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FRAME COMPOSITION IN DISPLAY GRAPHICS: A COMPARATIVE STUDY

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Abstract: Frame composition ins display processors has attained a place of significant importance in the utilization of the computing resources due to the rising trends of larger display panel screens in the smartphone market. There is a significant demand among the user demographics of smartphones for a need of better visual output and user-interface of the smartphone screens. A better and more complex user-interface and graphics on the smartphone screen results in a larger number of frames to be composited together to show the user the final display output. Frame composition refers to the process of overlaying various frames such as the user-interface bar, app icons, wallpaper, splash screen in a certain order pertaining to its z order to make up the final display out which the users sees. This task of composition of the frames can be carried out by various approaches which will be explored and an in depth understanding of the differences and the similarities between them will be gained and logged to optimize the approaches resulting in better performance of the frame composition process.

Index Terms **- Composition, Writeback, OpenGLES, Mobile Display, Pipelines.**

I.INTRODUCTION

In today's competitive world it is imperative for businesses of all scales to understand their customers' needs and trends in order to help serve them better. Data driven decision making is very crucial since every business today is inclined towards a growth beyond boundaries. It has been estimated that, in 2020 information generated per second for every human being will approximate to 1.7 megabytes accumulating to a volume of roughly 44 zettabytes or 44 trillion GB. Hence Data Analytics plays a pivotal role in its overall growth and market penetration.[1]

With advancements in technology and tremendous increase in computational capabilities, extensive research and comparison is required between the various approaches in order to weight the pros and cons and apply each approach based on the use case. Huge expanse in mobile phones, IoT devices and other internet services are key sources of raw data which are churned to form sense out of it. Hence an extensive comparative study between the various techniques of frame composition is required to generate meaningful patterns and make the optimal changes to the process of frame composition to gain the maximum performance from the display processors.[2]

In this research, well discuss 5 approaches of frame composition and the various advantages and disadvantages associated with each one of them.

1. GPU composition approach
2. Hardware composition approach
3. OpenGLES approach
4. GPU offloading approach
5. WB module approach

Figure 1 gives a basic understanding of how the frame composition [3] method works. The display input consists of two sources: app A and app B. The app A handles the display of the notification bar and the background wallpaper. The app B handles the display of a simple widget on the screen. The frame compositor is used to access each display input of the two apps via two pipelines and are composited together in a layer mixer. The final display is linked to a surface flinger to handle user touch interactions and finally displayed on the screen.

II. OVERVIEW AND PROBLEM STATEMENT

Composition of the layers is restricted by the number of pipelines in the display hardware. When the number of layers which needs to render to the displays goes more than that of the number of pipelines [4] which are present in the display HW then GPU will be used for composition.

Using GPU for composition means increased power usage and also increasing wait team for the processes which actually need GPU for drawing. This will finally affect the overall performance of the device. Thus, there is a need to research and comparative alternate means of frame composition techniques and draw meaningful conclusions and a new approach with better performance parameters.

III. APPROACHES

The five approaches of frame composition are discussed below and the distinguishing features such as model used, mobile architecture compatibility, number of buffers used, support for multiple pipelines, performance parameters such as latency, waiting time etc. are logged and compared.

3.1 GPU COMPOSITION

The GPU predominantly [6] used for graphics rendering is used for frame composition when the number of frames exceeds the number of pipelines. This GPU frame composition causes the following disadvantages and advantages.

3.1.1 ADVANTAGES

- Overcomes the hardware imitation faced by the number of pipelines.
- Faster composition due to the high hardware capability of the GPUs.

3.1.2 DISADVANTAGES

- Requires copy of buffers
- Requires processing power(CPU and, or GPU) to composite buffers.

3.2 HARDWARE COMPOSITION APPROACH

Most GPUs aren't optimized for composition, and when the GPU composes layers [10][6][7] from Surface-Flinger, apps cannot use the GPU for their own rendering. HWC implementations should support.

- Atleast four overlays:
  - Status bar
  - System bar
  - App
  - Wallpaper/background
- Layers that are larger than the display (for example, a wallpaper).
- Simultaneous pre-multiplied per-pixel alpha blending and per-plane alpha blending.
- Hardware path for protected video playback.
- RGBA packing order, YUV formats and tiling, swizzling and stride properties.

3.2.1 ADVANTAGES

- Contains dedicated primitive functions for frame compositing.

3.2.2 DISADVANTAGES

- Requires ground up code development with hardware integration.

3.3 OPENGLES APPROACH

OpenGL ES (GLES) describes a graphics-rendering API designed to be combined with EGL, a library that can build and access windows via the operating system (using GLES calls to draw textured polygons; placing rendering on the screen, using EGL calls). This page also covers a Native Window, the Java Surface class equivalent C / C++ used to build an EGL window from native code.
OPENGLEs [5] uses a combination of hardware and software for frame rendering and composition.

3.3.1 ADVANTAGES

- No dedicated hardware required.

3.3.2 DISADVANTAGES

- OpenGLES requires an additional processing time for each frame.
- It is better suited for computer GPUs.
- It is compatible with fixed pipeline architectures.

3.4 GPU OFFLOADING APPROACH

Kahawai: A system [9] that provides high-quality gaming on mobile devices, such as tablets and smartphones, by offloading a portion of the GPU computation to server side infrastructure. In contrast with previous thin-client approaches that require a server-side GPU to render the entire content, Kahawai uses collaborative rendering to combine the output to a mobile GPU and a server-side GPU into the displayed output.

3.4.1 ADVANTAGES

- Highly portable
- Can undertake high res frame composition even on moderate or low profile hardware capabilities.

3.4.2 DISADVANTAGES

- Requires a server side processing unit.

3.5 WRITEBACK MODULE APPROACH

The WB module is mainly used for screen casting and is idle at other times. This module can be used to composite the frames and write it to memory. The concerned clients can directly read the composited frames directly from this memory.This helps prevent involving the GPU for frame compositing, Thus the GPU can be fully used for graphic intensive tasks such as 3d games and video rendering

3.5.1 ADVANTAGES

- Utilizing hardware that is mostly idle during frame composition process.
- Faster composition since, the clock rate of the writeback buffers are faster than the display buffers
- Provides virtualization of display pipelines

3.1.2 DISADVANTAGES

- Requires a code development process from the ground up.

IV. RESULTS

From the comparisons made between the different approaches of frame composition, we can weigh the advantages and disadvantages of the approaches based on a few differentiating parameters such as:

- Hardware requirement
- Additional software development
- Response time
- Compatibility
- Portability
- Computing power
- Frame composition latency etc

All these parameters can be graphically tabulated in the form of a figure as shown in fig2

V. CONCLUSION

As seen from the previous approaches, we can observe that the performance parameters are determined by mobile resources such as hardware or processing or both. Utilizing the WB module for display compositing is a really novel way to improve GPU performance indirectly due to the lack of research in the WB module field.

VI. FIGURES AND TABLES

6.1 Mobile Display Processor frame composition

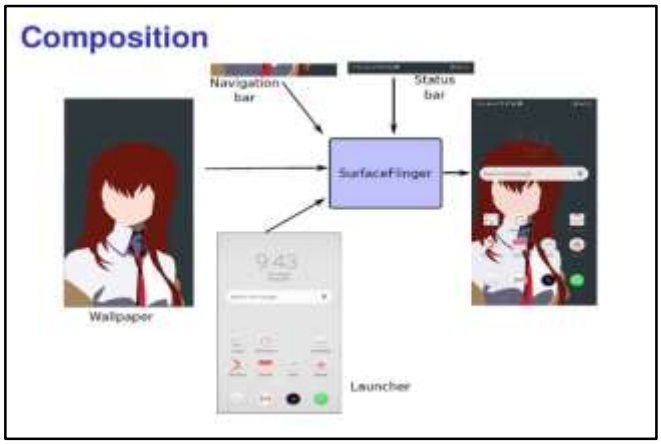

Figure 1Mobile Display Processor frame composition

6.2 Composition techniques table

VII. REFERENCES

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Year, Name of the Journal/ Conference	Title of the paper	Authors of the paper	Model/Sub Model used	Challenges of the paper	Limitations of the paper
Microsoft Research, Duke University, University of Washington	Kahawai: High-Quality Mobile Gaming Using GPU Offload	Eduardo Cuervo, Alec Wolman, Landon P. Cox, Kiron Lebec.	Dual gpu model client server model	handling latency while switching from local to cloud gpu and vice versa.	Requires a server side processing unit.
Adobe inc.	GPU assisted 3D compositing	Daniel O'donnell	GPU model	Increased power and waiting time	excess frames composition.
California State University. Northbridge	Graphics performance benchmarking using OPENGLES	Aram Akopian	opengles software woking in conjunction with MDP hardware	configuring it to work with multiple pipelines.	compatible with x86 computers architecture.
Nintendp Co .	Graphic systems	Timothy Van	Hadrdware gpu	Additional	Requires

Figure 2 Composition techniques table

Workloads on Hetero generous MPSoCs, June 2015.
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