IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 9, Issue 11, November 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.542

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 7.542

|| Volume 9, Issue 11, November 2021 ||

| DOI: 10.15680/IJIRCCE.2021.0911023 |

A Review on Cloud Gaming

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ABSTRACT: Cloud gaming is a new way to provide gamers with a high-quality gaming experience at any time and from any location. Cloud gaming involves sophisticated game software running on powerful servers in data centres, rendered game sceneries being streamed to gamers in real time over the Internet, and gamers interacting with the games via lightweight software running on a range of devices. Cloud gaming has received a lot of interest from academia and industry since the late 2000s, thanks to the expansion of high-speed networks and cloud computing. We review the most recent cloud gaming research from a variety of perspectives in this paper, including cloud gaming platforms, optimization techniques, and commercial cloud gaming services. The readers will gain an overview of cloud gaming research as well as become acquainted with recent developments in this field.

KEYWORDS: Acquainted, cloud gaming, optimization.

I. INTRODUCTION

We review the most recent cloud gaming research from a variety of perspectives in this paper, including cloud gaming platforms, optimization techniques, and commercial cloud gaming services. The readers will gain an overview of cloud gaming research as well as become acquainted with recent developments in this field. The cloud gaming platform runs computer game programmes, which are divided into two major components: I game logic, which converts gamer commands into in-game interactions, and (ii) scene renderer, which generates real-time game scenes. The command interpreter issues the gamer commands, and the game scenes are captured by the video capture and converted into videos, which are then compressed by the video encoder. As part of the cloud gaming platform, the command interpreter, video capture, and video encoder are all implemented. Cloud gaming's enormous popularity can be attributed to a number of potential benefits for gamers, game developers, and service providers.

Cloud gaming enables gamers to: I access their games from any location at any time, (ii) purchase or rent games on demand, (iii) avoid having to upgrade their hardware on a regular basis, and (iv) take advantage of unique features such as transferring between client computers during game sessions, watching ongoing tournaments, and sharing game replays with friends. For game developers, cloud gaming allows them to: I focus on a single platform, which reduces porting and testing costs; (ii) bypass retailers for higher profit margins; and (iii) focus on a single platform, which reduces porting and testing costs. Start-ups such as OnLive, Gaikai, G-cluster, and Ubitus began to offer cloud gaming services in the late 2000s. We also saw Gaikai being bought out by SONY, a major game console manufacturer. The competition between Sony's PlayStation Now (PS Now) and Nvidia's Grid Game Streaming Service then heated up the cloud gaming market even more. According to a 2014 report by Strategy Analytics, the number of cloud gaming users has increased from 30 million in 2014 to 150 million in 2015.

The cloud gaming platform, as shown in this diagram, sends video frames to and receives user input from thin clients used by gamers to play games. Despite the many advantages of cloud gaming, the research community must address a number of critical issues before it can fully realise its potential to attract more gamers, game developers, and service providers.

II. LITERATURE SURVEY

The present literature seeks to address several of the aforementioned difficulties in cloud gaming, which is an intriguing study area. Nonetheless, there is no comprehensive survey on cloud gaming research that we are aware of. Researchers interested in cloud gaming or other remote execution applications may be delayed or even prevented from joining the community due to the lack of a central survey of existing material. A thorough understanding and exploration of existing academic and industrial research and development can help lead to the building of future cloud gaming platforms. One such advance might come from future games being designed specifically with cloud gaming functionalities and supports in mind. How we accomplish this is still an open question, for example game developers could create cloud gaming aware contexts or even whole new programming paradigms. With this in mind, we carefully

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| DOI: 10.15680/IJIRCCE.2021.0911023 |

connect existing research on solving current challenges together, and come up with a classification system described below.

III. SCOPE AND CLASSIFICATION

We take a look at the cloud gaming literature in this article. We begin by gathering representative cloud gaming papers and categorising them into several categories. We emphasise that only a small number of papers are reviewed in order to provide readers with a better understanding of the cloud gaming research landscape. We propose a classification system, as shown in Figure 2, after selecting representative papers.

1) Cloud Gaming Overview (Section II): We look at overview, introductory, and positioning papers on general cloud gaming as well as specialised topics like mobile cloud gaming and Game-as-a-Service (GaaS).
2) Cloud Gaming Platforms (Section III): Papers that build basic cloud gaming platforms that support various performance evaluation methodologies are considered. These studies can be divided into three categories: system integration, quality of service evaluations, and quality of experience evaluations.
3) Cloud Gaming Platform Optimization (Section IV): We consider papers that optimise cloud gaming platforms from a variety of perspectives; typically, each work focuses on one or a few components. Such research can be divided into two categories: cloud server infrastructure and communications.

a) Cloud Server Infrastructure (Section IV-A): This section reviews existing studies on cloud server infrastructure optimization. Several papers investigate the problem of allocating server and network resources among multiple data centres, server nodes, and game clients in order to optimise the overall cloud gaming experience, taking into account a variety of criteria.

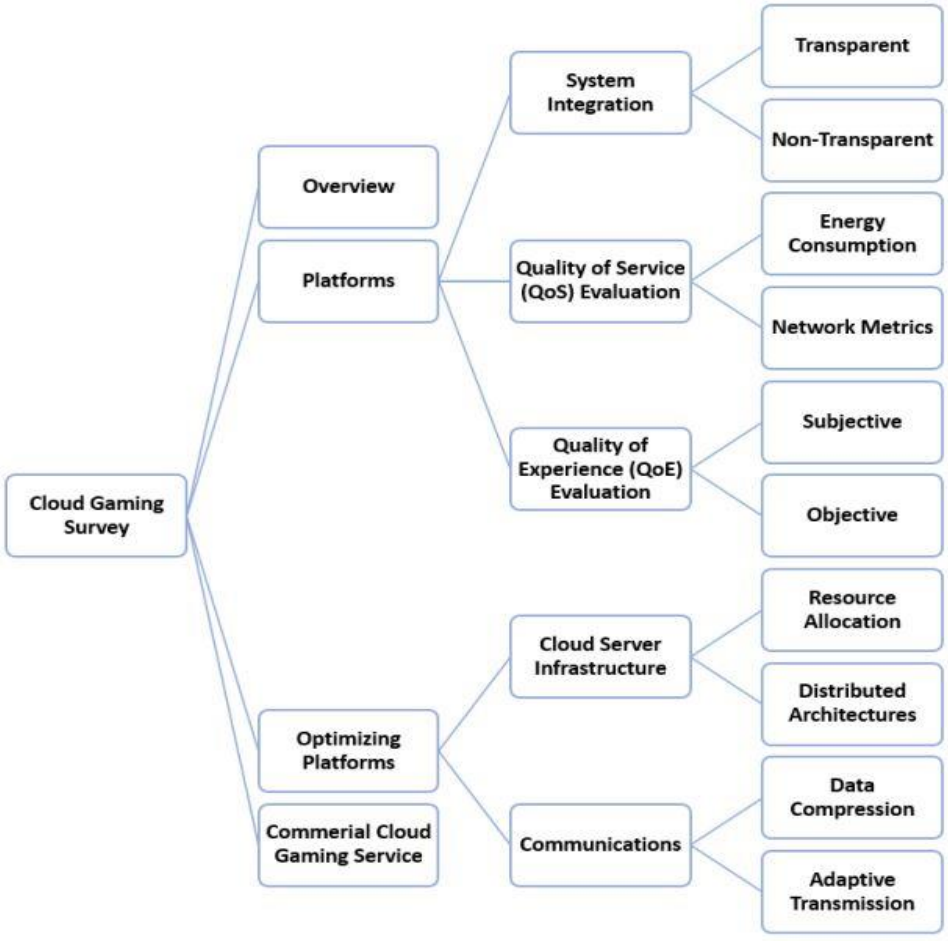

Fig: Our proposed classification system of cloud gaming papers.

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b) Communications (Section IV-B): We review existing research on improving content streaming efficiency over dynamic and heterogeneous communication channels. There are two types of studies in this category. First, several papers address the issue of data compression, proposing techniques such as layered coding and graphics compression, which may outperform traditional 2D image compression in certain situations. Second, there are papers on Adaptive Transmission, which deal with network dynamics by changing various parameters like encoding bitrate, frame rate, and image resolution on a regular basis.

4) Commercial Cloud Gaming Services (Section V): We take a look at some of the most popular commercial cloud gaming services and classify them according to their features.
We also go over the benefits and drawbacks of various cloud gaming services.
They're followed by Section VI, which brings the survey to a close. and ideas on cloud gaming from their perspectives in a number of high-level overview papers. We survey and summarise the representative papers in this direction in this section. Our concise summary situates readers within the context of cloud gaming research, while interested readers may discover new findings. However, a recent publication [59] envisions the cloud gaming system as a novel computer architecture that uses cloud resources to improve gaming performance, such as rendering, response time, precision, and fairness. To make this vision a reality, the authors distribute system workload across multiple cloud servers and game clients. To take it a step further, consider the essence of cloud games as interconnected components, and define cloud gaming as the use of cloud resources to host gaming components, thereby reducing gamers' workload.

1. Cloud Gaming platform

The work on cloud gaming platforms is presented in three steps in this section: I integrated cloud gaming platforms for complete prototype systems, (ii) measurement studies on QoS metrics, and (iii) measurement studies on QoE metrics.

A. System Integration

It's difficult to provide an easy-to-use platform for (cloud) game developers. This is due to the cloud gaming platforms' complex, distributed, and heterogeneous nature. There is, in fact, a clear trade-off between the two. Room for optimization and development complexity Transparent platforms that run unmodified games may suffer from limited room for optimization if they opt for very low (or even no) additional development complexity. Other platforms, on the other hand, choose to optimise performance at the expense of requiring more resources. Complexity of development, such as code augmentation and non-transparent platforms, which require recompilation. These two types of cloud gaming platforms each have their own set of benefits and drawbacks, which we'll go over in more detail below.
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The transparent platforms make it easier to deploy new games on cloud gaming platforms, but at the risk of sacrificing performance. present a RemoteFX-based cloud gaming platform. The Windows Remote Desktop Protocol has been extended. GPUs and Hyper-V virtualization are used in modern Windows servers. machines to support a variety of remote applications, such as cloud-based games RemoteFX allows them to do this, according to their tests. Windows servers will be able to adapt to network changes more easily, but the frame loss rate is still high, and the responsiveness is poor. Another cloud gaming platform with a distributed service platform, distributed rendering system, and encoding/streaming system is proposed. Their platform allows for isolated audio/video capture, as well as multiple audio/video captures. There are two types of clients: desktop clients and browser-based clients. Experiments with real people. A total of 40 subjects were tested, with a high level of responsiveness. Extensive, portable, configurable, and open are some of its design principles. The Gaming Anywhere server is compatible with both Windows and Linux.The GamingAnywhere client is available for Windows, Linux, and Mac.Android and Mac OS are two of the most popular operating systems. It has been demonstrated that GamingAnywhereoutperforms a number of commercial and proprietary cloud gaming platformsIt's been used and improved in a number of cloud platforms.studies on gaming in the literature. develop adaptation algorithms for multiple gamers, to maximize the gamer experience. In addition to: (i) a user study to map cloud gaming parameters to gamer experience and (ii) optimization algorithms for resource allocation, they also enhance Gaming Anywhere [38], [40] to support on-the-fly adaption of frame rate and bitrate.

B. Quality of Service Evaluation

Quantifying the performance of cloud gaming platforms requires performing QoS measurements. Furthermore, doing so in real-time allows us to troubleshoot and even optimise cloud gaming platforms dynamically. The cloud gaming papers that deal with QoS are divided into two groups: I Network metrics and (ii) energy consumption
They are surveyed in the following.

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I. Energy consumption

Consumer computing platforms have been known to be pushed to their limits by games. Game software is frequently expected and accepted in traditional systems such as desktop computers, where it is expected and accepted that it will push a system to its limits. Mobile environments, on the other hand, are in a very different situation because they have limited power reserves.Because a fully utilised mobile device may have a significantly reduced running time, it's critical to keep the complexity of game software for mobile devices to a minimum. Cloud gaming systems, on the other hand, offer a potential solution by offloading complex processing tasks like 3D rendering and physics calculations to powerful cloud servers.

II. Network Metrics

The user experience, like that of many other distributed multimedia applications, is heavily influenced by network conditions. As a result, in cloud gaming, evaluating various network metrics is critical, and we present a detailed survey below. measures the content of a variety of game genres in depth. The average Intra-coded Block Size (IBS) and Percentage of Forward/backward or Intra-coded Macroblocks (PFIM) are used to analyse scene complexity and motion in 28 games from four perspectives, including First-Person Linear, Third-Person Linear, Third-Person Isometric, and Omnipresent.According to the author's tests, Microsoft's remote desktop achieves a higher bitrate than No Machine's NX client, but the latter has a higher frame rate. A subsequent study looks into OnLive's network characteristics, including data size and frequency sent, as well as overall downlink and uplink bitrates.The authors discover that OnLive games' high downlink bitrates are very similar to those of live videos; however, OnLive's uplink bitrates are much more moderate, comparable to traditional game uplink traffic. They also found that game traffic features are similar across three game genres, including First-Person, Third-Person, and Omnipresent, despite total bitrates varying by up to 50%. Another important finding is that OnLive's ability to adapt bitrate and frame rates to network latency is not demonstrated.CloudUnion uses a geo-distributed infrastructure; (ii) CloudUnion occasionally experiences queuing issues with different locations; (iii) the User Datagram Protocol (UDP) outperforms the Transmission Control Protocol (TCP) in terms of response time while sacrificing video quality; and (iv) CloudUnion uses a conservative video rate recommendation strategy. By contrasting CloudUnion and GamingAnywhere, we can see how well they work together.

IV. CONCLUSION

We divided existing cloud gaming research into four categories in this article: I overview, (ii) platform, (iii) optimization, and (iv) commercialization. We included papers in Section II (overview) that introduced general and specialised (such as mobile) cloud gaming.We presented the basic cloud gaming platforms that support quantitative performance measurements in Section III (platform). We looked at I Quality of Service (QoS) evaluations, such as energy consumption and network metrics, and (ii) Quality of Experience (QoE) evaluations, such as gamer experience. The two major optimization directions were presented in Section IV (optimization): I cloud server infrastructure, including resource allocation and distributed architecture; and (ii) communications, including data compression and adaptive transmission. We gave a brief history of cloud gaming services in Section V (commercialization), followed by design decisions made by representative commercial cloud gaming services.

Cloud gaming isn't a panacea, and it comes with a hefty price tag for service providers. Minimizing cloud and networking resource costs while maintaining a high level of gamer experience necessitates careful optimization, such as the methods discussed in this survey. The service provider will not be able to consolidate enough cloud gaming users to each physical machine without these optimizations. As a result, the service provider's profits plummet, and the company may go out of business.

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INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 7.542

doi cross ref

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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