MagSerea: Fingerprinting Magnetic Field of Specified Area with Wearable Sensor

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Scan the QR code to view the demo :

Overview

MagSerea ▶ A method for stable position identification using triaxial magnetic data acquired during door opening and closing . The proposed method demonstrated high accuracy even under conditions such as the passage of time, changes in the user's belongings, and location fingerprinting evaluations by different users, confirming its effectiveness in real-world environments.

Research Background

- Advances in wireless communication and smartphones have boosted demand for location-based services.
  ⇨Indoors it is difficult to receive GPS signals, making accurate positioning challenging.
- A method for creating **location fingerprints** using magnetic data has been proposed for indoor positioning.
  ⇨ Low accuracy in positioning and limited convenience.

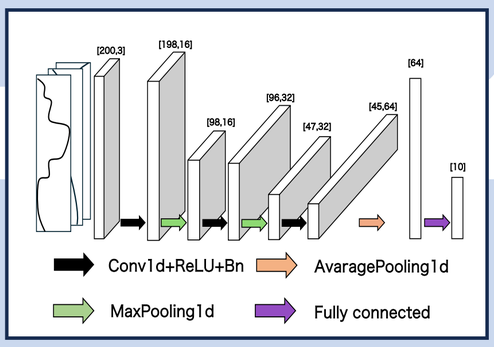
▶MagSerea

This method focuses on the everyday action of door opening and closing, proposing a simple and consistent way to identify locations.

Proposed Method

Location fingerprints are created using triaxial magnetic data and angular velocity data obtained during the actions of "lowering the doorknob," "pushing the door," and "raising the doorknob" while opening and closing the door.

Experiment



Machine Learning Model

- 1D-CNN extracts location features from location fingerprints.
- 3 CNN layers equip with ReLU activation functions and pooling layers.
- ArcFace distance learning metric reduces feature distances within each class.
- In the final layer, a 64-dimensional vector is extracted as a feature vector, and the similarity score is calculated.

EVALUATION

1. **Robustness against time lapse**: Evaluating the robustness of the proposed method over time.
2. **Robustness against changes in personal belongings**: Evaluating the impact of changes in the user's belongings.
   - **Case 0**: Smartphone in pocket
   - **Case 1**: Wireless earphones in pocket
   - **Case 2**: Wireless earphones worn in the ear
   - **Case 3**: Carrying a PC on the opposite arm
3. **Practicality with different users**: Evaluating the practicality when four different users record and verify location fingerprints.

Result

1. Robustness against time lapse :

Session	EER (%)	AUC (%)	F1 (%)
Session 1	0.075	99.9	99.9
Session 2	1.92	99.9	99.6
Session 3	2.39	99.6	97.6

2. Robustness against changes in personal belongings:

Case	Accuracy(%)
Case 0	100.00
Case 1	97.25
Case 2	100.00
Case 3	100.00

✓ Experimental results achieved high acuuracy, demonstrating the potential of the proposed method in real-world environments.

✓ Future research will evaluate spoofing resistance and enhance automatic detection of daily door-opening actions to create a more practical system.

3. Practicality with different users:

User	Accuracy(%)
User 0	100.00
User 1	58.50
User 2	100.00
User 3	54.00