Multi-Task Temporal and Spatial Networks for High-Precision Event Spotting in Volleyball Videos

Hoang Quoc Nguyen[1]ᵃ, Second Author Name[1]ᵇ and Third Author Name[2]ᶜ

[1]*Korea Institute of Science and Technology, Seoul, Republic of Korea*
[2]*Department of Computing, Main University, MySecondTown, MyCountry*
523503, second_author}@kist.re.kr, third_author@dc.mu.edu

Abstract: Accurate event spotting in sports videos relies not only on precise temporal detection but also on spatial understanding of key actions within the frame. In volleyball, where fast-paced plays unfold in specific court areas, integrating spatial localization is essential for meaningful analysis. We introduce a new task: high-precision spatial-temporal event spotting in volleyball videos, addressing the need to detect both when and where key events occur. To tackle this challenge, we develop a novel volleyball event dataset annotated for both temporal and spatial event localization. Our proposed multi-task deep learning model leverages this dual focus, jointly predicting event timing and spatial coordinates. Remarkably, we find that adding a spatial predictor improves temporal event detection by ???%, underscoring the synergy between spatial and temporal tasks. Evaluations demonstrate state-of-the-art performance on our dataset, surpassing existing methods in mean Average Precision (mAP), and highlighting the benefits of spatial-temporal networks in sports video analysis.

1 INTRODUCTION

Your paper will be part of the conference proceedings therefore we ask that authors follow the guidelines explained in this example in order to achieve the highest quality possible (Smith, 1998).

Be advised that papers in a technically unsuitable form will be returned for retyping. After returned the manuscript must be appropriately modified.

2 RELATED WORK

We strongly encourage authors to use this document for the preparation of the camera-ready. Please follow the instructions closely in order to make the volume look as uniform as possible (Moore and Lopes, 1999).

Please remember that all the papers must be in English and without orthographic errors.

Do not add any text to the headers (do not set running heads) and footers, not even page numbers, because text will be added electronically.

For a best viewing experience the used font must be Times New Roman, except on special occasions, such as program code 2.4.8.

2.1 Manuscript Setup

The template is composed by a set of 7 files, in the following 2 groups:

Group 1. To format your paper you will need to copy into your working directory, but NOT edit, the following 4 files:

```
- apalike.bst
- apalike.sty
- article.cls
- scitepress.sty
```

Group 2. Additionally, you may wish to copy and edit the following 3 example files:

```
- example.bib
- example.tex
- scitepress.eps
```

ᵃ https://orcid.org/0009-0002-2004-9285
ᵇ https://orcid.org/0000-0000-0000-0000
ᶜ https://orcid.org/0000-0000-0000-0000

2.2 Page Setup

The paper size must be set to A4 (210x297 mm). The document margins must be the following:

- Top: 3,3 cm;
- Bottom: 4,2 cm;
- Left: 2,6 cm;
- Right: 2,6 cm.

It is advisable to keep all the given values because any text or material outside the aforementioned margins will not be printed.

2.3 First Section

This section must be in one column.

2.3.1 Title and Subtitle

Use the command *title* and follow the given structure in "example.tex". The title and subtitle must be with initial letters capitalized (titlecased). The separation between the title and subtitle is done by adding a colon ":" just before the subtitle beginning. In the title or subtitle, words like "is", "or", "then", etc. should not be capitalized unless they are the first word of the title or subtitle. No formulas or special characters of any form or language are allowed in the title or subtitle.

2.3.2 Authors and Affiliations

Use the command *author* and follow the given structure in "example.tex". Please note that the name of each author must start with its first name.

2.3.3 Keywords

Use the command *keywords* and follow the given structure in "example.tex". Each paper must have at least one keyword. If more than one is specified, please use a comma as a separator. The sentence must end with a period.

2.3.4 Abstract

Use the command *abstract* and follow the given structure in "example.tex". Each paper must have an abstract up to 200 words. The sentence must end with a period.

2.4 Second Section

Files "example.tex" and "example.bib" show how to create a paper with a corresponding list of references.

This section must be in two columns.

Each column must be 7,5-centimeter wide with a column spacing of 0,8-centimeter.

The section text must be set to 10-point.

Section, subsection and sub-subsection first paragraph should not have the first line indent.

To remove the paragraph indentation (only necessary for the sections), use the command *noindent* before the paragraph first word.

If you use other style files (.sty) you MUST include them in the final manuscript zip file.

2.4.1 Section Titles

The heading of a section title should be in all-capitals.
Example: *section*{*FIRST TITLE*}

2.4.2 Subsection Titles

The heading of a subsection title must be with initial letters capitalized (titlecased).

Words like "is", "or", "then", etc. should not be capitalized unless they are the first word of the subsection title.
Example: *subsection*{*First Subtitle*}

2.4.3 Sub-Subsection Titles

The heading of a sub subsection title should be with initial letters capitalized (titlecased).

Words like "is", "or", "then", etc should not be capitalized unless they are the first word of the sub subsection title.
Example: *subsubsection*{*First Subsubtitle*}

2.4.4 Tables

Tables must appear inside the designated margins or they may span the two columns.

Tables in two columns must be positioned at the top or bottom of the page within the given margins. To span a table in two columns please add an asterisk (*) to the table *begin* and *end* command.
Example: *begin*{*table**}
　　　　end{*table**}

Tables should be centered and should always have a caption positioned above it. The font size to use is 9-point. No bold or italic font style should be used.

The final sentence of a caption should end with a period.

Table 1: This caption has one line so it is centered.

Example column 1	Example column 2
Example text 1	Example text 2

Table 2: This caption has more than one line so it has to be justified.

Example column 1	Example column 2
Example text 1	Example text 2

Please note that the word "Table" is spelled out.

2.4.5 Figures

Please produce your figures electronically, and integrate them into your document and zip file.

Check that in line drawings, lines are not interrupted and have a constant width. Grids and details within the figures must be clearly readable and may not be written one on top of the other.

Figure resolution should be at least 300 dpi.

Figures must appear inside the designated margins or they may span the two columns.

Figures in two columns must be positioned at the top or bottom of the page within the given margins. To span a figure in two columns please add an asterisk (*) to the figure *begin* and *end* command.

Example: \begin{figure*}
\qquad \end{figure*}

Figures should be centered and should always have a caption positioned under it. The font size to use is 9-point. No bold or italic font style should be used.

Figure 1: This caption has one line so it is centered.

Figure 2: This caption has more than one line so it has to be justified.

The final sentence of a caption should end with a period.

Please note that the word "Figure" is spelled out.

2.4.6 Equations

Equations should be placed on a separate line, numbered and centered.
The numbers accorded to equations should appear in consecutive order inside each section or within the contribution, with the number enclosed in brackets and justified to the right, starting with the number 1.

Example:

$$a = b + c \qquad (1)$$

2.4.7 Algorithms and Listings

Algorithms and Listings captions should have font size 9-point, no bold or italic font style should be used and the final sentence of a caption should end with a period. The separator between the title of algorithms/listings and the name of the algorithm/listing must be a colon. Captions with one line should be centered and if it has more than one line it should be set to justified.

Data: this text
Result: how to write algorithm with LATEX2e initialization;
while *not at end of this document* **do**
    read current;
    if *understand* **then**
        go to next section;
        current section becomes this one;
    else
        go back to the beginning of current
          section;
    end
end

Algorithm 1: How to write algorithms.

2.4.8 Program Code

Program listing or program commands in text should be set in typewriter form such as Courier New.

Example of a Computer Program in Pascal:

```
Begin
    Writeln('Hello World!!');
End.
```

The text must be aligned to the left and in 9-point type.

2.4.9 Reference Text and Citations

References and citations should follow the APA (Author, date) System Convention (see the References section in the compiled manuscript). As example you may consider the citation (Smith, 1998). Besides that, all references should be cited in the text. No numbers with or without brackets should be used to list the references.

References should be set to 9-point. Citations should be 10-point font size.

You may check the structure of "example.bib" before constructing the references.

For more instructions about the references and citations usage please see the appropriate link at the conference website.

3 PROPOSED METHOD

For the mutual benefit and protection of Authors and Publishers, it is necessary that Authors provide formal written Consent to Publish and Transfer of Copyright before publication of the Book. The signed Consent ensures that the publisher has the Author's authorization to publish the Contribution.

The copyright form is located on the authors' reserved area.

The form should be completed and signed by one author on behalf of all the other authors.

4 EXPERIMENTS

Please note that ONLY the files required to compile your paper should be submitted. Previous versions or examples MUST be removed from the compilation directory before submission.

We hope you find the information in this template useful in the preparation of your submission.

5 CONCLUSIONS

Please note that ONLY the files required to compile your paper should be submitted. Previous versions or examples MUST be removed from the compilation directory before submission.

We hope you find the information in this template useful in the preparation of your submission.

ACKNOWLEDGEMENTS

If any, should be placed before the references section without numbering. To do so please use the following command:

REFERENCES

Moore, R. and Lopes, J. (1999). Paper templates. In *TEMPLATE'06, 1st International Conference on Template Production*. SCITEPRESS.

Smith, J. (1998). *The Book*. The publishing company, London, 2nd edition.

APPENDIX

If any, the appendix should appear directly after the references without numbering, and not on a new page.

To do so please use the following command: