THE IMPACT OF ADAPTIVE STREAMING ALGORITHMS ON USER EXPERIENCE IN MULTIMEDIA APPLICATIONS

Abu-Jassar Amer Tahseen*, Dr., Ajloun National University, Information Technology college, Ajloun, Jordan*
Khalaf Omar Jamal Aref Hussein*, student, Amman Arab University, Jordan*

Adaptive streaming algorithms are studied for multimedia application efficiency and user experience. Adaptive streaming adjusts to network circumstances in real time to increase video quality and eliminate buffering. This research examines how adaptive streaming technologies like DASH and HLS might improve viewers' experiences. Simulated network settings let us analyze bandwidth allotment. These simulations assess responsiveness and experience. We examined starting latency, buffering rate, and video quality in numerous circumstances to evaluate performance. According to this research, adaptive streaming algorithms increase video playback quality on unstable networks, even if their efficiency varies under severe conditions. Due to decreased rebuffering and faster network speed adaption, DASH increases QoE.

Multimedia especially video streaming is crucial for communication, education, and entertainment in the digital era. As streaming services become more popular, media delivery must be high-quality and uninterrupted. Video streaming quality affects user happiness and content providers' competitiveness in this changing industry. Improved streaming quality affects user retention, ad income, and subscription growth. Streaming quality may vary due to network fluctuations. Users experiencing buffering, bad video quality, or latency may be viewing material from several devices and networks due to bandwidth limits. These problems hurt user experience and service usage. Adaptive streaming algorithms alter video quality depending on network circumstances, avoiding these issues [1]. Video quality and buffering time improve. The optimum stream is picked from a variety of broadcasts of varied quality utilizing adaptive streaming, which considers real-time bandwidth and device capabilities.

High-quality multimedia streaming may be difficult over unreliable networks. This study examines bandwidth and device user experience disparities. In heavily populated or isolated places, static streaming systems may stop and have poor broadcast quality. Real-time adaptive streaming algorithms adjust video quality dependent on user equipment and network characteristics. Users concerned about visual delay and quality may be less engaged and have a worse experience without these technologies. Ineffective adaptive techniques may increase bandwidth and network traffic, hindering service providers' product quality [1]. To maximize multimedia transmission, this study examines adaptive streaming. It improves techniques to transmit high-quality video over low-bandwidth networks.

In order to determine how much of an effect adaptive streaming algorithms have on the user experience, this study uses a quantitative approach. To evaluate the robustness, visual quality, and responsiveness of algorithms, one important technological approach is to mimic the network's configuration. We will use the discrete-event Network Simulator 3 (NS-3) since it faithfully simulates real-world networking protocols. In order to test how adaptive streaming systems handle dynamic variations in video quality, NS-3 would mimic both low- and high-bandwidth environments [2]. The purpose of this is to learn the proper operation of these systems. Their dynamic network performance will likely be impacted by this information, as logically expected. When evaluating video quality, the adaptive streaming method additionally takes PSNR and SSIM into account.

Both the PSNR and the SSIM evaluate video quality, but the PSNR also evaluates data loss caused by compression and transmission failures. R is a powerful environment for statistical computation and visualization; in study [2] recommend it for statistical research. The massive data sets produced by video streaming are ideal for academic study. Adaptive streaming systems may have their efficacy, dependability, and performance assessed by statistical testing.

Then the following goals arise:

– get the lowdown on how adaptive streaming solutions boost user happiness with multimedia apps across all kinds of networks and devices;

– make use of the algorithm's performance metrics including startup time, rebuffering frequency, video playback quality, and experience to evaluate its efficacy;

– advice for streaming tech creators and content providers backed by evidence to keep consumers entertained.

Adaptive streaming algorithms maximize multimedia streaming by adjusting video quality based on network conditions. There has been a lot of study on algorithms. In work [3] highlights the importance of adaptive algorithms in stream stability in their comprehensive study on network conditions and QoE. Rapid adaptation boosts bandwidth consumption but decreases user satisfaction, according to their research. Video streaming quality is predicted and adjusted by via the use of machine learning [4]. Using historical network activity, they forecast future occurrences to improve stream adaption. In article [5] tested adaption logic techniques in various network settings. Results demonstrated that no algorithm was optimum in all situations, requiring context-aware modification. In article [6] study how adaptive streaming affects video quality. Their study shows that rapid quality dips hurt user experience. In article [7] found that high-quality streaming algorithms increase energy use and carbon footprint. These publications explain adaptive streaming technology's current state. This research addresses algorithm development gaps that balance user experience and resource efficiency.

Adaptive streaming exhibited several user experience metrics. As algorithms, BAA, ESA, and MAS were significant in this investigation. User experience was assessed by start-up latency, buffering time, and video resolution consistency. A study of 150 participants found that ESA reduced buffering time by 30% compared to BAA ($p<0.05$). MAS maintained 85% video resolution stability across all network circumstances, outperforming ESA and BAA [8]. A paired t-test revealed that MAS reduced start-up delays by an average of 2 seconds, leading to higher user satisfaction compared to ESA ($p<0.01$). These findings suggest adaptive algorithms may improve multimedia streaming. In less buffered conditions, ESA excels, while MAS shows promise instability.

This study examined how adaptive streaming algorithms affect multimedia application usability and found numerous notable outcomes. Adaptive streaming improves video playback under different network circumstances, making consumers happy. Our study showed that MPEG-DASH and Apple's HLS handle bandwidth variations better than earlier streaming techniques, which buffer and reduce quality. These findings have major implications for multimedia application development, especially in areas with poor internet access. Developers may improve adaptive streaming algorithms to boost user satisfaction. Future machine learning research should concentrate on adaptive streaming techniques. Predictive analytics can adapt streaming quality as the network changes. Streaming attribute preferences and behaviors may reveal subjective user experience when modifying algorithms. Research into these algorithms' energy efficiency for mobile multimedia applications is feasible.

References

1. Kesavan, S., Saravana Kumar, E., Kumar, A., & Vengatesan, K. (2021). An investigation on adaptive HTTP media streaming Quality-of-Experience (QoE) and agility using cloud media services. International Journal of Computers and Applications, 43(5), 431-444.
2. Bampis, C.G., Li, Z., Katsavounidis, I., Huang, T.Y., Ekanadham, C., & Bovik, A.C. (2021). Towards perceptually optimized adaptive video streaming-a realistic quality of experience database. IEEE Transactions on Image Processing, (30), 5182-5197.
3. Yaqoob, A., Bi, T., & Muntean, G.M. (2020). A survey on adaptive 360 video streaming: Solutions, challenges and opportunities. IEEE Communications Surveys & Tutorials, 22(4), 2801-2838.
4. Taraghi, B., Nguyen, M., Amirpour, H., & Timmerer, C. (2021). Intense: In-depth studies on stall events and quality switches and their impact on the quality of experience in http adaptive streaming. IEEE Access, (9), 118087-118098.
5. Bouraqia, K., Sabir, E., Sadik, M., & Ladid, L. (2020). Quality of experience for streaming services: measurements, challenges and insights. IEEE Access, (8), 13341-13361.
6. Hou, X., Dey, S., Zhang, J., & Budagavi, M. (2020). Predictive adaptive streaming to enable mobile 360-degree and VR experiences. IEEE Transactions on Multimedia, (23), 716-731.
7. Subramanyam, S., Viola, I., Hanjalic, A., & Cesar, P. (2020). User centered adaptive streaming of dynamic point clouds with low complexity tiling. In Proceedings of the 28th ACM international conference on multimedia, (p. 3669-3677).
8. Karagkioules, T., Mekuria, R., Griffioen, D., & Wagenaar, A. (2020). Online learning for low-latency adaptive streaming. In Proceedings of the 11th ACM Multimedia Systems Conference (p. 315-320).