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LOW-ORBIT COMMUNICATION SATELLITE NETWORK TRAFFIC BASED ON MACHINE LEARNING

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ABSTRACT

In the area of communication technology, satellite communication has emerged as a significant research trend. Due to their enormous coverage, high degree of flexibility, and lack of geographical restrictions, low-orbit satellites have long been the subject of intense study by academics. This article discusses certain low-orbit satellite technologies as well as the DDPG routing method, which is based on machine learning and designed for simulation trials. A result is reached after comparing the performance of this method with that of three widely utilised low-orbit satellite routing algorithms. The machine learning-based routing method has the least average delay, with an average value of 126 ms for various weights. With an average packet loss rate of 2.9%, it has the lowest rate. With an average throughput of 201.7 Mbps and a load distribution index of 0.54, it has the highest throughput and the lowest load distribution index. In conclusion, machine learning-based routing algorithms outperform conventional methods in terms of performance.

Keywords: Low-Orbit, Communication, Satellite, Network, Traffic, Based, Machine Learning..

I. INTRODUCTION

Radio, television, and multimedia communications have all progressively embraced satellite communications. On the one hand, users' demands for latency, bandwidth, and fault tolerance are starting to be met by satellite networks. Satellite-based services like telemedicine, remote communication, and global location have long been integral parts of people's everyday lives. The promotion of logistics and transportation, environmental monitoring, material discovery, navigation positioning, digital cities, and other relevant disciplines is also greatly aided by it.

Satellites offer a wide range of uses now that satellite communication technology has advanced so quickly, including gathering and processing data about space and associated resources. Additionally, one of the crucial aspects that must be taken into account while developing satellite network routing algorithms is how to lessen the stress on satellite networks in light of the emergence of non-geostationary orbit satellites and interstellar linkages. Machine learning research for routing algorithms is still in its infancy. It will astound people when it is really put to use.

II. LOW-ORBIT SATELLITE NETWORK LOAD BALANCING ROUTING ALGORITHM

This study aims to demonstrate that the machine learning-based traffic load balancing routing algorithm of the LEO communication satellite network performs better than the conventional approach. In order to make the subsequent experiments easier, we first briefly discuss the process and evaluation indicators of the balanced routing algorithm before describing the overall composition and essential technologies of several LEO satellites.

Satellite Communication System Composition

The space segment, ground segment, and user segment make up the satellite communication system. The space segment consists of a constellation of satellites that are dispersed across its orbit in accordance with predetermined guidelines. The user segment refers to users, including different terminals, while the ground section refers to the control centre.

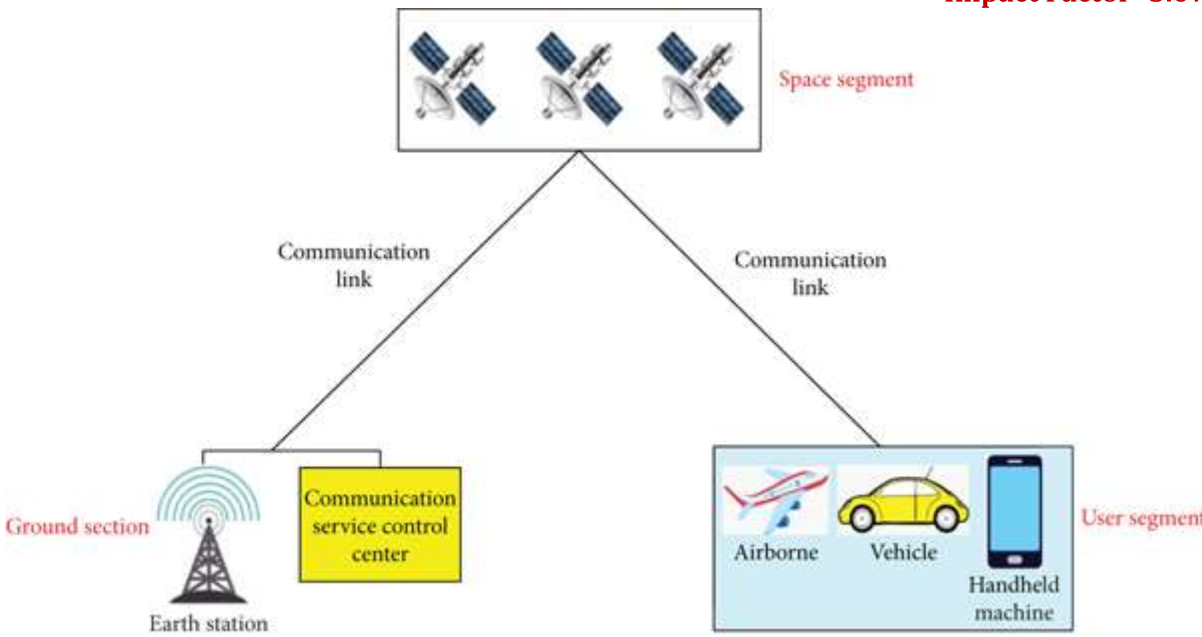

Fig.1: Low-Orbit Communication Satellite Network Traffic Based on Machine Learning Flow

Parameters of the LEO Satellite System

To ensure continuous worldwide coverage of the network, the low-earth orbit (LEO) satellite system may consist of dozens to hundreds of satellites. All of its satellite nodes orbit the planet quickly and have low orbits for their satellites. The average visibility time to the ground station is shorter for LEO satellite communication systems, and the satellite-to-earth connection communication delay formed with the ground user is smaller. The LEO satellite network is often compatible with portable devices.

III. SATELLITE CONSTELLATION

A satellite constellation is a group of satellites created using the geometric relationships and relative placements of several spacecraft to carry out challenging communication tasks. The size, shape, direction, and location of a satellite's orbit may all be influenced by its constellation characteristics. The six primary satellite constellation parameters fall into three groups. The size and form of the orbit are determined by two constellation parameters. It establishes one constellation parameter that establishes the relative location in addition to the three constellation parameters that establish the orbital position.

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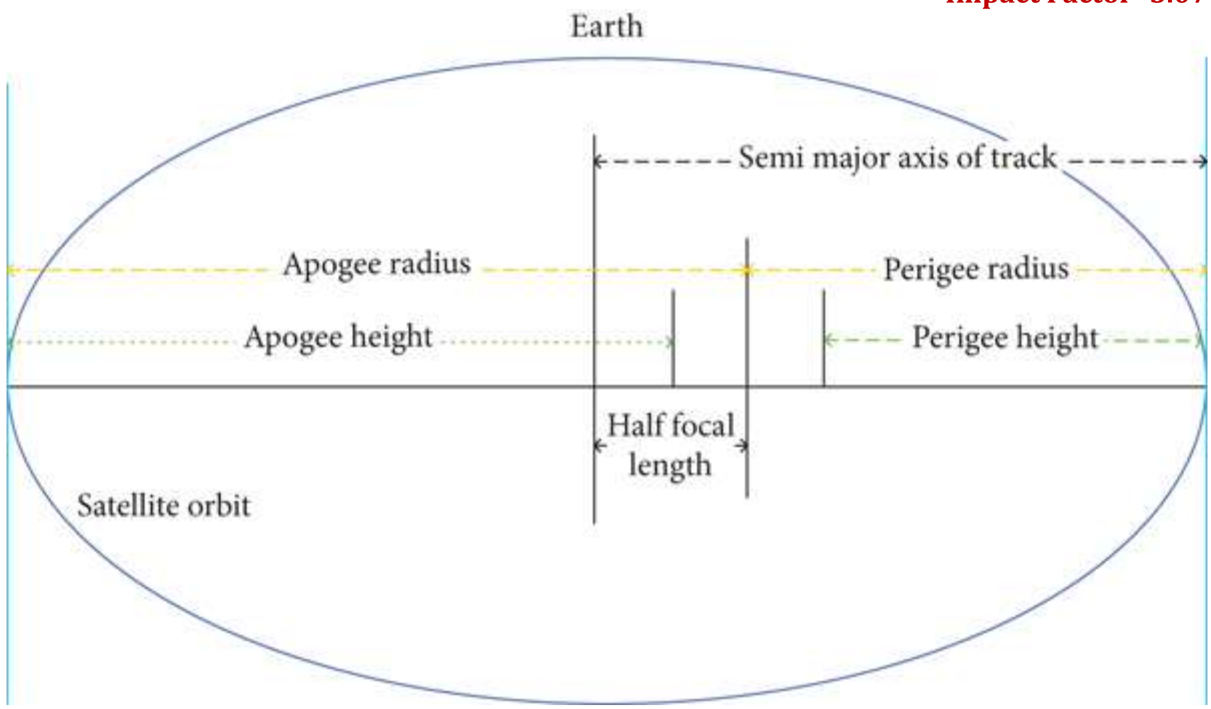

Fig.2: Low-Orbit Communication Satellite Network Traffic Based on Machine Learning Cycle.

Satellite Network Routing

A satellite network made up of several satellites or multilayer satellites may now transmit data via a variety of different methods thanks to advancements in satellite communication technology. The choice of an appropriate path for data transmission from source to destination is very crucial. As a result, a critical technology for ongoing study in satellite networks is the construction of routing algorithms. Satellite routing may be classified into intersatellite routing, access routing, and border routing in accordance with the various routing roles of each component in the satellite network [11, 12]. Intersatellite routing is one of them, and because of how complicated satellite network mobility is, it has always been a significant and challenging issue for many academics.

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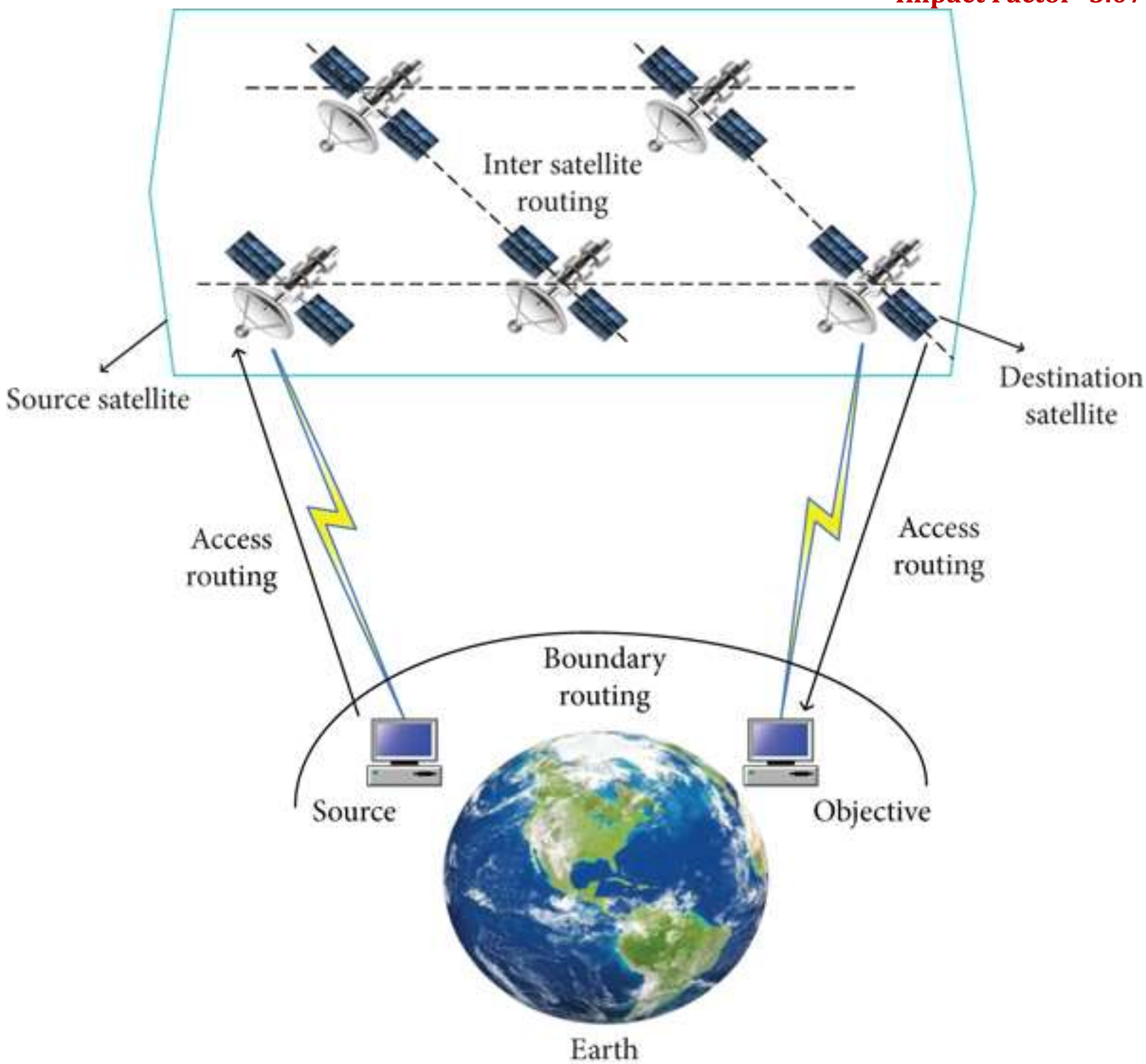

Fig.3: Low-Orbit Communication Satellite Network Traffic Based on Machine Learning

Method for Setting Routing Link Weight of Low-Orbit Satellite Network

Different satellite constellations have various network topologies for low-orbit satellite networks. Additionally, the network structure of the satellite varies with time. These are the features that distinguish satellite networks from terrestrial networks, and they also explain why the link weights used in satellite routing are more varied. After connection information is received, satellite network routing may better adapt to the intersatellite network's features and increase the effectiveness of its operations.

Collected, these uncertain factors are considered to be optimized in the link weight. This is currently a better choice for satellite network routing.

IV. ALGORITHM DESIGN

This experiment will design a routing optimization algorithm based on reinforcement learning. It includes algorithm input state design, output action design, and reward function design.

(1) Input State Design. This chapter employs the link utilisation rate of the whole network as the input state of the reinforcement learning algorithm taking into account the measurement overhead of the traffic matrix and the viability of the method. An -dimensional vector (which indicates the number of links in the network architecture) serves as the input state for time, and the vector's value for each link's link utilisation. Additionally, the performance variance of the routing optimisation between the two input stages is investigated utilising the flow matrix and the link utilisation rate as the method. The study of the reinforcement learning routing optimisation technique utilising the traffic matrix as an input continues in this chapter.

For the routing method where the input is a flow matrix, the input state is a -dimensional vector (represents the number of network nodes), and each value in the vector represents the flow of each flow.

V. CONCLUSION

This study investigates the traffic load balancing routing algorithm for low-orbit communication satellite networks. This article defines low-orbit satellites, defines its routing algorithm, and describes how the algorithm's performance is assessed. This article introduces a traffic load balancing routing method that incorporates machine learning before examining some of the algorithm's fundamental performance, as follows: (1) The fundamental elements, general layout, and LEO satellite system characteristics are introduced. (2) Low-orbit satellite intersatellite connections and their weights are introduced.

(3) In addition to discussing the general equilibrium routing algorithm's computation and workflow, this article also discusses several techniques for evaluating the performance of the LEO satellite routing algorithm. (4) Simulation tests were conducted together with the introduction of a routing system based on machine learning. Three widely used low-orbit satellite routing methods were tested against the performance of this algorithm. (5) This research concludes that routing algorithms based on machine learning outperform other methods in terms of average latency, packet loss rate, throughput, and load distribution performance.

REFERNCES

1. D. Jiang, P. Zhang, Z. Lv, and H. Song, "Energy-efficient multi-constraint routing algorithm with load balancing for smart city applications," *IEEE Internet of Things Journal*, vol. 3, no. 6, pp. 1437–1447, 2016.
2. H. Xia, R.-h. Zhang, J. Yu, and Z.-k. Pan, "Energy-efficient routing algorithm based on unequal clustering and connected graph in wireless sensor networks," *International Journal of Wireless Information Networks*, vol. 23, no. 2, pp. 141–150, 2016.
3. M. Kawecki and R. O. Schoeneich, "Mobility-based routing algorithm in delay tolerant networks," *EURASIP Journal on Wireless Communications and Networking*, vol. 2016, no. 1, 2016.
4. A. Erickson, A. E. Kiasari, J. Navaridas, and I. A. Stewart, "An optimal single-path routing algorithm in the datacenter network DPillar," *IEEE Transactions on Parallel and Distributed Systems*, vol. 28, no. 3, pp. 689–703, 2015.
5. F. Lu, J. Li, S. Jiang, Y. Song, and F. Wang, "Geographic information and node selfish-based routing algorithm for delay tolerant networks," *Tsinghua ence & Technology*, vol. 22, no. 3, pp. 243–253, 2015.
6. R. Wang, J. Wu, Z. Qian, Z. Lin, and X. He, "A graph theory based energy routing algorithm in energy local area network," *IEEE Transactions on Industrial Informatics*, vol. 13, no. 6, pp. 3275–3285, 2015.
7. N. Kumar and M. Dave, "BIIR: a beacon information independent VANET routing algorithm with low broadcast overhead," *Wireless Personal Communications*, vol. 87, no. 3, pp. 869–895, 2013.
8. G. Mahalaxmi and R. K. Esther, "Multi-agent technology to improve the internet of things routing algorithm using ant colony optimization," *Indian Journal of Science & Technology*, vol. 10, no. 31, pp. 1–8, 2012.
9. K. Kaneko and A. Bossard, "A set-to-set disjoint paths routing algorithm in tori," *International Journal of Networking & Computing*, vol. 7, no. 2, pp. 173–186, 2011.
10. L. ZENG, T. PAN, X. JIANG, and T. WATANABE, "An efficient highly adaptive and deadlock-free routing algorithm for 3D network-on-chip," *Ieice Transactions on Fundamentals of Electronics Communications & Computer Sciences*, vol. E99.A, no. 7, pp. 1334–1344, 2016.
11. L. Qiao, Y. Li, D. Chen, and S. Serikawa, "A survey on 5G/6G, AI, and robotics," *Computers & Electrical Engineering*, vol. 95, article 107372, 2015.

12. S. Avallone and A. Banchs, "A channel assignment and routing algorithm for energy harvesting multiradio wireless mesh networks," *IEEE Journal on Selected Areas in Communications*, vol. 34, no. 5, pp. 1463–1476, 2016.
13. W. Wang, H. Shi, D. Wu et al., "VD-PSO: an efficient mobile sink routing algorithm in wireless sensor networks," *Peer-to-Peer Networking and Applications*, vol. 10, no. 3, pp. 537–546, 2012.
14. W. Jia and Z. Chen, "Sensor communication area and node extend routing algorithm in opportunistic networks," *Peer-to-Peer Networking and Applications*, vol. 11, no. 8, 2018.
15. T. Ren, Z. Jiang, X. Cai et al., "A dynamic routing optimization problem considering joint delivery of passengers and parcels," *Neural Computing and Applications*, vol. 33, no. 16, pp. 10323–10334, 2011.
16. Y. Meraihi, D. Acheli, and A. Ramdane-Cherif, "QoS multicast routing for wireless mesh network based on a modified binary bat algorithm," *Neural Computing and Applications*, vol. 31, no. 7, pp. 3057–3073, 2016.