

A Handover Decision Scheme using Reinforcement Learning in the 5G Ultra Dense Network

Abate Selamawit Chane and Seong Ho Jeong*
 Hankuk University of Foreign studies
 selamchane@hufs.ac.kr, *shjeong@hufs.ac.kr

5G 초고밀도 네트워크에서 강화학습을 활용한 핸드오버 결정 기법

셀라마윗, 정성호
 한국외국어대학교

Abstract

As 5G networks evolve and incorporate millimeter-wave (mmWave) frequencies, the dense deployment of base stations becomes increasingly prevalent. The massive deployment of small base stations (BS) in ultra-dense networks (UDNs) introduce a significant challenge in mobility management and handover procedures. The increased number of BSs lead to more frequent handovers, especially for high mobility scenarios. Frequent handovers not only increase signaling overhead but also pose a risk of degraded Quality of Service (QoS) and Quality of Experience (QoE) for users. So, this paper proposes a handover (HO) decision scheme based on deep reinforcement learning (DRL) to reduce the frequency of unnecessary handovers in UDNs. In particular, Proximal Policy Optimization (PPO) algorithm is proposed to implement the scheme. The objective of this paper is to present a HO scheme that guarantees a certain level of throughput with a minimized HO rate.

I. Introduction

In 5G and future technologies, UDNs emerge as a vital infrastructure, particularly in densely populated urban regions. As mmWaves provide larger bandwidth compared to lower frequency waves, they are commonly used in UDNs. However, with the shorter wavelength of mmWaves, signal propagation is more prone to blockage and shadowing effects, leading to an increased frequency of handovers. In order to minimize the signaling overhead caused by frequent handovers, various handover decision making schemes based on DRL has been proposed. For instance, a handover decision scheme employing double deep reinforcement learning was proposed in [1]. However, this approach requires a large set of data, as it is an offline training method.

This paper proposes an online DRL algorithm by utilizing a simulation environment to model channel characteristics, capacity, and users' mobility within a specific geographic area. Subsequently, Proximal Policy Optimization (PPO) algorithm is employed to train the model within the environment.

II. Method

In an urban UDN environment, a number of small base stations and a single macro base station are considered in this scenario.

The SINR becomes:

$$SINR = P_{Rx} - N_o BW - I$$

Where ' N_o ' is noise power spectral density, ' BW ' is the bandwidth of the system, and ' I ' is inter-cell interference. The SINR of a UE from each small BS in the area is measured and reported. Fig. 1 illustrates the architecture of the proposed scheme. The state to the RL agent 's' is:

$$s = \{Y_1, Y_2, Y_3, \dots, Y_i \dots Y_m, BS_i\}$$

' BS_i ' is the serving cell ID and Y_i is SINR from each BS. A fully connected neural network serves as a state processing unit to extract relevant features. In turn, the action space $A(s)$ comprises of all candidate target cell IDs in the area. Reward is calculated from the throughput ' \mathcal{T} ' and HO cost. HO cost considers the HO rate along with the HO interruption time.

$$r = \begin{cases} \mathcal{T} \times HO \text{ cost if HO} \\ \mathcal{T}, \text{ otherwise} \end{cases}$$

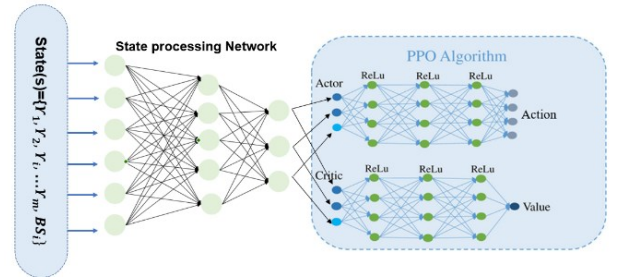


Fig. 1. DRL based Handover Management in UDN

The model underwent training within a simulated RL environment, employing the PPO algorithm.

III. Conclusion

In this paper, we presented a handover decision scheme that uses reinforcement learning in the 5G ultra dense network, which utilizes the contemporary PPO algorithm to train the HO decision making scheme. It can be used to guarantee a certain level of throughput with a minimized HO rate.

ACKNOWLEDGMENT

This work was supported by Institute of Information & communications Technology Planning & Evaluation (IITP) grant funded by the Korea government (MSIT) (No. 2021-0-00484). This research was supported by the MSIT (Ministry of Science and ICT), Korea, under the ITRC (Information Technology Research Center) support program (IITP-2023-RS-2022-00156353) supervised by the IITP (Institute for Information & Communications Technology Planning & Evaluation).

REFERENCES

- [1] M. S. Mollel, A. I. Abubakar, M. Ozturk et al., "Intelligent handover decision scheme using double deep reinforcement learning," Physical Communication, vol. 42, article 101133, 2020