A PNN- Jensen-Bregman Divergence for a WLAN Indoor Positioning System

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Abstract

For decades, humans have been keen on creating smart spaces where advanced technology is utilized to provide enhanced services Indoor positioning systems (IPS) can be used to provide a wide range of user navigation and directions services, particularly in abnormal conditions such as needing emergency healthcare services. IPS also can be a friendly tool for people with vision impairment to allow for better livable communities for them. Other applications for IPS fall under tracking applications which may include activity recognition for security purposes and observation for the elderly or infirmed individuals. An indoor positioning system can be a hybrid system that uses multiple technologies such as wireless LAN, vision via cameras, motion sensors, or lasers to name few. In this paper we propose a technique for IPS using WiFi. The technique is based on a probabilistic neural network (PNN) scheme in which we incorporate the Jensen-Bregman divergence method. To validate our proposed method, we compare our results with the nearest neighbor method. Results indicate that our integrated system outperforms this method in terms of nearest neighbor estimation. Our results show that this method has the ability to achieve less than 1m accuracy in an academic building.

Introduction

1. Indoor Positioning System (IPS) brings the power of the Global Positioning System (GPS) indoors, the IPS is considered as the Next Big Thing.
2. The GPS can't be used inside buildings because: it can't perform a line-of-sight (LOS) with satellite and the lack to determine the floor [1].
3. S. Kumar [2] had reported that the global of indoor localization market around $935.05 million in 2014, and by 2019 is expected to be around $4,424.1 million. The Compound Annual Growth Rate (CAGR) is expected to be 36.5% from 2014 to 2019.

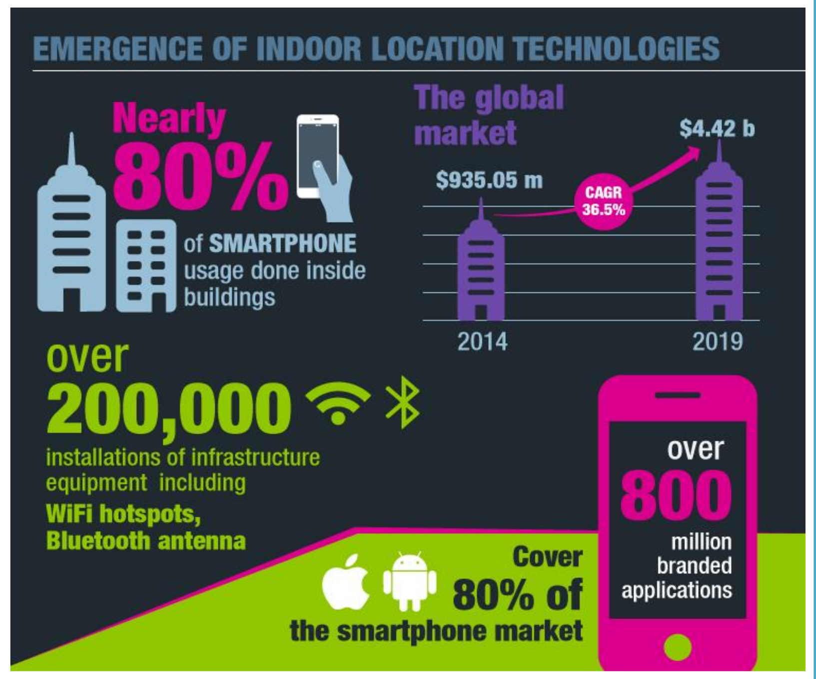

Fig. 1. Compound Annual Growth Rate of IPS

IPS Technology

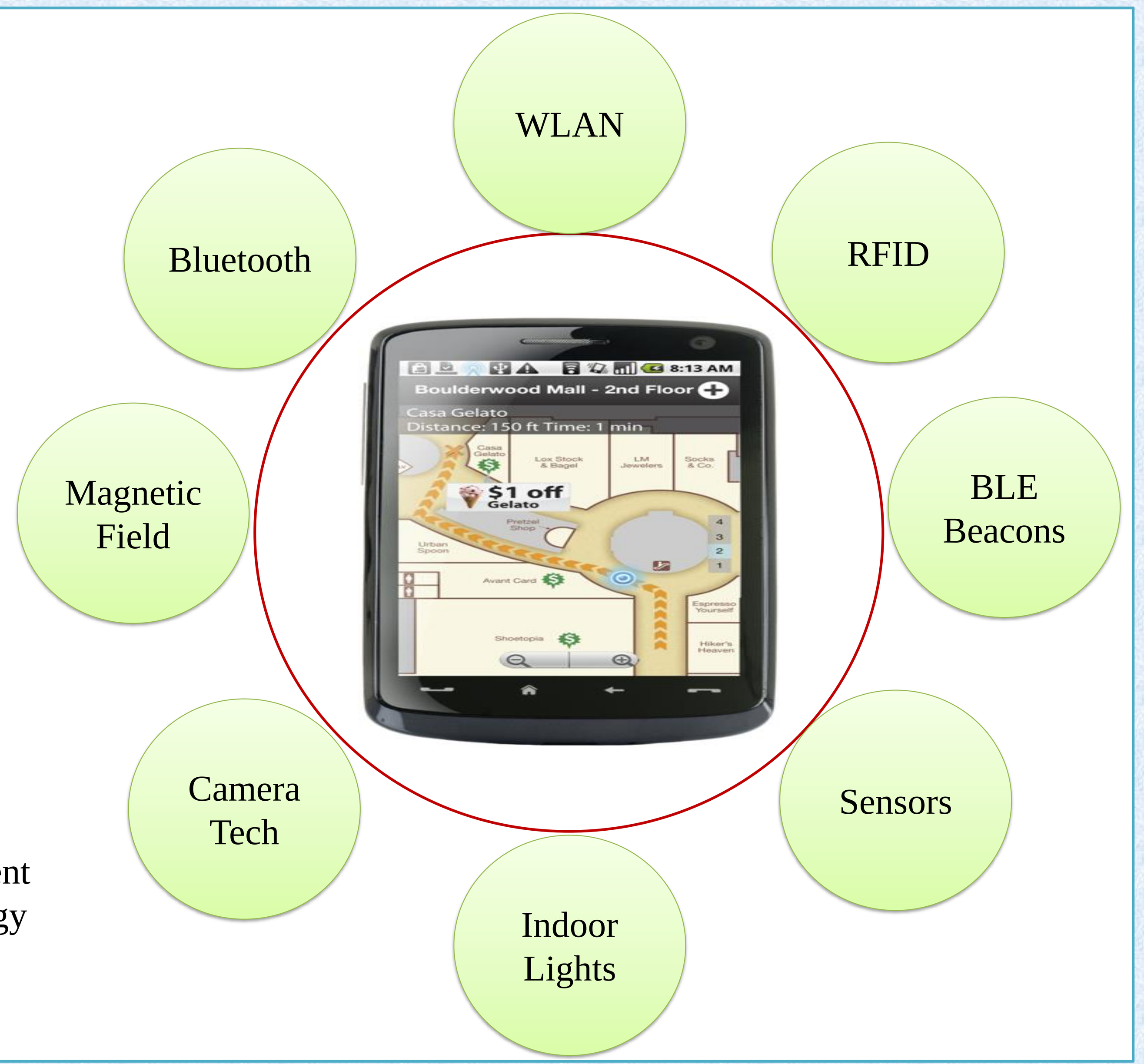

Fig. 2. Different IPS Technology

IPS Methods

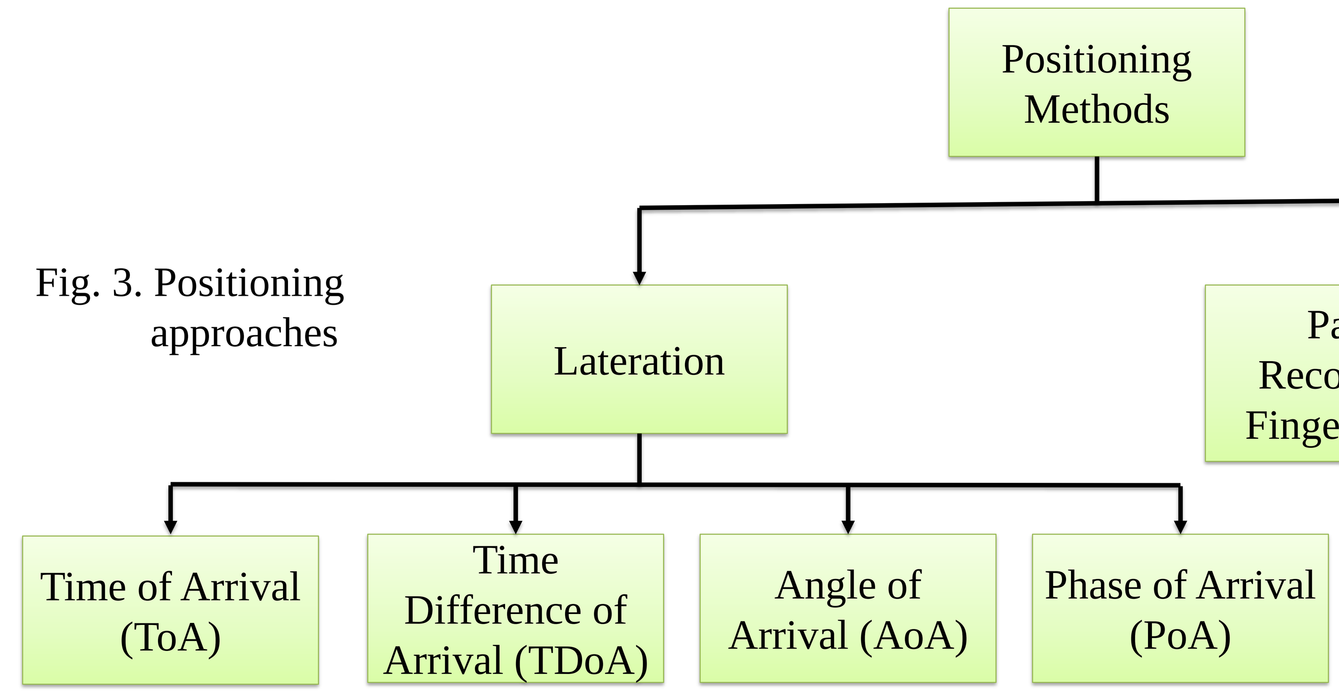

Fig. 3. Positioning approaches

Architecture of the Fingerprinting method

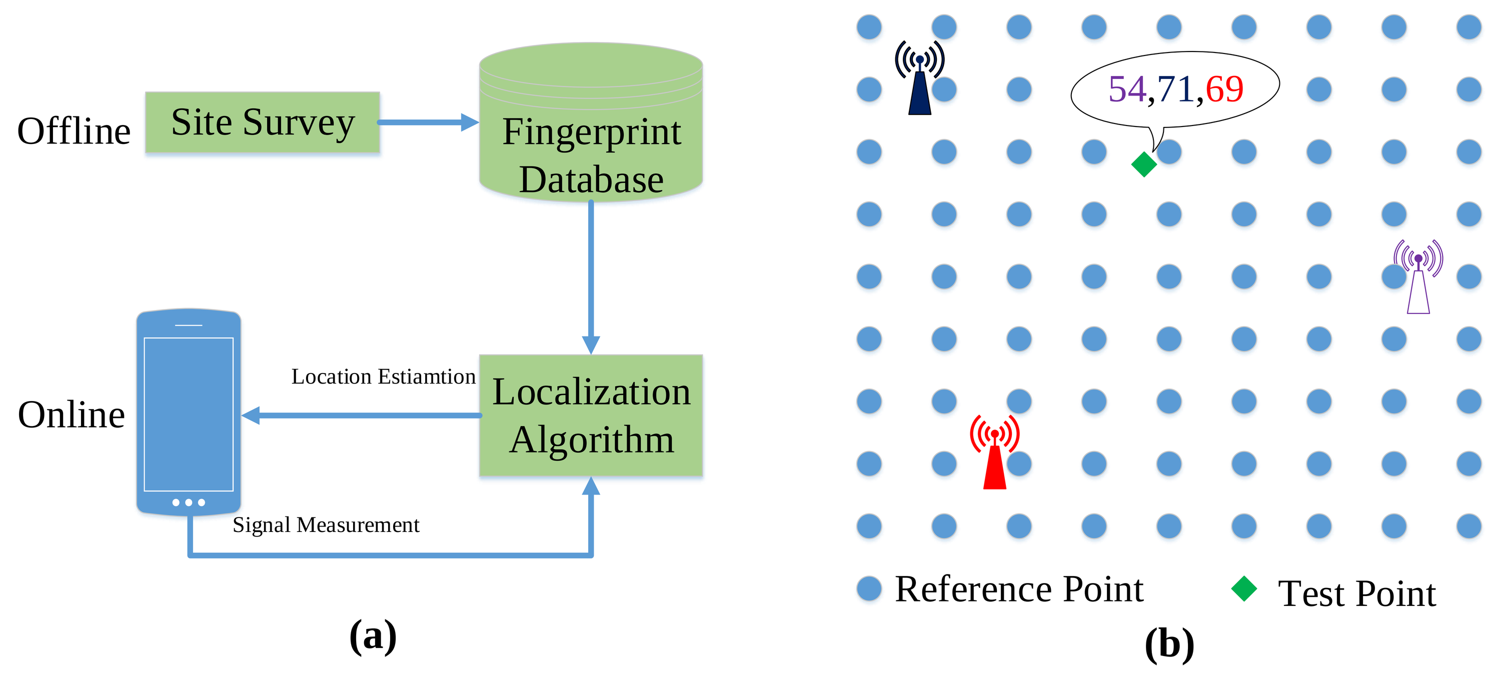

Fig. 4. (a) IPS Architecture and (b) site map in a Wi-Fi indoor localization system.

1. The Offline phase
   - The recording of RSS was taken with four different orientations (45 °, 135 °, 225 °, and 315°). to prevent the body-blocking effects.
   - Ten scans were taken in the same place with a delay of 10 seconds
2. The online phase
   - the RSS a mobile device will be compared to predefined fingerprints to determine its location using the developed system.

PNN - Jensen-Bregman Divergence formulation

1. Most of the prior work are ignoring the multimodal signal of the WLAN .
2. **Jensen-Bregman divergence (JSD)** seems very attractive to deal with this variation because JSD measures encapsulate both the geometric (squared) Euclidean distance and the information-theoretic relative entropy.

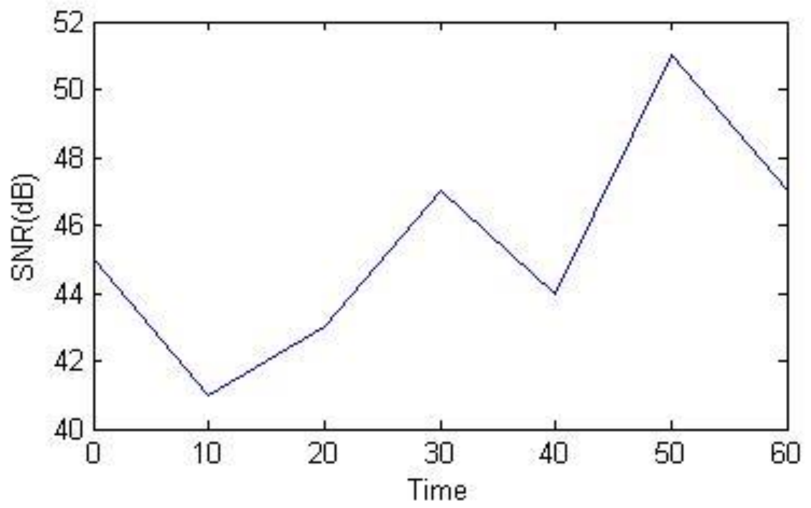

Fig. 5. Signal-to-Noise Ratio (SNR) of the RSSI Variation Distribution over time

Analysis of PNN-JBD implementation and discuss results

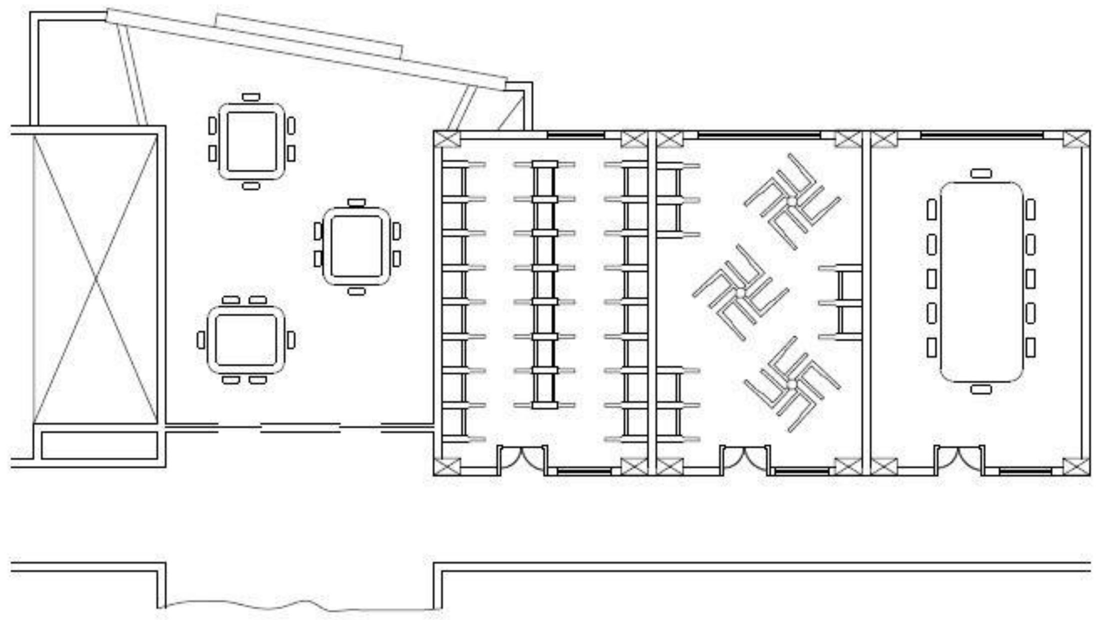

Fig. 6. Tracking results on the 2D layout for the first floor of the College of Engineering and Applied Sciences at WMU

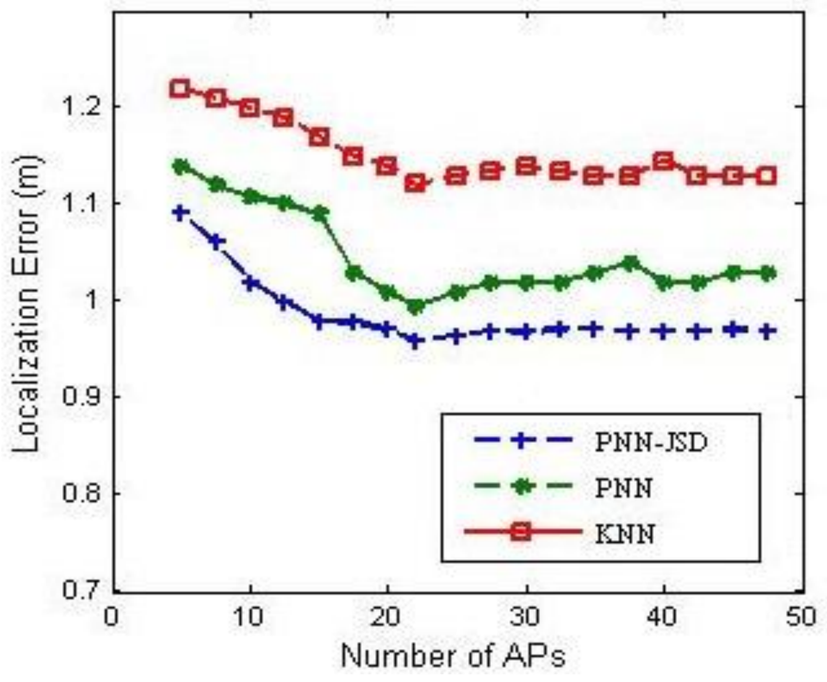

Fig. 7. Comparison of the localization accuracy with respect to APs with 80 NN

TABLE I. POSITION ERROR STATISTICS

Technique	Median (m)	Accuracy 90% (m)
kNN	1.8	3.7
Kernel-based	1.6	3.6
CS-based	1.5	2.7
PNN-JSD	**0.89**	**1.93**

Summary and Conclusion

1. This result is adequate for an indoor environment under normal conditions. The PNN-JBD method results have higher accuracy than PNN and both produced slightly better accuracy than the kNN stand-alone method.
2. We are in the process of investigating position prediction error distributions and in need to quantify the localization variation of the WiFi signal distribution in space.

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