12th Multidisciplinary International Student Workshop (MISW2021)
August 5-6, 2021, Tokyo Institute of Technology, Tokyo, Japan

Extended Abstract

Outdoor mmWave Band Tx Localization Using Scattering Path under Spectrum Sharing Scenario

Chi Weiqi*, N. Keerativoranan* and Jun-ichi Takada*

* Department of Transdisciplinary Science and Engineering
School of Environment and Society,
Tokyo Institute of Technology
email: weiqi.c.aa@m.titech.ac.jp

I. Introduction

Spectrum resources are artificially scarce because the static legacy regulatory prevents the spectrum to be shared more intensively. To solve this problem, we can adopt the spectrum sharing technology spatially and temporally to optimize congested wireless channels as shown in Fig 1. In this work, the authors are focusing on the spatial spectrum sharing.

The targeted frequency band is the millimeter wave (mmWave) band of Fixed Wireless Access (FWA) using in Japan. FWA is a way of providing wireless connectivity through radio links between two fixed stations. Though FWA is fixed, there are also a portable transmitters operating as a temporary station which may not be registered in the spectrum sharing database in advance. Hence, identifying the location of unregistered portable transmitters is necessary for carrying out the spatial spectrum sharing.

In mmWave band, the propagation characteristic is highly directive. In an urban area, mmWave can be easily blocked by buildings. Hence, localization based on an empirical model may not be applicable due to a very site-specific propagation characteristic. Instead, the assist of an environment map is needed for the localization analysis in such scenario. The angular information of line-of-sight (LOS) and non line-of-sight (NLOS) propagation paths obtained from different positions can be applied to localize the transmitter (Tx). However, LOS is unlikely guaranteed in the urban environment. Thus, the authors are interested in utilizing the NLOS paths, such as scattering paths along the street and street corners, as depicted in Fig 1., to improve the localization performance in the NLOS scenario.

II. NLOS Detection Problem

The received signal obtained at different spatial snapshots may or may not contain LoS paths depending on the environment. Since the Tx localization model and assumption based on information of each path type are totally different, the task to distinguish between LOS and NLOS is non-trivial prior to localizing the Tx. LOS and NLOS path presents the salient difference in many aspects such as: (i) NLOS signals are considerably more attenuated [1] due to reflection from surrounding objects, resulting in relatively smaller received power. (ii) NLoS power has a large angular spread due to the diffuse scattering paths and vice versa to the LoS path due to the direct path.

The aforementioned properties criteria for distinguishing NLOS and LOS paths can be formulated.

III. Localization Methods for Spectrum Sharing

MLE is one of the widely-used localization algorithms that utilize the angular power spectrum obtained from the spatially separated receiver [2]. However, previous works utilized MLE only for estimating Tx location which is not sufficient for spatial spectrum sharing. Additional Tx parameters such as the unknown peak direction and beamwidth should also be estimated. To achieve a better estimation in both Tx localization and parameters, the localization model must be modified such that it accounts for the environment map in addition to received power and direction. Moreover, this methodology is able to provide visualization and physical interpretation of transmitted signals.

References

[1] S. Maranò, W. M. Gifford, H. Wymeersch, and M. Z. Win, "Nlos identification and mitigation for localization based on uwb experimental data," *IEEE Journal on Selected Areas in Communications*, vol. 28, no. 7, pp. 1026–1035, 2010.

[2] K. Doğançay and G. Ibal, "3d passive localization in the presence of large bearing noise," in *2005 13th European Signal Processing Conference*, 2005, pp. 1–4.

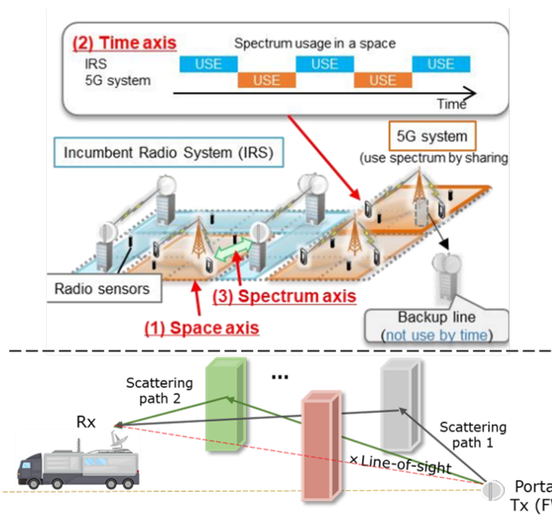

Figure 1: Spectrum sharing concept (above) and NLOS localization concept (below)