심층강화학습 기반 분산 오프로딩 기법의 성능 평가

Emmanuella Adu[1], 권정은[1], 방인규[*2], 김태훈[*1]

[1]국립한밭대학교 컴퓨터공학과, [2]국립한밭대학교 지능미디어공학과

Performance Evaluation of Decentralized Offloading Scheme with Deep Reinforcement Learning

Emmanuella Adu[1], Jeongeun Kwon[1], Inkyu Bang[*2], Taehoon Kim[*1]

[1]Dept. of Computer Engineering, Hanbat National University

[2]Dept. of Intelligence Media Engineering, Hanbat National University

{ellaadu, 20211868}@edu.hanbat.ac.kr, {ikbang, thkim}@hanbat.ac.kr

Abstract

We investigate a decentralized task offloading strategy with deep reinforcement learning in this paper. We evaluate its performance with MATLAB simulations and verify its validity.

Ⅰ. Introduction

An implementation of the edge computing paradigm, the mobile edge computing (MEC) has over the years been recognized as a promising technology to reduce the burden of edge devices (EDs) when it comes to fast and real-time processing of computationally intensive applications that have been made possible by the popularity and rapid increase of Internet-of-Things (IOT) devices.

Thus, computation offloading strategies for MEC systems have been widely investigated to achieve higher energy efficiency or better computation experience such as reduced task completion latency.

However, in most of these works, the authors either consider a centralized algorithm [1] or do not consider the specific communication protocol needed for operating the MEC systems in practice, which incur extra task latency affecting the overall task completion latency of the devices [2].

* Corresponding Authors: Inkyu Bang and Taehoon Kim

Motivated by these issues, we seek to propose a decentralized task offloading strategy and evaluate its performance.

Ⅱ. Decentralized Task Offloading Strategy

We considered a single base station (BS) equipped with multiple antennas (N_r) integrated with a MEC server that provides computation services to several single antenna EDs K. We assumed that a random amount of data (α) is generated at the ED at each time slot that requires processing.

In our algorithm we look at a multiagent scenario where the number of users corresponds to the number of EDs and each agent determines the amount of data to be offloaded (β) based on the local observations of the users. We considered our states as follows;

- Observation Space – CSI_k, K
- Action Space – β_k
- Agent – rlDQN
- Reward – -1 * discount * C_m

CSI_k denotes the channel gain of each ED and C_m is the maximum of the offloading latency and local latency that denotes the latency of a generated task. Our overall operation procedure considered is summarized in Fig. 1. Where M_{max} (maximum allowable attempts) and m ensures there is connection establishment between the EDs and the BS before offloading is done.

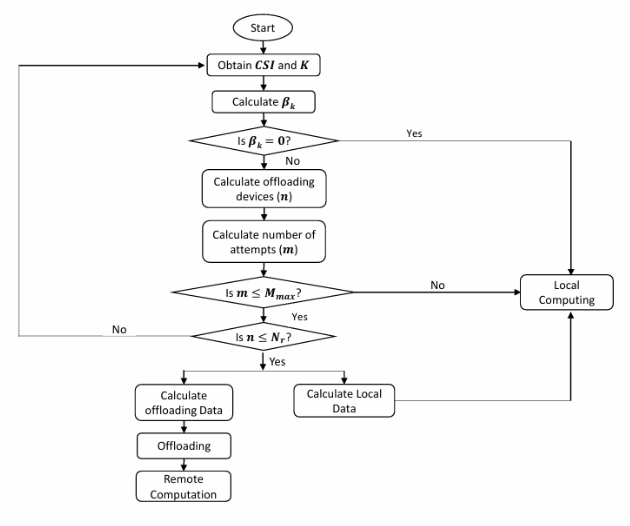

Fig. 1. Flowchart of Overall Procedure

Ⅲ. Numerical Results

We evaluate the performance of our proposed strategy based on the following parameters, K = 1~15, N_r = 4, and α = 100Mbits. In Fig. 2, we plotted a graph of the latency of the devices against the total number of devices in the system. It could be deduced that our algorithm is able to maintain a low and constant latency when the number of offloading devices (n) is less than or equal to N_r as demanded by our constraints set in Fig. 1. However, for n greater than N_r, the total latency for the devices increases and converges at 1 sec, the maximum attainable latency required when the devices undergo local computation only. Furthermore, the offloading latency also becomes equal to the reattempt latency only for values of K > N_r, since no offloading is done as the devices could not establish a connection with the BS, hence the offloading latency is only the time spent on trying to establish a connection.

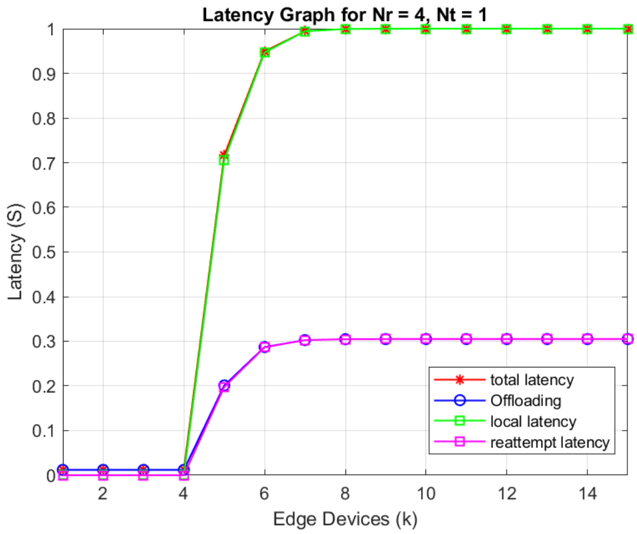

Fig. 2. Average Latency for Varying Number of EDs

IV. Conclusion

In conclusion, we proposed a decentralized task offloading decision strategy based on reinforcement learning and evaluated its performance based on our numerical results.

ACKNOWLEDGMENT

"This research was supported by the MSIT (Ministry of Science, ICT), Korea, under the National Program for Excellence in SW), supervised by the IITP (Institute of Information & communications Technology Planning & Evaluation) in 2024"(2022-0-01068)

REFERENCES

[1] T. Kim, Y. Kim, E. Adu and I. Bang, "On Offloading Decision for Mobile Edge Computing Systems Considering Access Reservation Protocol," in IEEE Access, vol. 11, pp. 40457-40468, 2023

[2] Z. Chen and X. Wang. "Decentralized computation offloading for multi-user mobile edge computing: A deep reinforcement learning approach," EURASIP Journal on Wireless Communications and Networking 2020, 188(2020)