol. *x*, no. *x*, pp. xxx–xxx, Abbrev. Month, year, DOI. 10.1109. XXX.123456.

#### Examples:

- [1] J. U. Duncombe, “Infrared navigation—Part I: An assessment of feasibility,” *IEEE Trans. Electron Devices*, vol. ED-11, no. 1, pp. 34–39, Jan. 1959, doi: 10.1109/TED.2016.2628402.
- [2] E. P. Wigner, “Theory of traveling-wave optical laser,” *Phys. Rev.*, vol. 134, pp. A635–A646, Dec. 1965, doi: 10.1109. XXX.123456.
- [3] E. H. Miller, “A note on reflector arrays,” *IEEE Trans. Antennas Propagat.*, to be published.

#### Basic format for reports:

J. K. Author, “Title of report,” Abbrev. Name of Co., City of Co., Abbrev. State, Country, Rep. xxx, year.

#### Examples:

- [1] E. E. Reber, R. L. Michell, and C. J. Carter, “Oxygen absorption in the earth’s atmosphere,” Aerospace Corp., Los Angeles, CA, USA, Tech. Rep. TR-0200 (4230-46)-3, Nov. 1988.
- [2] J. H. Davis and J. R. Cogdell, “Calibration program for the 16-foot antenna,” Elect. Eng. Res. Lab., Univ. Texas, Austin, TX, USA, Tech. Memo. NGL-006-69-3, Nov. 15, 1987.

#### Basic format for handbooks:

*Name of Manual/Handbook*, *x* ed., Abbrev. Name of Co., City of Co., Abbrev. State, Country, year, pp. xxx–xxx.

#### Examples:

- [1] *Transmission Systems for Communications*, 3rd ed., Western Electric Co., Winston-Salem, NC, USA, 1985, pp. 44–60.
- [2] *Motorola Semiconductor Data Manual*, Motorola Semiconductor Products Inc., Phoenix, AZ, USA, 1989.

#### Basic format for books (when available online):

J. K. Author, “Title of chapter in the book,” in *Title of Published Book*, *x*th ed. City of Publisher, State, Country: Abbrev. of Publisher, year, ch. *x*, sec. *x*, pp. xxx–xxx. [Online]. Available: <http://www.web.com>

#### Examples:

- [1] G. O. Young, “Synthetic structure of industrial plastics,” in *Plastics*, vol. 3, Polymers of Hexadromicon, J. Peters, Ed., 2nd ed. New York, NY, USA: McGraw-Hill, 1964, pp. 15–64. [Online]. Available: <http://www.bookref.com>.
- [2] *The Founders’ Constitution*, Philip B. Kurland and Ralph Lerner, eds., Chicago, IL, USA: Univ. Chicago Press, 1987. [Online]. Available: <http://press-pubs.uchicago.edu/founders/>
- [3] The Terahertz Wave eBook. ZOmega Terahertz Corp., 2014. [Online]. Available: [http://dl.z-thz.com/eBook/zomega\\_ebook\\_pdf.1206\\_sr.pdf](http://dl.z-thz.com/eBook/zomega_ebook_pdf.1206_sr.pdf). Accessed on: May 19, 2014.
- [4] Philip B. Kurland and Ralph Lerner, eds., *The Founders’ Constitution*. Chicago, IL, USA: Univ. of Chicago Press, 1987, Accessed on: Feb. 28, 2010, [Online] Available: <http://press-pubs.uchicago.edu/founders/>

#### Basic format for journals (when available online):

J. K. Author, “Name of paper,” *Abbrev. Title of Periodical*, vol. *x*, no. *x*, pp. xxx–xxx, Abbrev. Month, year. Accessed on: Month, Day, year, doi: 10.1109. XXX.123456, [Online].

#### Examples:

- [1] J. S. Turner, “New directions in communications,” *IEEE J. Sel. Areas Commun.*, vol. 13, no. 1, pp. 11–23, Jan. 1995, DOI. 10.1109. XXX.123456.
- [2] W. P. Risk, G. S. Kino, and H. J. Shaw, “Fiber-optic frequency shifter using a surface acoustic wave incident at an oblique angle,” *Opt. Lett.*, vol. 11, no. 2, pp. 115–117, Feb. 1986, doi: 10.1109. XXX.123456.
- [3] P. Kopyt et al., “Electric properties of graphene-based conductive layers from DC up to terahertz range,” *IEEE THz Sci. Technol.*, to be published, doi: 10.1109/TTHZ.2016.2544142.

#### Basic format for papers presented at conferences (when available online):

J.K. Author. (year, month). Title. presented at abbrev. conference title. [Type of Medium]. Available: site/path/file

#### Example:

- [1] PROCESS Corporation, Boston, MA, USA. Intranets: Internet technologies deployed behind the firewall for corporate productivity. Presented at INET96 Annual Meeting. [Online]. Available: <http://home.process.com/Intranets/wp2.htm>

#### Basic format for reports and handbooks (when available online):

J. K. Author. "Title of report," Company. City, State, Country. Rep. no., (optional: vol./issue), Date. [Online] Available: site/path/file

*Examples:*

- [1] R. J. Hijmans and J. van Etten, "Raster: Geographic analysis and modeling with raster data," R Package Version 2.0-12, Jan. 12, 2012. [Online]. Available: <http://CRAN.R-project.org/package=raster>
- [2] Teralyzer. Lytera UG, Kirchhain, Germany [Online]. Available: [http://www.lytera.de/Terahertz\\_THz\\_Spectroscopy.php?id=home](http://www.lytera.de/Terahertz_THz_Spectroscopy.php?id=home), Accessed on: Jun. 5, 2014

*Basic format for computer programs and electronic documents (when available online):*

Legislative body. Number of Congress, Session. (year, month day). *Number of bill or resolution, Title.* [Type of medium]. Available: site/path/file

*NOTE:* ISO recommends that capitalization follow the accepted practice for the language or script in which the information is given.

*Example:*

- [1] U.S. House. 102nd Congress, 1st Session. (1991, Jan. 11). *H. Con. Res. 1, Sense of the Congress on Approval of Military Action.* [Online]. Available: LEXIS Library: GENFED File: BILLS

*Basic format for patents (when available online):*

Name of the invention, by inventor's name. (year, month day). Patent Number [Type of medium]. Available: site/path/file

*Example:*

- [1] Musical toothbrush with mirror, by L.M.R. Brooks. (1992, May 19). Patent D 326 189 [Online]. Available: NEXIS Library: LEXPAT File: DES

*Basic format for conference proceedings (published):*

J. K. Author, "Title of paper," in *Abbreviated Name of Conf.*, City of Conf., Abbrev. State (if given), Country, year, pp. xxxxxx.

*Example:*

- [1] D. B. Payne and J. R. Stern, "Wavelength-switched passively coupled single-mode optical network," in *Proc. IOOC-ECOC*, Boston, MA, USA, 1985, pp. 585–590, doi: 10.1109. XXX .123456.

*Example for papers presented at conferences (unpublished):*

- [1] D. Ebehard and E. Voges, "Digital single sideband detection for interferometric sensors," presented at the *2nd Int. Conf. Optical Fiber Sensors*, Stuttgart, Germany, Jan. 2-5, 1984.

*Basic format for patents:*

J. K. Author, "Title of patent," U.S. Patent x xxx xxx, Abbrev. Month, day, year.

*Example:*

- [1] G. Brandli and M. Dick, "Alternating current fed power supply," U.S. Patent 4 084 217, Nov. 4, 1978.

*Basic format for theses (M.S.) and dissertations (Ph.D.):*

- a) J. K. Author, "Title of thesis," M.S. thesis, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.
- b) J. K. Author, "Title of dissertation," Ph.D. dissertation, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.

*Examples:*

- [1] J. O. Williams, "Narrow-band analyzer," Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, USA, 1993.
- [2] N. Kawasaki, "Parametric study of thermal and chemical nonequilibrium nozzle flow," M.S. thesis, Dept. Electron. Eng., Osaka Univ., Osaka, Japan, 1993.

*Basic format for the most common types of unpublished references:*

- a) J. K. Author, private communication, Abbrev. Month, year.
- b) J. K. Author, "Title of paper," unpublished.
- c) J. K. Author, "Title of paper," to be published.

*Examples:*

- [1] A. Harrison, private communication, May 1995.
- [2] B. Smith, "An approach to graphs of linear forms," unpublished.
- [3] A. Brahms, "Representation error for real numbers in binary computer arithmetic," IEEE Computer Group Repository, Paper R-67-85.

*Basic formats for standards:*

- a) *Title of Standard*, Standard number, date.
- b) *Title of Standard*, Standard number, Corporate author, location, date.

*Examples:*

- [1] IEEE Criteria for Class IE Electric Systems, IEEE Standard 308, 1969.
- [2] Letter Symbols for Quantities, ANSI Standard Y10.5-1968.

*Article number in reference examples:*

- [1] R. Fardel, M. Nagel, F. Nuesch, T. Lippert, and A. Wokaun, "Fabrication of organic light emitting diode pixels by laser-assisted forward transfer," *Appl. Phys. Lett.*, vol. 91, no. 6, Aug. 2007, Art. no. 061103, doi: 10.1109. XXX .123456.
- [2] J. Zhang and N. Tansu, "Optical gain and laser characteristics of InGaN quantum wells on ternary InGaN substrates," *IEEE Photon. J.*, vol. 5, no. 2, Apr. 2013, Art. no. 2600111, doi: 10.1109. XXX .123456.

*Example when using et al.:*

- [1] S. Azodolmolky et al., Experimental demonstration of an impairment aware network planning and operation tool for transparent/translucent optical networks," *J. Lightw. Technol.*, vol. 29, no. 4, pp. 439–448, Sep. 2011, doi: 10.1109. XXX .123456.

*Basic format for datasets:*

Author, Date, Year. "Title of Dataset," distributed by Publisher/Distributor, <http://url.com> (or if DOI is used, end with a period)

*Example:*

- [1] U.S. Department of Health and Human Services, Aug. 2013, "Treatment Episode Dataset: Discharges (TEDS-D): Concatenated, 2006 to 2009," U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Office of Applied Studies, doi: 10.3886/ICPSR30122.v2.

*Basic format for code:*

Author, Date published or disseminated, Year. "Complete title, including ed./vers.#," distributed by Publisher/Distributor, <http://url.com> (or if DOI is used, end with a period)

*Example:*

- [1] T. D'Martin and S. Soares, 2019, "Code for Assessment of Markov Decision Processes in Long-Term Hydrothermal Scheduling of Single-Reservoir Systems (Version 1.0)," Code Ocean, doi: .1.24433/CO.7212286.v1



**First A. Author** (Fellow, IEEE) and all authors may include biographies. Biographies are often not included in conference-related papers. This author is an IEEE Fellow. The first paragraph may contain a place and/or date of birth (list place, then date). Next, the author's educational background is listed. The degrees should be listed with type of degree in what field, which institution, city, state, and country, and year the degree was earned. The author's major field of study should be lower-cased.

The second paragraph uses the pronoun of the person (he or she) and not the author's last name. It lists military and work experience, including summer and fellowship jobs. Job titles are capitalized. The current job must have a location; previous positions may be listed without one. Information concerning previous publications may be included. Try not to list more than three books or published articles. The format for listing publishers of a book within the biography is: title of book (publisher name, year) similar to a reference. Current and previous research interests end the paragraph.

The third paragraph begins with the author's title and last name (e.g., Dr. Smith, Prof. Jones, Mr. Kajor, Ms. Hunter). List any memberships in professional societies other than the IEEE. Finally, list any awards and work for IEEE committees and publications. If a photograph is provided, it should be of good quality, and professional-looking.

**Second B. Author**, photograph and biography not available at the time of publication.

**Third C. Author Jr.** (Member, IEEE), photograph and biography not available at the time of publication.



TABLE II  
ABLATION EXPERIMENTS ON THE FEATURE CLUSTERING BLOCK ON BRAIN TUMOR DATASET

No.	settings			DSC(%)	mNOC%90
	position encoding	similarity measurement	multi-head		
1	None/Absolute Positional Embedding	Euclidean Distance + Gaussian KRF	×	–	–
2	Actual Euclidean Distance	Cosine	×	$88.6 \pm 1.9^*$	Unable
3	Actual Euclidean Distance	Euclidean Distance + Gaussian KRF	×	$91.6 \pm 3.1^*$	7.1
4	Actual Euclidean Distance	Euclidean Distance + Gaussian KRF	✓	$93.4 \pm 2.2$	3.7

\*Indicates a t-test significance level of  $p < 0.05$  compared to the best performance.

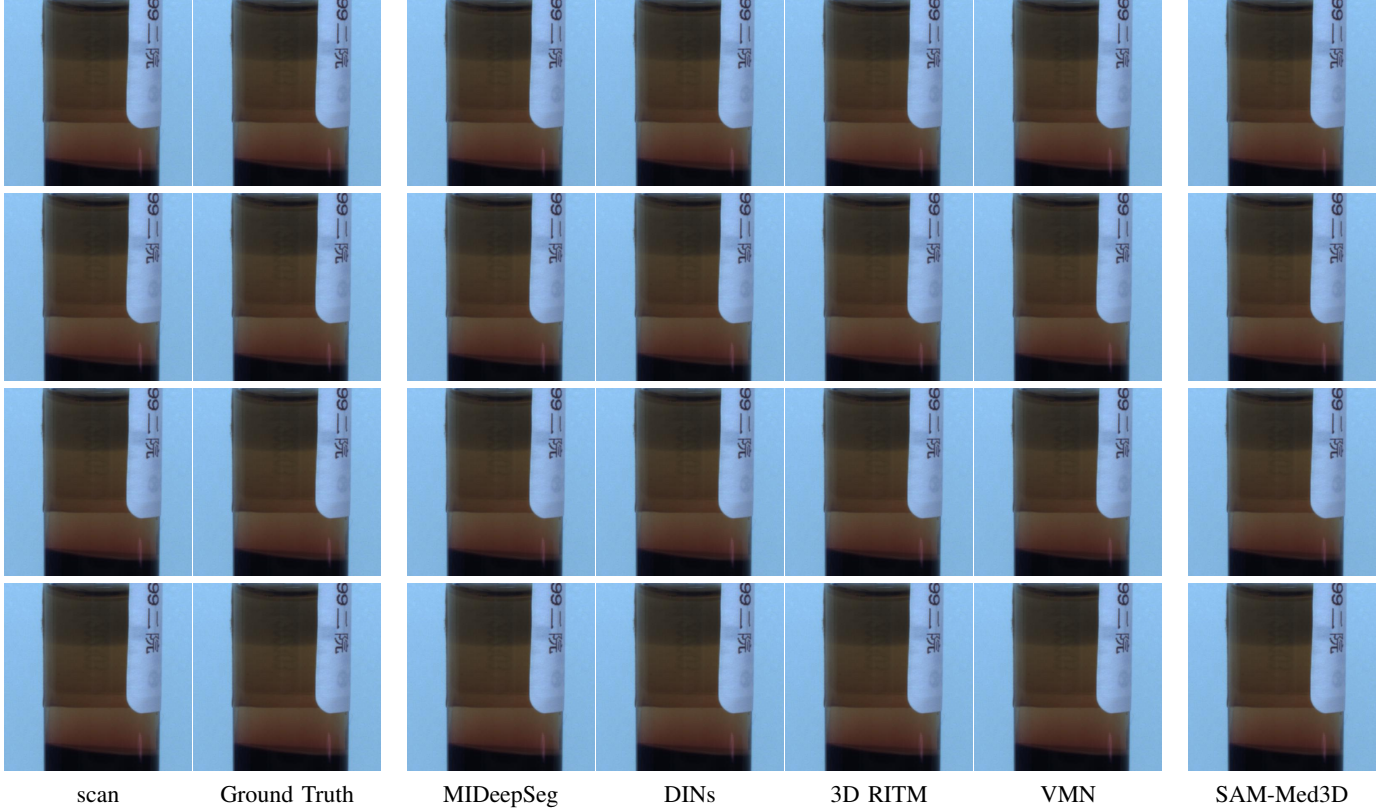


Fig. 2. Qualitative comparison grid (7 columns). Small gaps except large gaps between Col2–Col3 and Col6–Col7. Row gaps set by  $\setY$ .

TABLE III  
COMPARISON OF CAISEG AGAINST OTHER APPROACHES ACROSS BRAIN TUMOR AND COLON CANCER SEGMENTATION TASKS IN TERMS OF VARIOUS METRICS

Method	Interaction	“Brain Tumor” from MRI					“Colon Cancer” from CT				
		Dice(%)	mNOC@90	HD <sub>95</sub> (mm)	ASD(mm)	Jaccard	Dice(%)	mNOC@75	HD <sub>95</sub> (mm)	ASD(mm)	Jaccard
Graph Cuts <sub>2001</sub>	points, bounding boxes	$79.2 \pm 8.5$	>20	$8.49 \pm 4.21$	$3.49 \pm 1.82$	$0.66 \pm 0.16$	$53.4 \pm 16.9$	>20	$20.02 \pm 10.89$	$3.19 \pm 1.75$	$0.36 \pm 0.15$
Random Walker <sub>2006</sub>	points, bounding boxes	$80.1 \pm 9.4$	>20	$8.61 \pm 4.19$	$3.75 \pm 2.26$	$0.67 \pm 0.18$	$58.6 \pm 12.4$	>20	$17.35 \pm 11.42$	$2.74 \pm 1.94$	$0.41 \pm 0.12$
MIDeepSeg <sub>2021</sub>	points	$90.3 \pm 6.4$	15.7	$4.50 \pm 3.67$	$1.41 \pm 1.19$	$0.82 \pm 0.12$	$77.9 \pm 4.7$	10.4	$3.98 \pm 0.95$	$0.75 \pm 0.09$	$0.64 \pm 0.08$
DiNS <sub>2022</sub>	points	$91.2 \pm 1.9$	10.3	$3.35 \pm 1.21$	$1.09 \pm 0.21$	$0.84 \pm 0.05$	$70.9 \pm 6.2$	>20	$4.56 \pm 0.22$	$0.72 \pm 0.28$	$0.55 \pm 0.09$
3D RITM <sub>2022</sub>	points	$91.3 \pm 1.6$	9.7	$3.18 \pm 1.18$	$0.97 \pm 0.19$	$0.84 \pm 0.04$	$71.3 \pm 5.8$	>20	$5.31 \pm 1.20$	$0.84 \pm 0.11$	$0.55 \pm 0.08$
VMN <sub>2023</sub>	points	<u><math>92.6 \pm 1.4</math></u>	4	$2.59 \pm 0.85$	<u><math>0.99 \pm 0.25</math></u>	<u><math>0.86 \pm 0.04</math></u>	<u><math>80.2 \pm 5.1</math></u>	11.1	$3.91 \pm 0.98$	<b><math>0.41 \pm 0.08^\dagger</math></b>	<u><math>0.67 \pm 0.10</math></u>
SAM-Med3D <sub>2023</sub>	points	$92.1 \pm 2.1$	4.8	<u><math>2.47 \pm 0.98</math></u>	$0.86 \pm 0.43$	$0.85 \pm 0.06$	$79.5 \pm 7.7$	<u>8.2</u>	<u><math>3.76 \pm 1.33</math></u>	$0.68 \pm 0.29$	$0.66 \pm 0.15$
MedLSAM <sub>2023</sub>	bounding boxes	$90.4 \pm 1.0$	–	$2.66 \pm 0.44$	$1.37 \pm 0.28$	$0.82 \pm 0.03$	$68.7 \pm 2.9$	–	$15.78 \pm 3.55$	$1.83 \pm 0.84$	$0.52 \pm 0.04$
MedSAM <sub>2024</sub>	bounding boxes	$90.2 \pm 1.3$	–	$3.02 \pm 0.41$	$1.19 \pm 0.37$	$0.82 \pm 0.04$	$69.5 \pm 4.2$	–	$14.96 \pm 4.83$	$1.52 \pm 0.76$	$0.53 \pm 0.06$
CAISEg(Ours) <sub>2024</sub>	points	<b><math>93.4 \pm 2.2^\dagger</math></b>	2.7	<b><math>2.12 \pm 1.23</math></b>	<b><math>0.80 \pm 0.45</math></b>	<b><math>0.88 \pm 0.06^\dagger</math></b>	<b><math>81.1 \pm 7.3</math></b>	<b>4.6</b>	<b><math>3.12 \pm 0.81</math></b>	<u><math>0.53 \pm 0.13</math></u>	<b><math>0.68 \pm 0.15</math></b>

Here, the gray font indicates fully automated segmentation methods.  $^\dagger$  indicates that CAISEg outperforms the best-performing method among other approaches for the corresponding metric with a t-test significance level of  $p < 0.05$ .

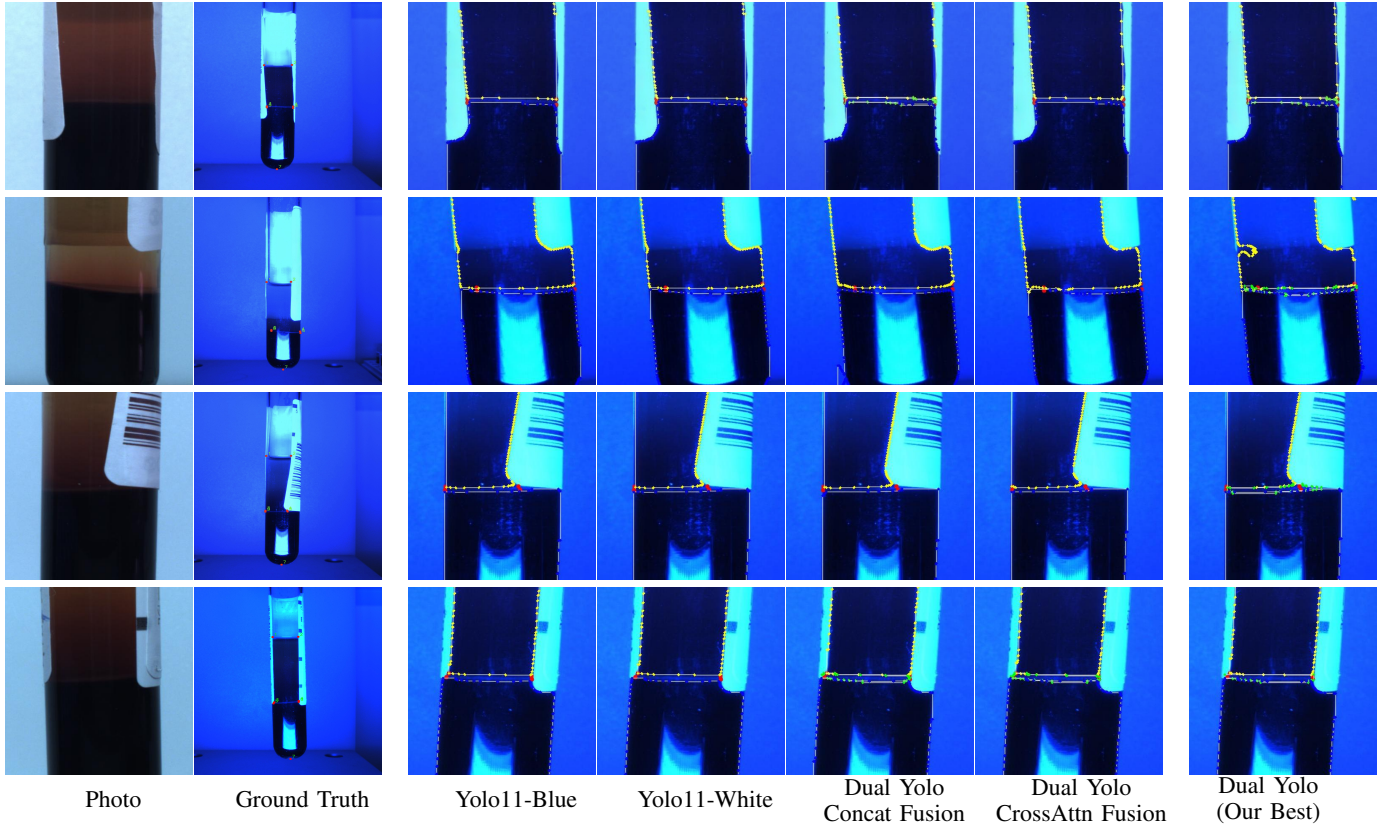


Fig. 3. Demonstrations of segmentation results from different models for the Blood Fractionation Component Segmentation task. In the figure, from top to bottom, the components are plasma, buffy coat, and red blood cell, respectively. From the third column, yellow, green, and blue points represent the segmented regions for plasma, buffy coat, and red blood cell. The regions outlined by white contours are the boundaries formed by the respective methods. From left to right, the columns display the following: original photo for the testing tube, ground truth annotated by professional blood testing personnel, Yolo11-Blue result, Yolo11-White result, Dual Yolo Concat Fusion result, Dual Yolo CrossAttn Fusion result, and Dual Yolo (Our Best).

TABLE IV

COMPARISON OF OUR DUAL-ILLUMINATION CROSS-ATTENTION FUSION AGAINST OTHER APPROACHES ACROSS PLASMA, BUFFY COAT AND RED BLOOD CELLS SEGMENTATION TASKS IN TERMS OF VARIOUS METRICS

Method	Dual-backbone	Plasma + Red Blood Cells Segmentation@65				Buffy Coat Segmentation@65			
		Detection Rate(%) $\uparrow$	IOU $\uparrow$	Diff <sub>up</sub> (px) $\downarrow$	Diff <sub>low</sub> (px) $\downarrow$	Detection Rate(%) $\uparrow$	IOU $\uparrow$	Diff <sub>up</sub> (px) $\downarrow$	Diff <sub>low</sub> (px) $\downarrow$
Yolo11-Blue	×	—	—	—	—	96.39	0.73 $\pm$ 0.22	6.2 $\pm$ 6.6	6.9 $\pm$ 4.9
Yolo11-White	×	—	—	—	—	96.39	0.73 $\pm$ 0.22	6.2 $\pm$ 6.6	6.9 $\pm$ 4.9
Dual Yolo Concat	✓	—	—	—	—	90.56	0.73 $\pm$ 0.22	<u>6.2<math>\pm</math>5.1</u>	<b>6.6<math>\pm</math>5.1</b>
Dual Yolo Weighted	✓	—	—	—	—	11.39	<b>0.77<math>\pm</math>0.16</b>	7.8 $\pm$ 6.2	7.7 $\pm$ 6.8
Dual Yolo CrossAttn	✓	—	—	—	—	<u>97.50</u>	0.73 $\pm$ 0.22	6.2 $\pm$ 5.4	6.8 $\pm$ 5.1
<b>Dual Yolo (Our Best)</b>	✓	—	—	—	—	<b>97.78</b>	<u>0.73<math>\pm</math>0.22</u>	<b>6.1<math>\pm</math>5.1</b>	<u>6.8<math>\pm</math>4.9</u>

TABLE V

COMPARISON OF OUR DUAL-ILLUMINATION CROSS-ATTENTION FUSION AGAINST OTHER APPROACHES ACROSS PLASMA, BUFFY COAT AND RED BLOOD CELLS SEGMENTATION TASKS IN TERMS OF VARIOUS METRICS

Method	Dual-backbone	Plasma + Red Blood Cells Segmentation@70				Buffy Coat Segmentation@70			
		Detection Rate(%) $\uparrow$	IOU $\uparrow$	Diff <sub>up</sub> (px) $\downarrow$	Diff <sub>low</sub> (px) $\downarrow$	Detection Rate(%) $\uparrow$	IOU $\uparrow$	Diff <sub>up</sub> (px) $\downarrow$	Diff <sub>low</sub> (px) $\downarrow$
Yolo11-Blue	×	—	—	—	—	91.67	0.73 $\pm$ 0.22	6.3 $\pm$ 6.7	7.0 $\pm$ 5.0
Yolo11-White	×	—	—	—	—	91.67	0.73 $\pm$ 0.22	6.3 $\pm$ 6.7	7.0 $\pm$ 5.0
Dual Yolo Concat	✓	—	—	—	—	86.11	0.73 $\pm$ 0.22	<u>6.2<math>\pm</math>5.2</u>	<u>6.6<math>\pm</math>5.2</u>
Dual Yolo Weighted	✓	—	—	—	—	9.44	<b>0.77<math>\pm</math>0.17</b>	41.8 $\pm$ 104.3	7.6 $\pm$ 6.5
Dual Yolo CrossAttn	✓	—	—	—	—	<u>94.72</u>	<u>0.74<math>\pm</math>0.22</u>	6.2 $\pm$ 5.4	<b>6.4<math>\pm</math>5.1</b>
<b>Dual Yolo (Our Best)</b>	✓	—	—	—	—	<b>97.78</b>	0.73 $\pm$ 0.22	<b>6.1<math>\pm</math>5.1</b>	6.8 $\pm$ 4.9

TABLE VI  
COMPARISON OF OUR DUAL-ILLUMINATION CROSS-ATTENTION FUSION AGAINST OTHER APPROACHES ACROSS PLASMA, BUFFY COAT AND RED BLOOD CELLS SEGMENTATION TASKS IN TERMS OF VARIOUS METRICS

Method	Dual-backbone	Plasma + Red Blood Cells Segmentation@75				Buffy Coat Segmentation@75			
		Detection Rate(%) $\uparrow$	IOU $\uparrow$	Diff <sub>up</sub> (px) $\downarrow$	Diff <sub>low</sub> (px) $\downarrow$	Detection Rate(%) $\uparrow$	IOU $\uparrow$	Diff <sub>up</sub> (px) $\downarrow$	Diff <sub>low</sub> (px) $\downarrow$
Yolo11-Blue	×	–	–	–	–	80.83	0.73 $\pm$ 0.23	6.3 $\pm$ 6.9	7.1 $\pm$ 5.1
Yolo11-White	×	–	–	–	–	80.83	0.73 $\pm$ 0.23	6.3 $\pm$ 6.9	7.1 $\pm$ 5.1
Dual Yolo Concat	✓	–	–	–	–	76.67	0.73 $\pm$ 0.22	<u>6.1<math>\pm</math>5.2</u>	<u>6.6<math>\pm</math>5.1</u>
Dual Yolo Weighted	✓	–	–	–	–	6.39	<b>0.76<math>\pm</math>0.17</b>	48.8 $\pm$ 114.7	7.8 $\pm$ 7.0
Dual Yolo CrossAttn	✓	–	–	–	–	<b>86.39</b>	<u>0.74<math>\pm</math>0.22</u>	6.3 $\pm$ 5.5	<b>6.5<math>\pm</math>5.0</b>
<b>Dual Yolo (Our Best)</b>	✓	–	–	–	–	<u>85.56</u>	0.73 $\pm$ 0.22	<b>6.1<math>\pm</math>5.1</b>	6.9 $\pm$ 5.0

TABLE VII  
ABLATION EXPERIMENTS ON THE BLOOD FRACTIONATION COMPONENT SEGMENTATION TASK@70

No.	Settings			Detection Rate(%) $\uparrow$	IOU $\uparrow$
	Dual-backbone	Dual-illumination fusion method	Pre-training		
1	×	None	From Scratch	91.67	0.73 $\pm$ 0.22
2	✓	Concatenation + Compression	From Scratch	–	–
3	✓	Concatenation + Compression	Transfer Learning	86.11	0.73 $\pm$ 0.22
4	✓	Adaptive Weighted Fusion	From Scratch	–	–
5	✓	Adaptive Weighted Fusion	Transfer Learning	9.44	0.77 $\pm$ 0.17
6	✓	Cross Modal Attention Fusion	From Scratch	–	–
7	✓	Cross Modal Attention Fusion	Transfer Learning	<b>97.78</b>	0.73 $\pm$ 0.22