Dynamic Composition of 3D Graphic Streams

Houda Chehab
Masahiro Takatsuka
School of Information Technologies
FACULTY OF ENGINEERING & INFORMATION TECHNOLOGIES

BACKGROUND

Conventional Transmission of 3D Data

- Server renders a 3D model and then sends a series of 2D images of the rendered scene to network clients [1]
- This technique is favourable as 2D content transmission has an upper bound on bandwidth costs, unlike 3D content transmission
- However 3D content is not available locally at the client

Using Bit Planes to Transmit 3D Contents

- Bit planes are 2D images that have single bit pixels [2]
- They can be compressed like images and transmitted to a client with an upper bound on bandwidth costs
- 3D content is encoded into bit planes at the server and sent to the client where the content is decoded
- 3D content is available locally at the client

RESEARCH PROBLEM

Extending the Bit Plane Solution

- Transmission via bit planes is limited to a single server to single client setup
- In real world scenarios, data can come from multiple servers in a network

Aims

- Extend the bit plane solution to handle numerous streams of 3D content, coming from different servers, to a single client
- Define how data coming from different servers can be combined onto one scene in real time

MOTIVATION

Real World Applications

The ability to combine 3D streams of data in real time has many real world applications

Advertisements in Gaming

- Advertisements sent from one server can be displayed within a game in real time

Medical Field

- Medical personnel can view 3D imaging scans of a patient in real time
- Local access to the 3D content will allow a doctor to determine what they wish to view and from which angle without the need for continually requesting 2D rendered images from a server

REFERENCES

[1] Liang Cheng, Anusheel Bhushan, Renato Pajarola, and Magda El Zarki. 2004. Real-time 3d graphics streaming using mpeg-4. In Proceedings of the IEEE/ACM Workshop on Broadband Wireless Services and Applications (BroadWise04), pages 116.

[2] John Stavrakakis. 2011. Transmission of 3D Contents for On-Demand Scene Reconstruction. Ph.D. thesis, The University of Sydney.

IMPLEMENTATION

Dynamic Composition

- A graphic stream is a stream of 3D content encoded using bit planes, transmitted over a network from a server
- Dynamic composition is the process of displaying 3D content from different graphic streams onto the same scene in real time

Defining the Composition

To ensure a meaningful composition, 3D content cannot be rendered onto a scene without prior thought into its location in that scene

Main Data Stream

- Stream of 3D content originating from the primary server
- Dictates where additional content can be composed to by defining a bounding box (a pair of coordinates that define the minimum x, y and z values and maximum x, y and z values for the space in which additional data is allowed)

Secondary Data Streams

- Streams of 3D content originating from servers in the network which are not the primary server
- Content of secondary streams can only be displayed within the bounding box defined by the main data stream

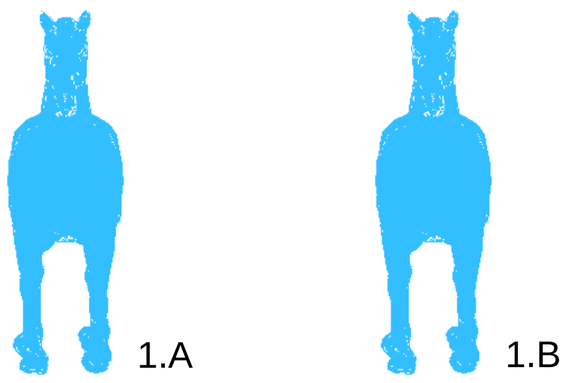


Figure 1.
A. 3D content sent from main server
B. 3D content sent from secondary server

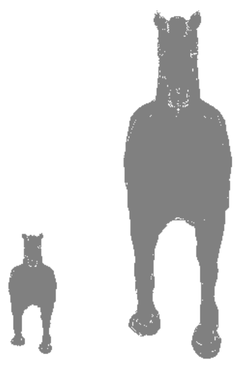


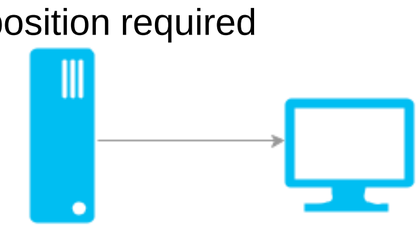
Figure 1.C. Composed 3D content displayed at the client
Note that even though the same model is sent from both the main and secondary servers, the secondary stream data has been manipulated to fit within a certain area (bounding box)

Network Models

Investigate the impact location of composition has on the average time to perform composition in three network models

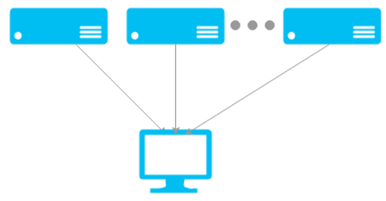
A) Single server to single client

- No composition required



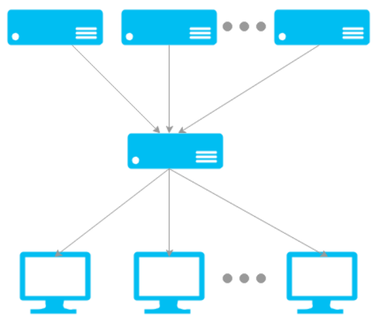
B) Many servers to single client

- Composition occurs at the client



C) Many servers to single intermediary server to many clients

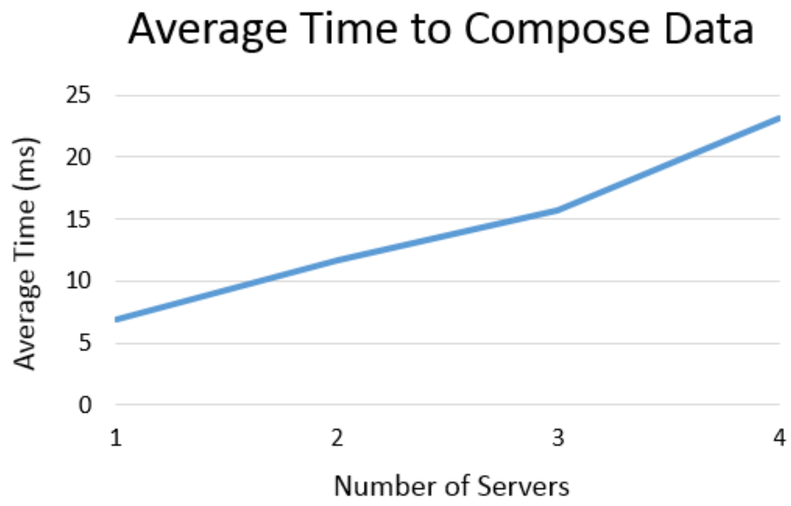
- Composition occurs at the intermediary server



INVESTIGATION AND RESULTS

Impact of Increasing Number of Servers

- Calculate the average time for data streams to be displayed onto a single scene with composition for network model B
- As the number of servers increases, the average time it takes to perform the composition and display to scene also increases – see Graph 1



Graph 1. Average time (milliseconds) to compose data vs. number of servers

FUTURE WORK

- Add synchronization mechanism for time-sensitive data. *Example: Main stream data is of a soccer player running and then performing a kick. Secondary stream is of a ball being kicked. Combined; the two streams show a ball being kicked by a soccer player.*
- Perform the composition at the bit plane level, i.e. while still encoded. For network model C this means data will not need to be decoded prior to being composed and then re-encoded prior to being sent to the clients.

KEY CONTRIBUTIONS

- Extended single server to single client solution to a many servers to one client solution
- Implemented dynamic composition of 3D graphic streams in real time
- Investigated the effect of adding more servers to the average time of dynamic composition for network model B