Spectrum Management System for Emergency Radio in Disaster Scenario (Implementation)

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Introduction

- ❑ Earthquake may damage any infrastructure in the disaster area
- ❑ Intensity of the damage depends on the magnitude and duration of the earthquake
- ❑ It also depends on the type of constructions of the area under the disaster
- ❑ Prediction beforehand is very difficult

Developed System

- ❑ Implemented a cooperative spectrum sensing system using USRP and GNU radio
- ❑ Integrated the automatic modulation recognition system with the sensing system
- ❑ Implemented the identification and database maintenance system using the PHP and MySQL.
- ❑ A web interface displays active emitter information
- ❑ Raytracing simulation results for disaster environment in Ookayama, Tokyo area using “Wireless Insite” from “Remcom”
- ❑ AOA based geolocation simulation results with multipath effect reduction

Approach

- ❑ Raytracing simulator “Wireless Insite” by Remcom is used to simulate the disaster channel
- ❑ 3D data of Ookayama, Tokyo, area in DXF format was imported to create .city file (a 3D city)
- ❑ To create destroyed area
  - o Some houses were removed randomly (completely destroyed house)
  - o Height of some houses were decreased randomly (collapse of floor)
  - o Some houses were tilted randomly
  - o Faces of some houses were removed
- ❑ AOA of each path is used to calculate the geolocation error for the area

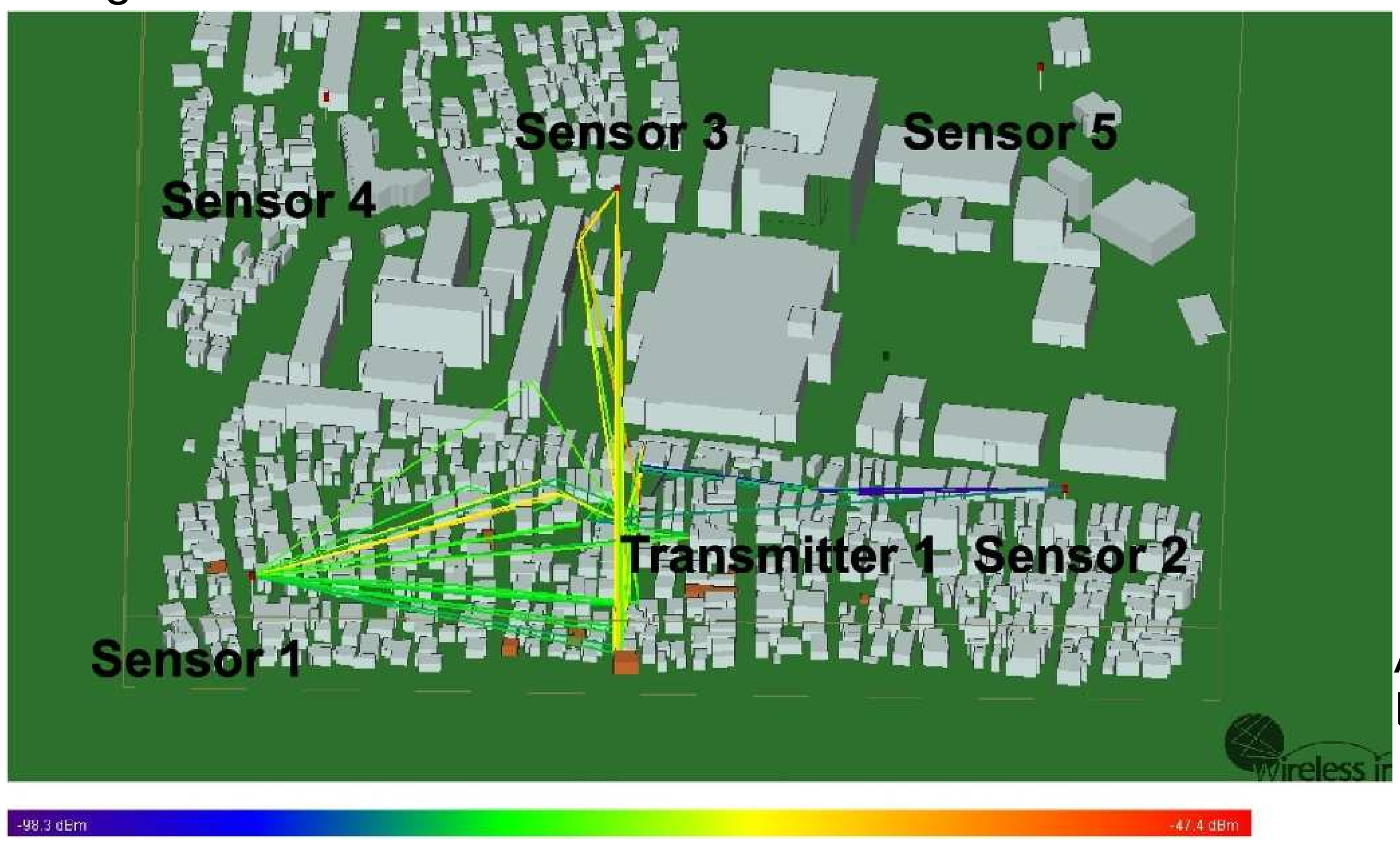


Fig. 1: Propagation paths from Tx. 1

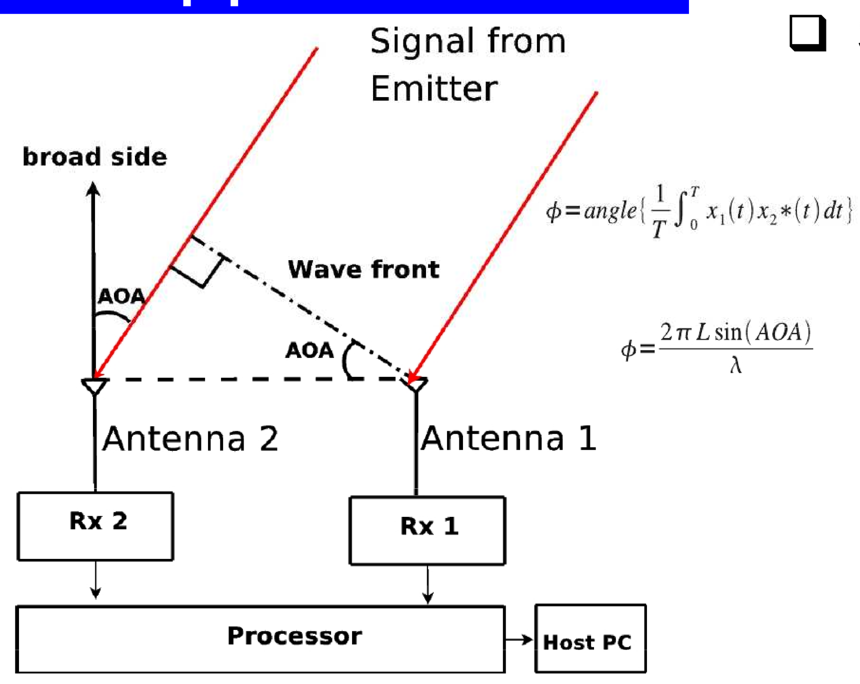


Fig. 2 : AOA based Interferometry

Table 1 : Channel model parameters

Antenna Type	Omnidirectional
Polarization	Vertical
Gain(dBi)	3
VSWR	1
Receiver Threshold (dBm)	−98
Transmitter height(m)	1.5
Sensor height(m)	15

Pulse Shape	Sinusoidal
Pulse Width	$1\mu s$
Carrier Frequency	800 MHz
Bandwidth	25 kHz

Assumptions

- ❑ Foliage, Objects like electric poles and vehicles and human movements are not considered
- ❑ Terrain is assumed to be flat

- ❑ DC spike on the center frequency of the USRP should be compensated
- ❑ Sensing time increases

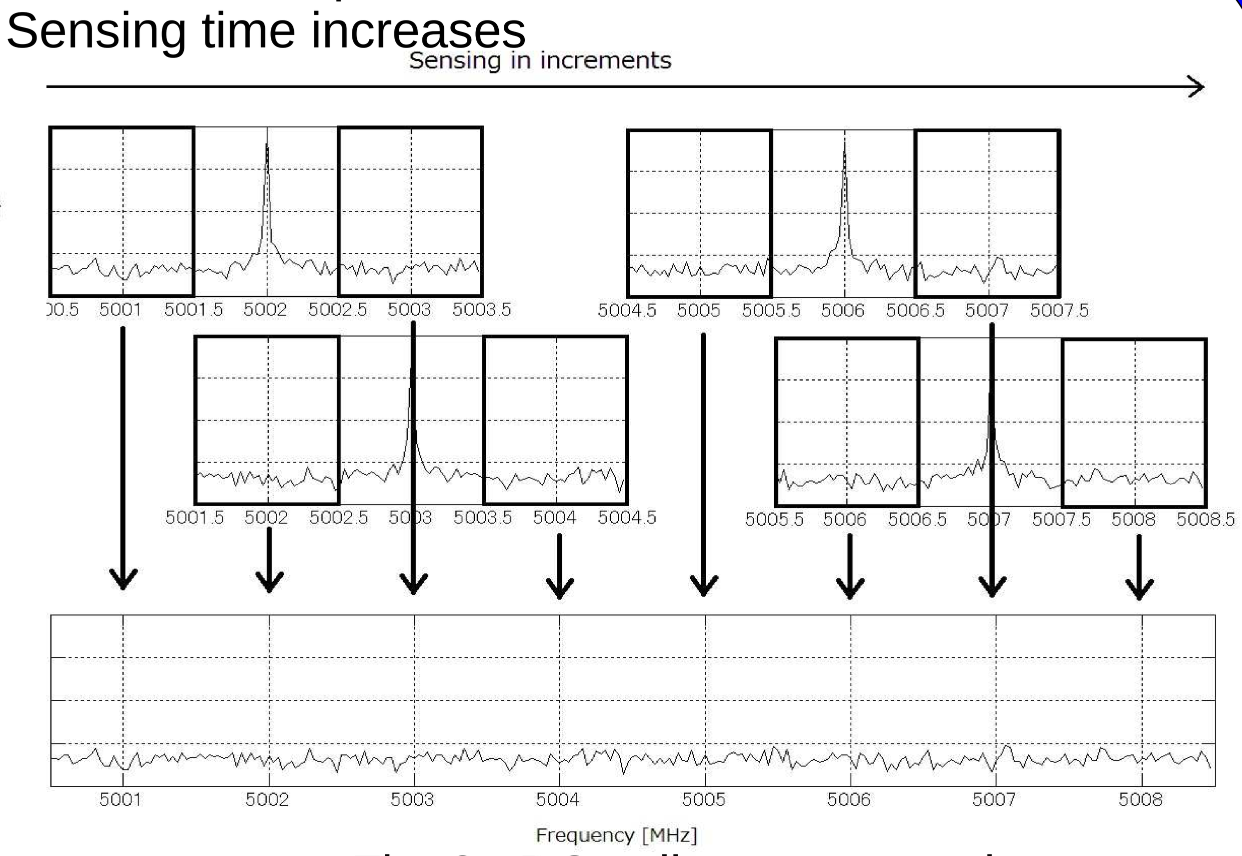


Fig. 3 : DC spike compensation

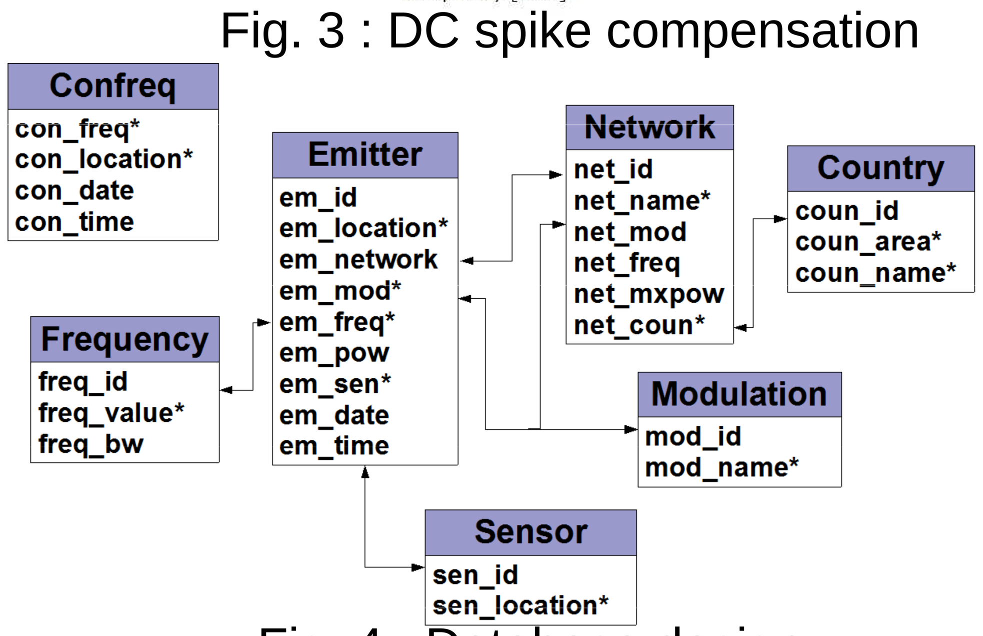
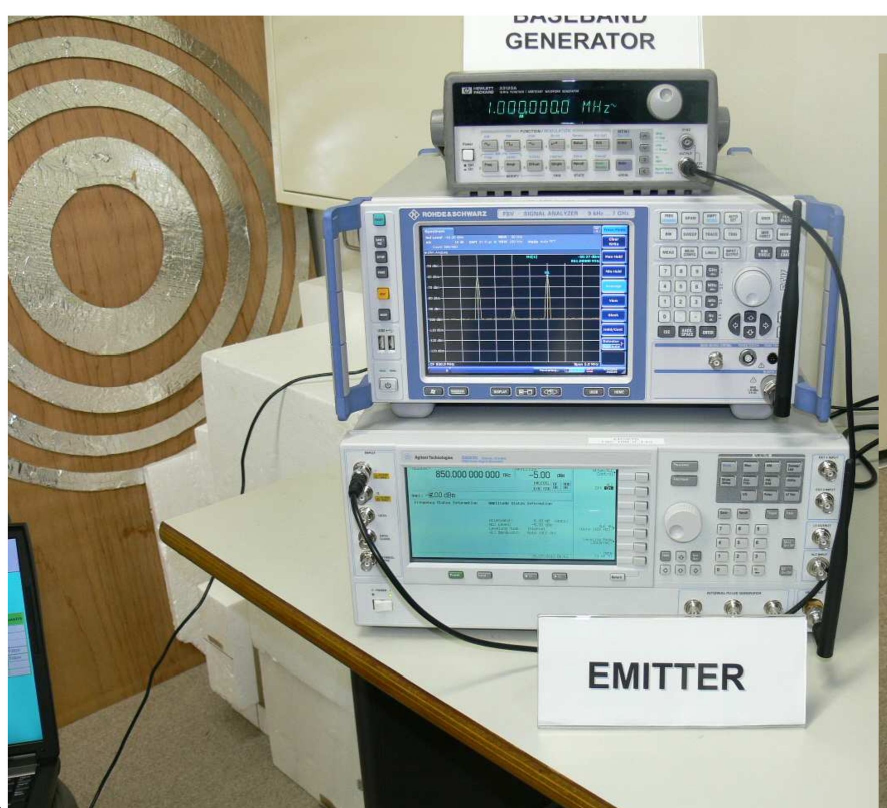
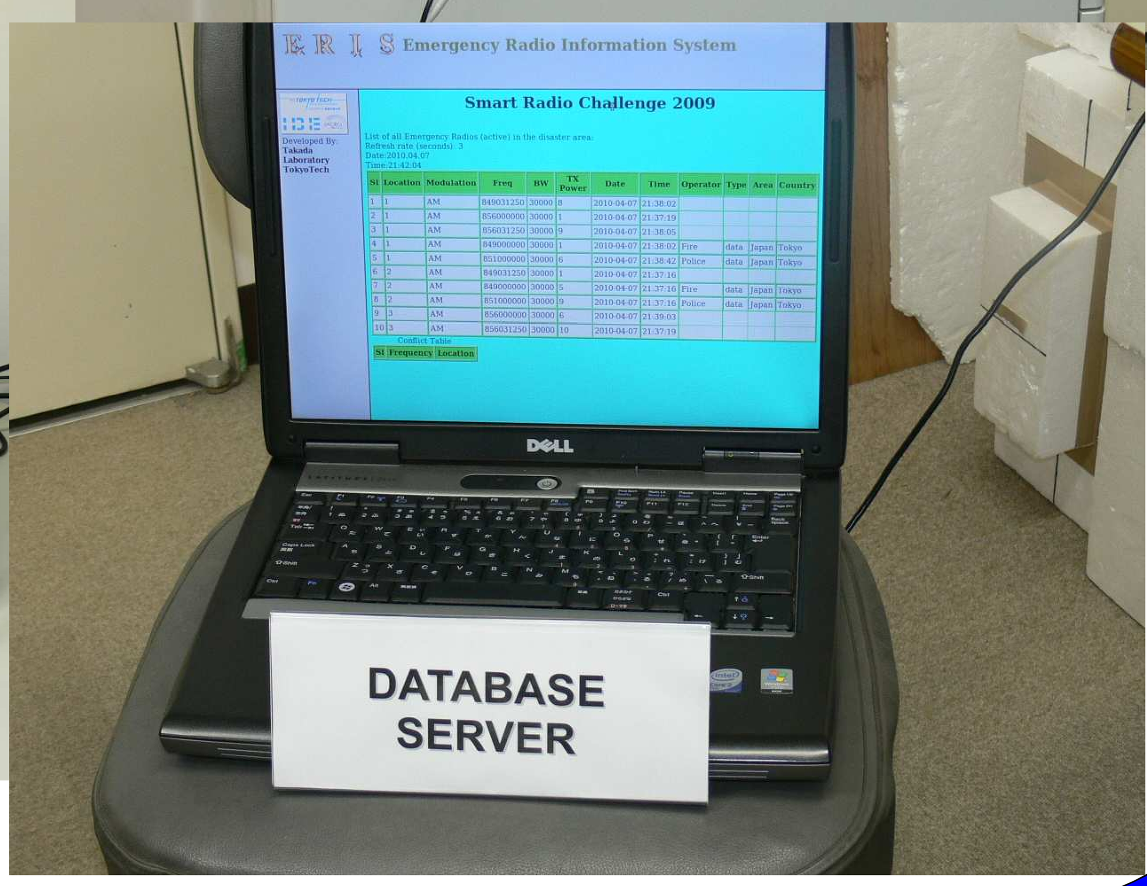


Fig. 4 : Database design

Demonstration

Head node sends sensing time to sensor nodes
↓
Sensor nodes scan the spectrum simultaneously
↓
Sensor nodes send FFT data to head node
↓
Head node checks for FFT bins above threshold
↓
For each of those FFT bins, head node chooses the sensor node with highest SNR
↓
Head node sends command to sensor nodes
↓
Sensor nodes send time domain samples to head node
↓
Head node determines modulation type etc.
↓
Head node sends text file to database





Conclusion

- ❑ Raytracing simulation is used as a preliminary study for the disaster scenario
- ❑ Positioning of the sensor nodes has some significant impact on the sensing performance
- ❑ Geolocation calculation is limited by the accuracy of the AOA and antenna synchronization
- ❑ The system can not track a specific emitter in the disaster area
- ❑ Geolocation calculation is not yet implemented in the demonstration

Future Studies

- ❑ Raytracing simulation with scatterers (e.g. vehicles, human etc.)
- ❑ Incorporate the real terrain profile of the disaster area and study the effect of terrain on propagation
- ❑ Perform cooperative sensing simulation
- ❑ Finding a way to dissipate the sensed data toward the emergency emitters
- ❑ Improvement of the identification algorithm to identify a specific emitter
- ❑ Optimize the performance of each subsystem

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