AiFiMatch: Accurate Indoor Map Matching Algorithm Based on Activity Detection and Crowd-sourced Wi-Fi

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Abstract—Map matching has been widely investigated in indoor pedestrian navigation to improve positioning accuracy and robustness. In this paper, we present AiFiMatch: a map matching algorithm that can provide accurate pedestrian walking trajectory tracking based on Hidden Markov model (HMM) for smartphone users. AiFiMatch abstracts the indoor map using a directed graph model in which the location-related activities, such as turn, walking stairs, taking the elevator, are directed edges, indoor road segments between these special locations are nodes. With the help of a novel HMM model, AiFiMatch maps pedestrian's walking trajectory subset sequence to indoor map based on activity detection (AD). Simultaneously, Wi-Fi fingerprints can be bound to physical locations by timestamp. AiFiMatch can automatically construct and update radio map of indoor road segments via crowdsourcing. With this radio map, AiFiMatch efficiently solves the multiple hypotheses problem. We have evaluated our proposed algorithm using smartphones in the fifth floor of a teaching building on campus. Experimental results show that AiFiMatch can accurately track a pedestrian even without knowing the initial point in the experimental environment. The mean offline positioning error is about 1.24 m. The results also demonstrate that AiFiMatch significantly improves the convergence speed in buildings with Wi-Fi infrastructure.

Index Terms—Map Matching, Hidden Markov Model, Activity Detection, Crowdsourced Wi-Fi

I. Introduction

Location based services (LBS) have spilled over into all aspects of people's daily life. Outdoors, global positioning system (GPS) is able to provide a reasonably good positioning [1]. However, robust and effective indoor pedestrian positioning is still at its infancy due to the blockage of GPS signals.

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$$a + b = \gamma \tag{1}$$

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- 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.)
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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.

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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.

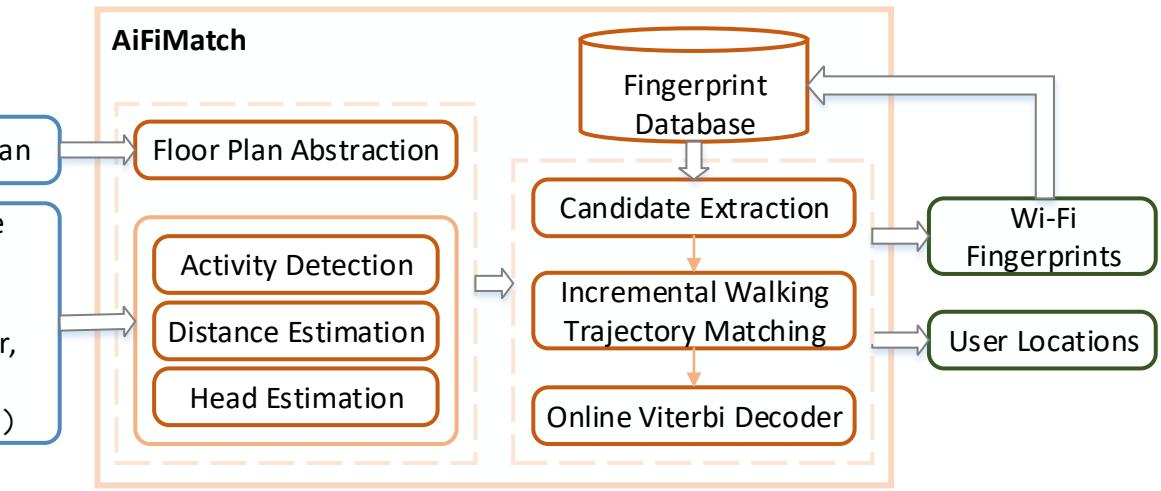

Fig. 1. Example of a figure caption.

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References

[1] F. Zampella, A. R. J. Ruiz, and F. S. Granja, "Indoor positioning using efficient map matching, rss measurements, and an improved motion model," IEEE Transactions on Vehicular Technology, vol. 64, no. 4, pp. 1304–1317, 2015.