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Literature Review of Game Development Technologies and its Impact

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Abstract: *In today's day and age, games are considered as one of the most crucial elements for having fun and spend time with friends. Gaming have become one of the mainstream phenomena as games provide various people around the global not only relaxation but forms a connection between people by interacting virtually and having fun by playing games together games. Gaming industry has revolutionized not only multimedia but also challenging the technology which we use in our daily life. To contribute towards this industry, we are developing our own games as a project. Gaming engine such as Unreal engine are being currently used to model and make use of its ability to project and calculate lighting value in movies gaming has changed its view on world where many people are pursuing entertainment and game development and playing and streaming game leading to need of more games and creation of streaming platform, in this paper we are going to take a look at the presented information and how the need are fulfilled.*

Keywords: Game Development

I. INTRODUCTION

Game Development is mix of IT and ART field and can be described as art of creating and designing games, it involves design, build, test and release. When designing games, it is important to think about the game mechanics, rewards, player engagement and level design.

Game development helps to develop creativity and problem-solving skill of an individual, Game Development is typically divided into 3 parts **pre-production, production, and post-production.**

Beginners should be proficient in **C++ programming and other languages like C and Java**. Getting Familiarity with the popular game engines and core SDKs is a plus.

Career in game industry is one of the most rewarding careers **on the planet**, but it is also extremely challenging and often requires specific skills and even personalities to be successful.

In this we will focus on upcoming frame work technologies which are being developed with the purpose of making more lifelike.

We will focus on technologies such as Parallel Processing, Ray Tracing, Upscaling, Audio Engine Development, Artificial Intelligence, Graphic Design Software, Encoding and Streaming Codecs for Streaming of videos on Internet which are being developed and optimized to improve gameplay experience.

II. CONCEPTUAL DEVELOPMENT

2.1 Parallel Processing

[1][2] & [3] In Parallel processing to computation is done on separate parts of an overall task by breaking tasks up and running simultaneously on multiple CPUs in turn resulting in lower time for processing an completing the task;

Parallel processing was in game development whenever a polygon draw call was made to display raster-based frame in game, it splits task among Graphical processing unit cores by scheduling among available resources leading to use of parallel processing in game development as well as developing more versatile methods to implement Parallel processing not only for game development but General Computational Development as well

2.2 Ray Tracing

Ray Tracing is technique or methods of Graphical rendering to simulate the real-life behavior of light, this in volves ray casting, recursive ray tracing, distribution ray tracing, photon mapping to path tracing to calculate behaviors of how a light bounces from material surface, this is completely different from rasterized rendering of frame.

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2.3 Upscaling

Upscaling involves Video scaler which converts uses lower resolution image/signal from source and output to a higher Resolution image/signal

For example, converting a 1080p image to a 4k image

Upscaling isn't a new concept in game development but the tools which are currently used are getting more important, pinnacle resolution for gaming is 4K with 120hz or 144hz refresh rate but since many games if not most are demanding and hard to run at 4k; so, there was a need to upscale image from lower resolution to Higher resolution (or native)

III. FINDINGS AND DISCUSSION

3.1 Programming Languages

Most of Game developers already use existing programming languages like C, C++, C#, java and HTML-5 (for web-based games), since many of games require low level access to hardware multiple packages and api's are being Developed to full fill to the above requirement such development has led multiple new methods of implementation in General data set computation.

Many Game Engine still rely on languages like C, C++, C#, java, etc hence the need to develop api's to integrate it in game development

Take Game 'Elder Scrolls V: Skyrim' Bethesda Softworks its developer created a new programing language to work with its Game Engine called **Papyrus** [4]. Papyrus is a scripting language developed and is part of **creation kit** which is used by community to develop mods for the game.

3.2 Audio Engine Development

Audio engine are key part of Game Engine they can be sperate or be integrated in Game Engine for the purpose of game development.

No matter how a game looks and feel in terms of visuals it feels incomplete without proper audio implementation as they wouldn't make quite the same impact without voices ,music or even ambiance or subtle sound effects ,since audio is a huge part of game development and many game studio go to great length to make sure user has a mind blowing experience some studio hire music orchestra for sound track and some hire Famous actors such as Keanu Reeves (role in cyber punk)

To deliver above audio engine is developed to implement the surround sound to user to provide a great user experience as audio is one of the key component.

One of the key necessities of audio engine development is that game audio is dynamic and audio changes depending on how the players interacts with environment of games.

As such various methods are developed and various audio software are developed in conjunction with games leading indirect development of audio manipulation software.

3.3 Artificial Intelligence

[15] Ai can also be used to generate face of character as seen on example.

[16] Ai is also used in optimizing Lod distance and rendering detail as a technology called as **Nanite** in Unreal Engine 5 Ai can also be used to optimize by converting High polygon assets in game to low polygon asset while let appearing visually same leading performance gains

[11] Graphic card not only are made for game development but they are also able to be used for AI Thanks to ability of Parallel computing

Ai in Game development has existed for many years, just not on the same level as Deep learning, Ai in game is mostly limited to NPC (non-playable-character) which follows command conditions laid by the developer of the Game, when right conditions are met these NPC react in Certain ways describe by the developers.

Companies like Google are currently developing Ai called **DeepMind** which is trying to move beyond the scope of teaching programs to predict and not just simulate. This Ai goes beyond classic games such as chess and etc.

Excellent example of Ai implementation is RTX Voice by Nvidia which use Ai and runs the software on cuda or its tensor cores by filtering background noise from actual audio.

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Parallel computing using Ai allows data to be streamed from sensor to the GPU and GPU must process the data to server as the central Computer for driverless car as GPU process large amount of data sets and instruction set for proper computation.

Due to advancement in Gaming sectors developers used artificial intelligence computing code that Graphic Cards run .AI development was the Beginning of machine learning although games still mainly involve more-rudimentary if-then case scenario where Ai Character in games interact with the users. However, mainstream games have begun to take advantage of machine-learned to optimize game although to a lesser extent.

3.4 Graphic Design Software

Graphic designers design the superficial elements of game development such as character's portrait and art/illustration related to it, to design such art/illustration software like Adobe Photoshop, Illustrator and InDesign, Gimp, Blender for 3d Illustrator is used.

Since some of the Interface, animation, menus are part of graphic design technologies so development of Graphic Design Software become a necessity and it majorly influences the flow and development of such software.

Graphic Design software like AdobeXD, Figma are currently being used to design the game UI. Since user reacts with UI on daily basis it is important to develop UI and the tools allow designer to design UI separately without needing to be integrated in game engine directly for the purpose of testing

3.5 Encoding and Streaming Codecs

Since Many of Codec such as H.265, h.266 are proprietary many videos site such as YouTube, Netflix, Twitch cannot just simply use and allow user to access such files which are encoded with such codec making a need for development of open standard of codec

As Such AV1 codec was created by Alliance for Open Media (with members like AMD, Intel, Nvidia, Amazon Netflix, Google, Arm, Apple, Microsoft, Tencent, Bilibili, Broadcom Snapchat, Vlc and etc.)

Av1 was primarily developed for Streaming first in mind to give excellent quality at lower bitrate. **AOmedia Video 1(AV1)** is an open, royalty-free video coding format.

Development of such Video codec leading to better streaming of Games via internet since AV1 reference encoder achieved 34%, 46.2% and 50.3% higher data compression than libvpx-vp9, x264 High profile, and x264 Main profile respectively. For more Information refer [5]

Improvement in bitrate and it being opensource makes it an ideal choice to stream videos

Intel Has Released hardware-based Fast AV1 Video Encoder based upon their implementation of AV1 (Since it's an open standard) called Scalable Video Technology AV1 encoder and decoder or SVT-AV1

SVT-AV1 codec is Intel's implementation of AV1 and is slightly superior to the standard AOM-AV1 (**AOmedia Video 1(AV1)** In terms of quality at lower bitrate.

3.6 Upscaling

Many scaler Techniques used to upscale image will simply stretch pixel values resulting in a poor/bad image quality and a lack of clarity.

[8]When using a smarter upscaling technology(i.e. Content Adaptive Resampler) uses clever algorithms that will infer information from a scene or enhance certain features to ensure a more defined, crisp/sharp image leading to a more detailed output many of these Technology can be used not only in gaming but in day-to-day object such as Picture from smartphone, Upscaler in a Smart Tv, there are multiple sites such as [9] allow user to upscale artwork to higher resolution for free and is used by many people to upscale images.

Some of the smart upscaling techniques are:

AMD FSR 1.0: uses the spatial upscaling to generate super high-quality edges and distinctive pixel details, upscaling image to super resolutions, resulting in an experience that improves performance while minimizing the impact to visual fidelity [10].

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AMD FSR 2.0: uses temporal data manually tuned to generate more detailed image than AMD FSR 1.0 it does not require any special hardware for tensor data and can be used on any hardware unlike NVIDIA DLSS where dlss only works on NVidia GPU.

NVIDIA DLSS (Deep Learning Super Sampling): is uses AI rendering technology that increases graphics performance using dedicated Tensor Core AI processors present on GeForce RTX™ GPUs. DLSS uses power of a deep learning neural network to generate high visual fidelity image DLSS uses the power of NVIDIA's supercomputers to train and improve its AI model. These models are used to generate the output image

Unreal Engine 5 TSR: There are some Game engine which also follow the Similar ideology as AMD FSR such as **Unreal Engine 5** offers **Temporal Super Resolution (TSR)** feature. Which game developers can use.

3.7 Real-Time Ray Tracing

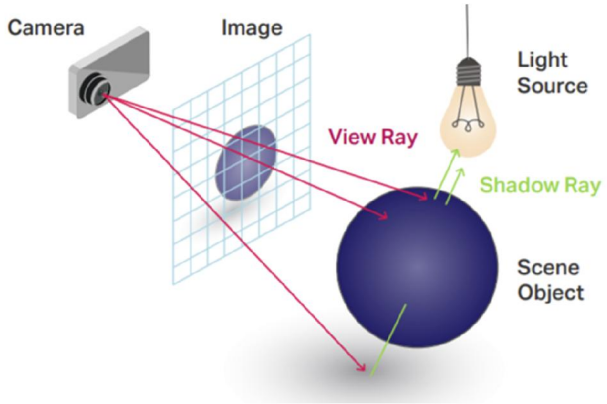

Fig- Real-Time Ray Tracing

[6] Since Ray Tracing generates image by tracing rays, cast through pixels of an image plane and simulate behavior of real-life light ray there is large number of calculations required to predict accurate representation of ray of light. Currently with today's computing power only 1 sample per pixel of rays can be ray traced leading incomplete ray traced image with lot of noise in image

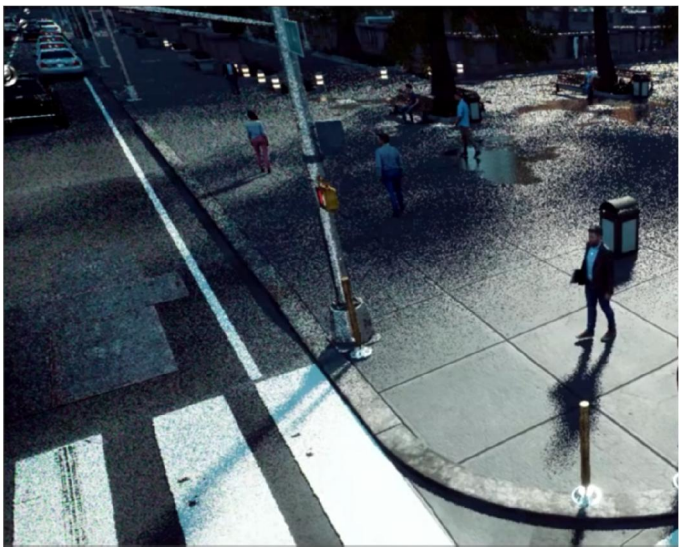

Fig - Sample per pixel Raytracing

As such needing to develop need for Development of Denoise and Upscaling Algorithm is required to clean-up the noisy image

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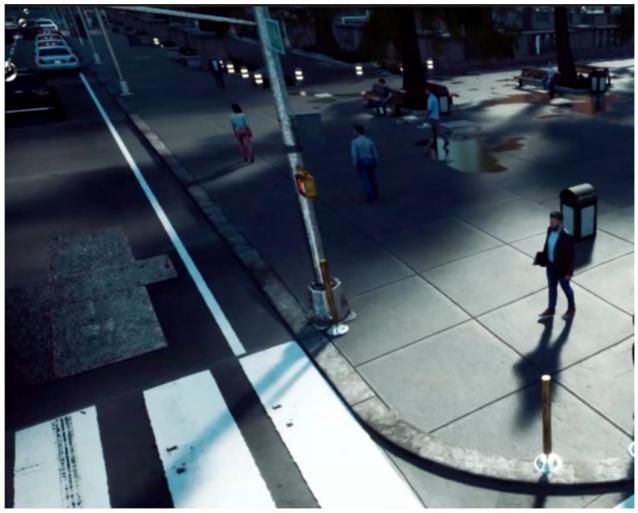

Fig- Sample per pixel Raytracing + Denoising

[6] & [8] these approaches demonstrate powerful way of raytracing to overcome 1 sample per pixel, they suffer from a common issue that is temporal information cannot be used when the motion vectors are invalid. Needing to be reliant on temporal data;

The image Created by this method is almost close to Real Raytraced image which requires lot of time to be rendered and is not Real-time

Despite this method reducing need for required computational power it is still taxing on the hardware.

Many Companies Such as -

Microsoft has its real time Software implementation ray tracing called **Microsoft DXR - DirectX Raytracing [12].**

Nvidia has its own SDK for Ray Tracing Nvidia RTX SDK which many game engine such as Unreal Engine have implemented

Ray Tracing in Vulkan – Vulkan is opensource api developed by Khronos Group (also developed OpenCL), vulkan also implements its own ray tracing by enable content using contemporary proprietary APIs, such as NVIDIA OptiX, Nvidia, Amd Do donate code with Khronos Group for Vulkan Development.

[7] **NVIDIA RTX™ platform:** NVIDIA RTX platform fuses ray tracing, deep learning and rasterization to generate High quality assets for the content creators and developers through its RTX Platform Dev Kit.

The RTX platform provides APIs and SDKs running on hardware to generate solutions capable of accelerating and enhancing graphics. They are used for: Ray Tracing (OptiX, Microsoft DXR, Vulkan), AI-Accelerated Features (NGX), Rasterization (Advanced Shaders), Simulation (CUDA 10, PhysX, Flex), Asset Interchange Formats (USD, MDL)

IV. LITERATURE REVIEW

[1] In this paper author Dong-Hee Yoon and Youngsun Han et. al. proposed to use parallel processing to reduce the computation time of data and instruction set with recent system developments to increase the speed of parallel computing using graphics processing units (GPU).

However, Drawback of such system is extreme dependent on manufacture on GPU and its support of drivers and features. Configuration changes are required to optimize for parallel processing as in turn leading initial time requirement for optimizing via sdk and toolkits for Hardware but when optimized leads to greater improvement in performance and reduction in computation time.

[2] In this paper author Yoji Yamato et. al. proposed an automatic GPU (graphics processing unit) offloading method for developing IoT

However, GPU offloading improve only a limited number of applications because it is required to optimizes the extraction of parallelisable loop statements. They also propose an improved GPU offloading method with fewer data transfers between the CPU and GPU

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So, when development of such IoT devices one must keep this in mind while developing as it is also time consuming. Development of ASIC for particular task might be viable alternative as GPU are mostly made for general computing unlike ASIC's.

[3] In this paper Authors: Robert Calatayud , Enrique Navarro-Modesto, Enrique A. Navarro-Camba , Nagula T. Sangary et. al. Demonstrate The parallelization of FDTD to calculate in GPU is possible using MATLAB and CUDA tools which is available on Nvidia's site using the power of parallel processing to reduce time, In this case they run the calculation using the cuda cores present on Gtx 1080ti (gpu) .

Note- MATLAB is multi-paradigm programming language and numeric computing environment developed by MathWorks. MATLAB allows for matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.

[5] In this paper Authors found that AV1 is about 30% more efficient than vp9/h.265 and about 50% than H.264 in case of low bitrate scenario led it to be optimal for live streaming a video source, though it will not completely replace codec like vp9/h.265 or the new upcoming h.266 which will be still used for recording and storing the video files

[6] The Authors Zheng Zeng, Shiqiu Liu, Jinglei Yang, Lu Wang, Ling-Qi Yan et. al. came to the conclusion that Real-time ray tracing is a reliable denoising scheme that allows for the reconstructs clean images from significantly undersampled noisy inputs, and 1 sample per pixel (Spp) as limited by current hardware's computing power to produce optimal frame rate video output, as lower frame rate will cause the video output to stutter. The development and newer methods as well as development in the Hardware will to more than 1Spp

Technologies Such as that Real-time ray tracing will definitely replace existing technology like screen-space reflection (which currently use trickery produce reflections) leading to accurate reflections, shadows and Global Illumination.

[8] Using Content Adaptive Resampler to upscale images, videos and game video resolution to improve clarity making the output to sharp and high-quality edges and distinctive pixel details, resulting in a frame which is significantly better than original, this method improves performance while minimizing the impact to visual fidelity as the frame generated is a lower resolution leading to less Stress on GPU

The Image Generated is close To Native image buts it's not the same and more development and newer methods needs to researched on.

[11] The AI running on GPU to further develop the Driverless car, this is an excellent example of training via machine learning and developing Ai.

Ai development has its impact Game development since the early days of game development with games like chess, etc.

V. CONCLUSION

This paper focuses on Game Development Technologies which are currently used and have scope of development in future and have impact not only in game development but in IT in general.

Game Development technologies such as Upscaling, Ray Tracing and Parallel Processing are used in conjunction with each other to overcome flaws produced by traditional rasterized rendering of games, though raytracing is demanding on hardware, using upscaling methods should improve performance.

Not only does Upscaling improves performance in raytracing it also improves performance in rasterized rendering of games making highly useful.so new ways of to develop upscaling methods are required and many companies are doing so.

Parallel Processing in game development has been influencing the IT Field for many years and if implemented properly performance almost scales linearly. Getting the implementation of parallel processing is time consuming and difficult process and more research needs to be done to implement it in game development.

Game development can serve as a viable choice of career and as we learned above impact game development has had on world of technology whether it be directly or be indirectly all technologies in IT are interlinked and integral part of development and hence one should not just ignore and may also consider career in Game Development.

3D Graphic are being used in multiple movies and technologies used in movies are a lot similar or same used to develop game such as Unreal Engine Can be used to developed games as well as Movie 3d Assets which are being used as of today. Take Oblivion movie as an example which used projector screen instead of green screen since movie set was

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mostly glass so light rays was calculated using Unreal Engine and projected and mapped in real time to give superior experience which cannot be achieved using a simple green screen.

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