ACM Word Template for SIG Site

1st Author

1st author's affiliation  
1st line of address  
2nd line of address  
Telephone number, incl. country code

1st author's E-mail address

2nd Author

2nd author's affiliation  
1st line of address  
2nd line of address  
Telephone number, incl. country code

2nd E-mail

3rd Author

3rd author's affiliation  
1st line of address  
2nd line of address  
Telephone number, incl. country code

3rd E-mail

**ABSTRACT**

Attributed to the omnipresence of the radio signals for communications, sensing and recognition utilizing the Wi-Fi signals has significant advantage in terms of accessibility over conventional sensing means such as the camera. However, utilizing the raw Wi-Fi signals to capture in-air handwritten signatures for identity verification is yet a challenging task. In this paper, we propose a system for identity verification based on the handwritten signature signals captured by the Wi-Fi Channel State Information (CSI). A triplet network is adopted to learn the correlation between the captured signals and the user identities. To facilitate a fast converging loss model, a kernel and the range space learning is initially adopted for mining the triplet inputs. Subsequently, the triplet network is trained on a ConvNet structure based on the mined triplet inputs. Our experiments on a Wi-Fi dataset collected in-house show encouraging verification accuracy with faster training loss convergence comparing with that of the baseline triplet network and the Siamese network.

**CCS Concepts**

**• Information systems➝Database management system engines**   • **Computing methodologies➝Massively parallel and** high-performance simulations. **This is just an example, please** use the correct category and subject descriptors for your submission*.* The ACM Computing Classification Scheme:

<http://www.acm.org/about/class/class/2012>. Please read the [HOW TO CLASSIFY WORKS USING ACM'S COMPUTING CLASSIFICATION SYSTEM](http://www.acm.org/publications/article-templates/CCS-HOWTO-v6-12Jan2015.docx) for instructions on how to classify your document using the 2012 ACM Computing Classification System and insert the index terms into your Microsoft Word source file.

**Keywords**

Wi-Fi signature signal; in-air handwritten signature verification; the Kernel and the Range space projection learning; triplet network

# INTRODUCTION

Over recent years, several behavioral biometric traits have attracted attention in view of their rigid physical body independence. Among these behavioral biometrics, the signature-based user authentication [1, 2, 3] has attracted considerable interest with the development of in-air signature recognition systems [4, 5, 6, 7]. With the help of sensors such as the depth camera [4, 5] or a mobile sensor [6], the in-air signature recognition system has lower the spatial constraint in the process of signature acquisition comparing with contact-based authentication systems [8, 9, 10].

Recently, the commercial Wi-Fi device has been adopted for in-air signature authentication due to its easy accessible property [7]. Based on the distortion of the Wi-Fi CSI signal according to the user’s gestures, the in-air signature recognition system showed reasonable user verification performance [7]. More recently, some studies attempted to implement the deep learning algorithms in Wi-Fi signal-based user authentication systems to improve the verification performance [11, 12].

In this paper, we utilize a deep triplet network for identity verification based on the Wi-Fi CSI signature signal. To achieve not only the desired verification accuracy but also a fast training speed, we adopt the kernel and the range (KAR) space learning [13, 14, 15, 16] in order to mine the distinctive triplet inputs. Subsequently, the triplet network which utilizes the ConvNet [17] structure as a feature extractor is trained based on the L2 distance comparison.

The main contributions of our work can be summarized as follows:

* Proposal of a system for identity verification based on the Wi-Fi handwritten signature signals using a deep triplet network.
* Adopted the kernel and the range (KAR) space learning in order to mine the distinctive triplet inputs which boosted the convergence speed of the training loss in the triplet network.
* Provision of an experimental study using a Wi-Fi handwritten signature dataset which was collected in-house based on 50 subjects.

The paper is organized as follows: related works including the triplet network and KAR space learning are introduced in Section 2 for immediate reference. Our proposed method is discussed in Section 3. Section 4 describes our experimental results and analysis. Some concluding remarks are given in Section 5.

# PAGE SIZE

All material on each page should fit within a rectangle of 18 × 23.5 cm (7" × 9.25"), centered on the page, beginning 1.9 cm (0.75") from the top of the page and ending with 2.54 cm (1") from the bottom. The right and left margins should be 1.9 cm (.75").

The text should be in two 8.45 cm (3.33") columns with a .83 cm (.33") gutter.

# TYPESET TEXT

## Normal or Body Text

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

*ICIME 2017,* October 9–11, 2017, Barcelona, Spain

© 2017 Association for Computing Machinery.

ACM ISBN 978-1-4503-5337-3/17/10…$15.00

DOI: https://doi.org/10.1145/3149572.3149592

Please use a 9-point Times Roman font, or other Roman font with serifs, as close as possible in appearance to Times Roman in which these guidelines have been set. The goal is to have a 9-point text, as you see here. Please use sans-serif or non-proportional fonts only for special purposes, such as distinguishing source code text. If Times Roman is not available, try the font named Computer Modern Roman. On a Macintosh, use the font named Times. Right margins should be justified, not ragged.

## Title and Authors

The title (Helvetica 18-point bold), authors' names (Helvetica 12-point) and affiliations (Helvetica 10-point) run across the full width of the page – one column wide. We also recommend phone number (Helvetica 10-point) and e-mail address (Helvetica 12-point). See the top of this page for three addresses. If only one address is needed, center all address text. For two addresses, use two centered tabs, and so on. For more than three authors, you may have to improvise.[[1]](#footnote-1)

## First Page Copyright Notice

Please leave 3.81 cm (1.5") of blank text box at the bottom of the left column of the first page for the copyright notice.

## Subsequent Pages

For pages other than the first page, start at the top of the page, and continue in double-column format. The two columns on the last page should be as close to equal length as possible.

Table . Table captions should be placed above the table

|  |  |  |  |
| --- | --- | --- | --- |
| **Graphics** | **Top** | **In-between** | **Bottom** |
| Tables | End | Last | First |
| Figures | Good | Similar | Very well |

## References and Citations

Footnotes should be Times New Roman 9-point, and justified to the full width of the column.

Use the “ACM Reference format” for references – that is, a numbered list at the end of the article, ordered alphabetically and formatted accordingly. See examples of some typical reference types, in the new “ACM Reference format”, at the end of this document. Within this template, use the style named *references* for the text. Acceptable abbreviations, for journal names, can be found here: <http://library.caltech.edu/reference/abbreviations/>. Word may try to automatically ‘underline’ hotlinks in your references, the correct style is NO underlining.

The references are also in 9 pt., but that section (see Section 7) is ragged right. References should be published materials accessible to the public. Internal technical reports may be cited only if they are easily accessible (i.e. you can give the address to obtain the report within your citation) and may be obtained by any reader. Proprietary information may not be cited. Private communications should be acknowledged, not referenced (e.g., “[Robertson, personal communication]”).

## Page Numbering, Headers and Footers

Do not include headers, footers or page numbers in your submission. These will be added when the publications are assembled.

# FIGURES/CAPTIONS

Place Tables/Figures/Images in text as close to the reference as possible (see Figure 1). It may extend across both columns to a maximum width of 17.78 cm (7”).

Captions should be Times New Roman 9-point bold. They should be numbered (e.g., “Table 1” or “Figure 2”), please note that the word for Table and Figure are spelled out. Figure’s captions should be centered beneath the image or picture, and Table captions should be centered above the table body.

# SECTIONS

The heading of a section should be in Times New Roman 12-point bold in all-capitals flush left with an additional 6-points of white space above the section head. Sections and subsequent sub- sections should be numbered and flush left. For a section head and a subsection head together (such as Section 3 and subsection 3.1), use no additional space above the subsection head.



Figure 1. Insert caption to place caption below figure.

.

## Subsections

The heading of subsections should be in Times New Roman 12-point bold with only the initial letters capitalized. (Note: For subsections and subsubsections, a word like *the* or *a* is not capitalized unless it is the first word of the header.)

### Subsubsections

The heading for subsubsections should be in Times New Roman 11-point italic with initial letters capitalized and 6-points of white space above the subsubsection head.

#### Subsubsections

The heading for subsubsections should be in Times New Roman 11-point italic with initial letters capitalized.

#### Subsubsections

The heading for subsubsections should be in Times New Roman 11-point italic with initial letters capitalized.

# ACKNOWLEDGMENTS

Our thanks to ACM SIGCHI for allowing us to modify templates they had developed.

# REFERENCES

1. Bowman, M., Debray, S. K., and Peterson, L. L. 1993. Reasoning about naming systems. *ACM Trans. Program. Lang. Syst.* 15, 5 (Nov. 1993), 795-825. DOI= <http://doi.acm.org/10.1145/161468.16147>.
2. Ding, W. and Marchionini, G. 1997. *A Study on Video Browsing Strategies*. Technical Report. University of Maryland at College Park.
3. Fröhlich, B. and Plate, J. 2000. The cubic mouse: a new device for three-dimensional input. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (The Hague, The Netherlands, April 01 - 06, 2000). CHI '00. ACM, New York, NY, 526-531. DOI= <http://doi.acm.org/10.1145/332040.332491>.
4. Tavel, P. 2007. *Modeling and Simulation Design*. AK Peters Ltd., Natick, MA.
5. Sannella, M. J. 1994. *Constraint Satisfaction and Debugging for Interactive User Interfaces*. Doctoral Thesis. UMI Order Number: UMI Order No. GAX95-09398., University of Washington.
6. Forman, G. 2003. An extensive empirical study of feature selection metrics for text classification. *J. Mach. Learn. Res.* 3 (Mar. 2003), 1289-1305.
7. Brown, L. D., Hua, H., and Gao, C. 2003. A widget framework for augmented interaction in SCAPE. In *Proceedings of the 16th Annual ACM Symposium on User Interface Software and Technology* (Vancouver, Canada, November 02 - 05, 2003). UIST '03. ACM, New York, NY, 1-10. DOI= <http://doi.acm.org/10.1145/964696.964697>.
8. Yu, Y. T. and Lau, M. F. 2006. A comparison of MC/DC, MUMCUT and several other coverage criteria for logical decisions. *J. Syst. Softw.* 79, 5 (May. 2006), 577-590. DOI= <http://dx.doi.org/10.1016/j.jss.2005.05.030>.
9. Spector, A. Z. 1989. Achieving application requirements. In *Distributed Systems*, S. Mullender, Ed. ACM Press Frontier Series. ACM, New York, NY, 19-33. DOI= <http://doi.acm.org/10.1145/90417.90738>.

Columns on Last Page Should Be Made As Close As Possible to Equal Length

Authors’ background

|  |  |  |  |
| --- | --- | --- | --- |
| Your Name | Title\* | Research Field | Personal website |
|  |  |  |  |
|  |  |  |  |

\*This form helps us to understand your paper better, the form itself will not be published.

\*Title can be chosen from: master student, Phd candidate, assistant professor, lecture, senior lecture, associate professor, full professor

1. If necessary, you may place some address information in a footnote, or in a named section at the end of your paper. [↑](#footnote-ref-1)