Measurements on Overreach Propagation of TV and FM waves from Korea to Japan

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***Abstract* - In this study, we measured terrestrial TV waves and FM waves from Korea to Japan to investigate overreach interference in digital TV waves. In order to evaluate co-channel interference in the TV waves, we proposed a measurement method that monitored both RSSI (Received Signal Strength Indicator) and CNR (Carrier to Noise power Ratio) of the digital TV waves and RSSI of FM broadcasting waves from several cities at the same time. Based on measurements of TV and FM waves, this study clarified that our proposed method was effective to evaluate the interference from Korea.**

***Index Terms* — Terrestrial Digital Broadcasting, Overreach Propagation, FM Broadcasting, RSSI, CNR**

I. INTRODUCTION

In digital terrestrial TV broadcastings, the same frequency band has been used in both Japan and Korea. Therefore it is important to investigate overreach characteristics of TV waves to keep a reception quality of TV services. In Kyushu and Chugoku region, western Japan, there reportedly exists some co-channel interference of TV waves from Korea[1]. To detect the overreach interference in TV waves, other group developed the device that can analyze an ID of interference TV waves from the received signals[2]. However, the broadcasting scheme in Korea is ATSC (Advanced Television Systems Committee standards) that is different from the scheme in Japan ISDB-T (Integrated Services Digital Broadcasting-Terrestrial)[3]. Therefore the overreach propagation superimposes the TV waves from Korea on Japanese TV waves as broadband noises. In this case, we cannot analyze the ID and identify a source of interference from Korea.

In order to evaluate co-channel interference in digital TV waves, the authors have proposed a measurement method that monitors both RSSI (Received Signal Strength Indicator) and CNR (Carrier to Noise power Ratio) of the digital TV waves and RSSI of FM broadcasting waves from several cities at the same time[4]. The proposed method is based on our previous measurement results that there are high correlation in non-LOS (Line-Of-Sight) propagations between VHF band FM waves and UHF band TV waves. So the proposed method has a possibility to identify the source of interference TV waves from Korea.

In this study, we have applied the proposed measurement method to evaluate the overreach propagation and interference of TV waves from Korea. This study shows the measurement results obtained at Kyushu Institute of Technology (KIT) from September 2013 to April 2014. The measurement targets are TV waves from Shimonoseki, Japan and from Busan, Korea, and FM waves from Busan, Changwon, Pohang, and Ulsan, Korea. The measurement results show that the overreach interference is due to duct propagation. And this study clarifies that our proposed method can evaluate the interference in the digital TV from Korea based on the measurement of TV and FM waves.

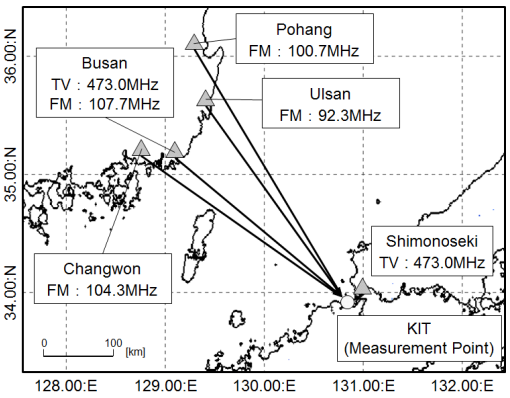


Fig. 1 Locations of transmitters and a measurement point

Table 1 Specifications of transmitters (TV/FM stations)

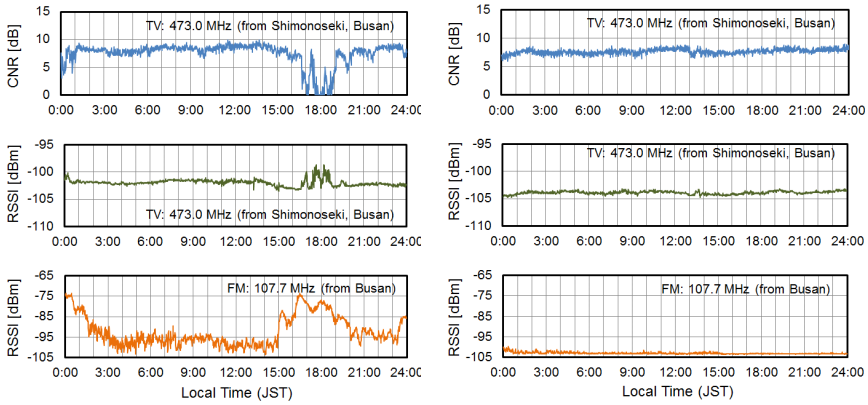
	Measurement Freq.	Station	Power
TV	473 MHz	Shimonoseki	100 W
		Busan	2.5 kW
FM	107.7 MHz	Busan	3 kW
	104.3 MHz	Changwon	3 kW
	100.7 MHz	Pohang	3 kW
	92.3 MHz	Ulsan	3 kW

Table 2 Specifications of a measurement system

	UHF-TV RSSI	VHF-FM RSSI	UHF-TV CNR
Measurement Limitation	-110 dBm	- 120 dBm	-105 dBm
Sampling Interval	2 sec		1 sec
Receiving Antenna	Monopole (from VHF to UHF)		

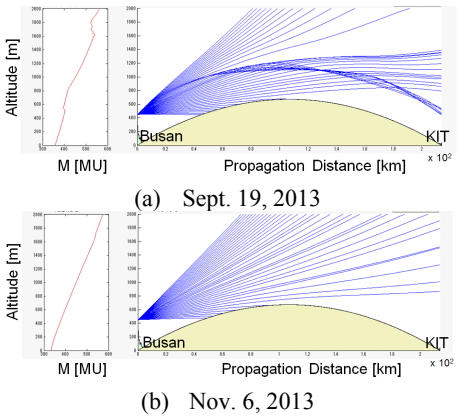
II. MEASUREMENT ON INTERFERENCE FROM KOREA

Fig.1 shows locations of transmitters of TV and FM waves and our measurement point (KIT). Propagation distances from these four cities in Korea are over 200 km. There are not LOS paths between transmitters and the measurement point because of the Earth bulge.



(a) Sept. 19, 2013 (b) Nov. 6, 2013

Fig. 2 Typical examples on one-day fluctuation of CNR and RSSI



(a) Sept. 19, 2013

(b) Nov. 6, 2013

Fig. 3 Ray-tracing simulation results

Main specifications of the transmitters (TV and FM stations) and the measurement system are shown in Table 1 and 2. Shimonoseki and Busan station transmit the same-channel TV waves in 473 MHz band. Channels of the FM waves in Korea shown in Table 1 are not assigned in Japan. In KIT, these TV waves and FM waves are received with a monopole antenna. Using broadband receivers and digital TV tuners, RSSI of TV and FM waves and CNR of TV waves are recorded in the PC. And we can remotely control the PC and transfer recorded RSSI and CNR data from KIT to our university through the Internet and a communication network.

III. Measurement Results

From over 8-month measurement results, we confirmed that the overreach propagation frequently occurred in fall and spring seasons, and that the RSSI level of FM waves from Busan was largest of all measured FM waves when overreach occurred. Therefore, focusing on radio waves from Busan, this section shows the typical results on one-day fluctuations of CNR and RSSI of TV waves and RSSI of FM waves. Fig. 2 shows typical example of one-day fluctuation of CNR and RSSI on (a) Sep. 19, 2013 and (b) Nov. 6, 2013. As shown in Fig. 2(a), the RSSI of FM waves increased around 18:00 JST, and then the CNR of TV waves decreased from 8 dB to 0 dB and the RSSI of TV waves increased 2 dB or 3 dB. From these results we could confirm that the overreach propagation occurred in both FM and TV waves from Korea and the receiving quality of TV waves from Shimonoseki decreased. On the other hand, as shown in Fig. 2(b), there were no overreach propagations on this day, because the RSSI of FM waves from Busan were stable all day. In this case, the CNR of TV waves did not decrease. These results indicated that the source of the interference was identified by monitoring RSSI of overreach FM waves.

Fig. 3 shows simulation results of ray-tracing method on (a) Sep. 19, 2013 and (b) Nov. 6, 2013. In these results, M profiles (height patterns of modified atmospheric refractivity M) were calculated from aerological data published in Fukuoka Aerological Observatory[5]. As shown in Fig. 3(a), there existed atmospheric duct propagations that caused overreach interference. On the other hand, as shown in Fig. 3(b), propagation rays were almost straight because of standard atmosphere with k = 4/3, where k is the effective Earth radius factor. From these ray-tracing simulation results, we confirmed that main reason of the overreach interference from Korea was atmospheric duct propagation.

IV. Conclusion

It was concluded that the source of the interference of TV waves from Korea was identified by our proposed method measuring RSSI and CNR of TV waves and RSSI of FM waves from several cities at the same time. In the future, we will continue the measurements and increase measurement points in order to evaluate the interference of TV waves in detail.

Acknowledgment

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