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[Poster Presentation]
Spectrum Database Aided Prior Vacant Frequency Band Detection for Spectrum Sharing

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Abstract Frequency sharing allows multiple users, i.e., a primary user (PU) and secondary users (SUs), to share the same frequency band while protecting the communication quality of the PU. Therefore, when an SU shares the same frequency band as the PU, it is necessary to protect the PU's communication temporally and spatially. In general, the protected area is constructed to guarantee the PU's transmission, by disabling frequency sharing within this area. However, this area is generally set to be wider than necessary, and the area that can be shared is limited. In addition, if the SU detects communication from the PU during frequency sharing, the SU must immediately switch to another frequency band to protect the PU communication. With existing technology, the presence or absence of PU communication is judged instantaneously, so the SU temporarily stops transmission at the moment of switching to another frequency band. A spectrum database (SD) stores measured values such as received signal strength (RSS) of the PU has been considered to be a solution for spectrum sharing. In this research, we develop an algorithm that uses the information stored in the SD to detect the vacant frequency in advance by taking into account the moving direction of SU.

Keywords Spectrum Sharing, Spectrum Database

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Background

- **Frequency Sharing**: The solution for frequency resource depletion problem
  - Multiple users, i.e., a primary user (PU) and secondary users (SUs), are allowed to use the same frequency band
  - PU has a protection area
    - SU communication within the PU protection area is prohibited
  - Frequency allocation for SUs is done by protecting the PU's communication quality
    - Frequency allocation of SU is in **instant** judgment ➡ Problem: blocking of SU communication

Proposed Method

- Detect vacant frequencies in **advance** using **Spectrum Database (SD)**
  - SD: accumulate radio information (RSSI etc.) of each mesh
  - The communication area is split into multiple disjoint meshes
  1) Aggregate information from sensors into SD (information 1)
  2) SU sends current time information (information 2) and requests acquisition of destination time information to SD
     - SU is using f_2
  3) Perform the proposed algorithm using information 1 and 2
  4) SU frequency switching control is performed based on the calculation result
     - SU is using f_1

  ➡ Possible to avoid interruption of SU communication

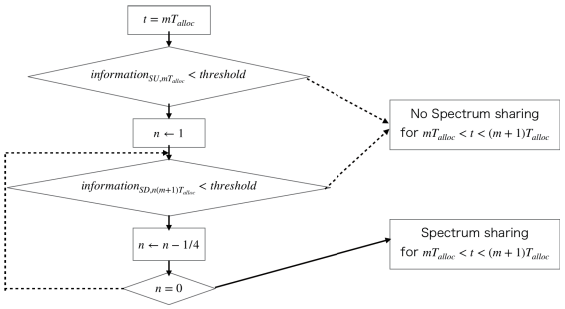


Fig.1: Proposed Algorithm

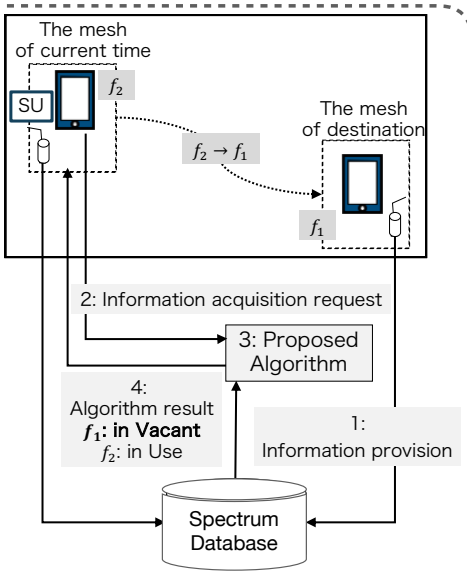


Fig.2: Overview of proposed method

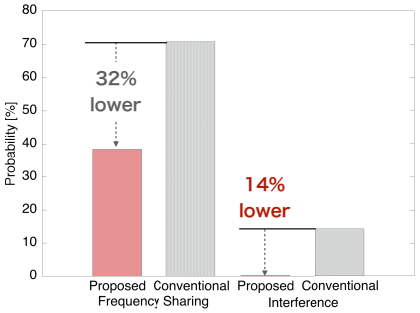
Numerical Simulation

- Chanel model: Pathloss + Spatially correlated shadowing [1] + Rayleigh fading
- Sensor placement: center of each mesh
- SU moving route: ideally grasp
- PU communication interval: follow the exponential distribution of mean interval $t_{ave,p}$
- Interference judgment: When the SU is shared at the RSS point above the threshold

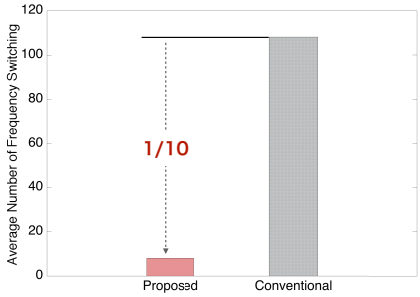
Table1. Simulation parameters

System model	Simulation Area	1×1 km²
	No. of meshes	10000
	Pathloss Model	128.1＋37.6log(distance)
	Shadowing deviation	6 dB
	No. of trials	100
SU	Moving speed	4 km/h
	Moving time	30 min
	Frequency Allocation t_{alloc}	5.0 sec
PU	Position	(1, 0.5) km
	Mean interval $t_{ave,p}$	0.5 sec
	Transmit power	40.0 dBm
	Threshold	-40 dBm

- Result
  - Conventional method: control with only current time information without using SD information
  - Frequency sharing rate is lower compared to the conventional method
    - The proposed algorithm is designed to protect PU communication
  - The proposed method can reduce the interfering rate by 14% and reduce the number of frequency switching to about 1/10 compared to the conventional method



(a) Frequency Sharing and Interfering probability



(b) Number of frequency switching

Fig.3: .Performance

Conclusion

- The algorithm to detect vacant frequency bands in advance using SD was proposed
  - Interference probability decreased by 14% and number of frequency switching decreased by 7.5% compared to algorithm using only information of current time

Reference

[1] H. Claussen, "Efficient Modelling of Channel Maps with Correlated Shadow Fading in Mobile Radio Systems", *in Proc. IEEE PIMRC*, Sep. 2005

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