DeepPositioning: Intelligent Fusion of Pervasive Magnetic Field and WiFi Fingerprinting for Smartphone Indoor Localization via Deep Learning

Introduction

Indoor localization

Example: Guoguo system (use the acoustic signal, accuracy is about 6-25cm).

No widely accepted solutions that can achieve the desired **accuracy** at an acceptable **cost**.

Why Wi-Fi ?

- Low complexity
- Real-time online process

CSI (Channel State Information): provide more information of the channel.
need specific WiFi network interface cards

Why Magnetic Field?

- Static
- Have sufficient local variability

Disadvantage:
- The values of magnetic field are different between two phone.

WiFi & Magnetic Field

Example: Magicol system designed a two-pass bidirectional particle filtering process.

DeepPosition: use deep learning method

traditional solutions: filtering, manual data analysis, time-consuming parameter tuning

RSS measurements

- a smartphone
- performed in a room, 13.4m×6.4m
- selected 120 reference locations
- The average distance between adjacent reference points is 0.6 m in both X and Y axis
- 120-130 fingerprint samples at each RP and the measurement lasts for 5 minutes
- RSSI data collected from 242 different APs with unknown locations are used
- lack of signal strength measurement is set to -110 dBm

Magnetic measurements

- convert to coordinates with respect to the world coordinate system
- chose the two values of y and z coordinates as part of fingerprint sample
- The fingerprinting consist of signal strengths from 242 APs, and y and z magnetic values in fixed world basis

Dataset

- DS1- the training set includes all of 120 RPs and testing set includes 20 extra positions that were randomly selected
- DS2- 120 RPs are divided into 88 training positions and 32 test positions

TABLE I. TWO DIFFERENT DATASETS

Dataset	Training Set	Testing Set
DS-1	120	20
DS-2	88	32

Effect of the Different Deep Neural Networks

TABLE III. MEAN ABSOLUTE ERROR FOR DIFFERENT DNNS WITH DS-1

DNN		Mean Error (m)	Std. Dev. (m)
4- reg	X	1.1035	1.0484
	Y	0.7487	0.6483
	Dis.	1.4551	1.0866
4-aut-reg	X	1.3455	0.9540
	Y	0.8670	0.6480
	Dis.	1.7270	0.9537
4- cls	X	1.2040	1.1588
	Y	1.1165	0.8701
	Dis.	1.8846	1.1153
3-reg	X	1.1857	0.9282
	Y	1.2192	0.7850
	Dis.	1.9442	0.9185

Effect of the Training Grid Size

TABLE IV. MEAN ABSOLUTE ERROR FOR DEEPPOSITIONING WITH TWO DIFFERENT DATASETS.

		DS-1		DS-2	
		Mean error (m)	***Std. dev. (m)***	***Mean error (m)***	***Std. dev. (m)***
4-reg	X	1.1035	1.0484	1.3816	1.1969
	Y	0.7487	0.6483	0.7925	0.6532
	Dis.	1.4551	1.0866	1.7172	1.2030
4-aut-reg	X	1.3455	0.9540	1.2483	1.1338
	Y	0.8670	0.6480	1.0653	0.8384
	Dis.	1.7270	0.9537	1.9977	1.0546

Effect of the Fusion of Magnetic Field and WiFi

TABLE V. MEAN ABSOLUTE ERROR FOR DEEPPOSITIONING AND WIFI-ONLY

		Mean Error (m)	**Std. Dev. (m)**
DeepPositioning (DS-1)	X	1.1035	1.0484
	Y	0.7487	0.6483
	Dis.	1.4551	1.0866
wifi-only (DS-1)	X	1.6566	1.1139
	Y	1.0186	0.6923
	Dis.	2.1742	0.9271
wifi-only (DS-2)	X	1.8838	1.2800
	Y	1.1687	0.8101
	Dis.	2.3878	1.2279

Advantages

		Mean Error (m)	Std. Dev. (m)
DeepPositioning (DS-1)	X	1.1035	1.0484
	Y	0.7487	0.6483
	Dis.	1.4551	1.0866
wifi-only (DS-1)	X	1.6566	1.1139
	Y	1.0186	0.6923
	Dis.	2.1742	0.9271
wifi-only (DS-2)	X	1.8838	1.2800
	Y	1.1687	0.8101
	Dis.	2.3878	1.2279

DeepPositioning proposed in this paper achieves a 30% improvement over the WIFI-only case.

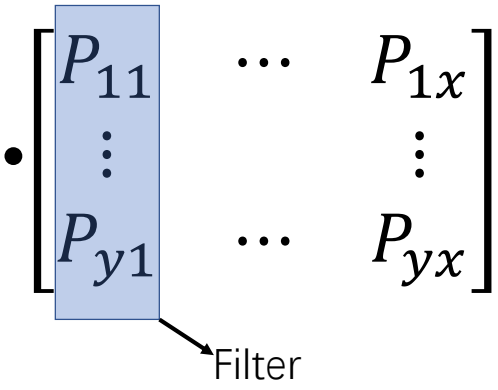
Drawbacks

- 1. Only use one phone to collect data
- 2. Depends on the number of Aps, RPs, and labeled samples in training dagtasets.

What we did in last week

- Solving the main problem: The dataset to use CNN
- Some ideas:
- 1. One channel for RSSI, one channel for Geo-magnetic
  Each row for each place.
- 2. Filtering a series of RSSI that affect most, concatenate to position.
- 3. Collect RSSI at one position in different orientations, in order to improve the accuracy using magnetic.

Future Plan



24/07 to 31/07

1. Test with UJIIndoor dataset
2. Collect our own data (*)
3. Start constructing CNN neural network for RSSI

01/08 to 07/08

1. Trying to construct CNN neural network for magnetic field.
2. Must collect data.
3. If CNN cannot work until this week, we will change to use DNN.