Flight simulation in 3D Web Map Services using Silverlight™ 3 to Reduce Simulation Costs in Pilot Training Institutes

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***Abstract*— Flight simulators used for pilot training requires a huge amount of information (data) for simulation and storage of the simulated data is a serious challenge. At present, Bing Maps 3D a Web Map service from Microsoft stores a massive 10 Petabytes of data which gives a full 3D view of the world and may be used in flight simulation. As Silverlight 3 supports perspective 3D which enables 3D transformation of 2D elements, it may be used to develop the application software which can download the necessary simulation data in real time from the Web Map servers for flight simulation and also act as a simulator on the client PCs.**

In this work, possible use of low-cost PCs for flight simulation is demonstrated. It is shown that instead of storing the simulation data in the user's PC, simulation client PCs may be connected to Bing Maps data servers via internet which download the necessary data during flight simulation. By proper use of Silverlight 3 Application software developed, simultaneous access by multiple client PCs to the Bing Maps servers is illustrated. Since the client PCs need not be powerful, it is shown that ultra-low cost PCs may be used to reduce the cost of flight simulators in pilot training centers. Other advantages of the proposed configuration are also discussed.

***Index Terms*— 3D, Bing, Flight Simulator, Silverlight 3, Web Map.**

I. Introduction

Flight simulators are widely used in pilot training institutes, air forces, and also by enthusiasts. Flight simulators are mostly used by the aviation industry to train pilots while cutting cost and risk factors. In general, flight simulators require a huge amount of information (data) for simulation. The main challenge is the storage and retrieval of data in the computer running the flight simulator and becomes a serious limitation for advanced flight simulators. In a low-cost PC, one cannot store typically more than 500 Gigabytes of data leaving no space for the user to store other types of data. Even if a state-of-the-art high-end workstation is used, one cannot store more than 10 Terabytes of data. The quantity of simulation data being almost endless, a proper system is needed to store and use the massive data for flight simulation. It would be cost effective if one could store the simulation data in a server from which multiple clients can access the data.

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A flight simulator is a system that tries to copy or simulates the experience of flying an aircraft. It is meant to be as realistic as possible. But as one moves on to flight simulator, one does not get the full view of the world as it is almost impossible to store the world's full view in a single PC with reasonable image quality and at a reasonable cost.

As the Bing Maps servers, hosted and maintained by Microsoft Corporation stores huge simulation data, it is proposed to get the most out of the flight simulators by using the Microsoft's Bing Maps 3D as the virtual world and Silverlight 3 as the platform to do so. In this work, it is proposed that instead of storing the simulation data in the user's PC if it would be possible to use the web map server data for flight simulation. For the purpose, one needs to connect simulation clients to Microsoft's Bing Maps data servers via internet. Further is needed to develop client based software that will download the necessary simulation data from the Web Map servers and act as a simulator on the client PCs. One needs to build a client based application software to render necessary data for the particular location of flying chosen by the user and present them as 3D simulation on the client PCs across the globe. To build the application software, one needs to have a detailed understanding of flight simulation controls and Silverlight 3 concepts.

II. Bing Maps 3D

Earlier known as Virtual Earth, Bing Maps is a Web Map service that stores almost whole of the earth's view in 3D [1].

Fig. 1. Photograph of the Microsoft Virtual Earth Data Servers [2].

The Bing Maps is a part of the Bing Services provided by Microsoft. The Bing Maps servers are located at Boulder, Colorado, storing more than 10 Petabytes of data and counting [2]. The 3D Maps features allow the user to see in 3D, with added facility to rotate and tilt the angle in addition to panning and zooming [3]. For achieving near photo realism, all 3D buildings are textured using composites of aerial photography.

III. Microsoft Silverlight 3

Microsoft Silverlight is a programmable web browser plug-in that enables features such as, animation, vector graphics and audio/video playback that characterizes rich Internet applications [4]. Silverlight 3 includes a large number of controls including, but not limited to *DataGrid*, *TreeView*, various layout panels, *DataForm* for forms-driven applications and *DataPager* for viewing paginated data. On the media front, Silverlight 3 supports AAC audio decoding as well as hardware accelerated H.264 video decoding. The native multimedia pipeline is also programmatically exposed, so that other formats can also be supported by third parties using managed code decoders.

Silverlight 3 supports perspective 3D which enables 3D transformations of 2D elements. These transformations, as well as many 2D operations like stretches, alpha blending etc. are hardware accelerated [5]. Custom animations including transforms and blends can be created on Silverlight elements using HLSL to make use of pixel shaders. A Bitmap API is provided to let Silverlight 3 applications manipulate bitmaps.

Silverlight 3 uses the GPU on the client PC to accelerate the composition of *Visual Trees* which can also be cached. This increases performance in cases like transforms, which creates lots of throw-away intermediate states, by not making the state transitions on the main Visual tree. Silverlight 3 also supports Out-of-Browser experiences i.e., Silverlight 3 applications can be installed to the system (provided the application manifest is designed to allow local installation) where they run outside the browser.

IV. Working

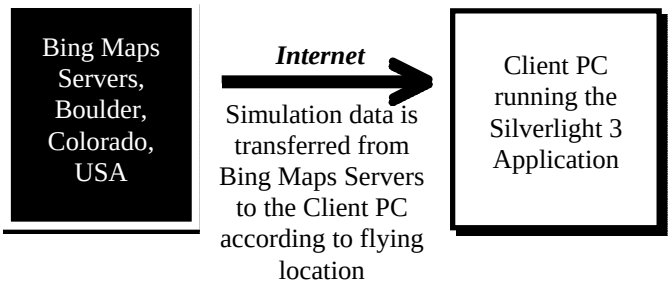

Fig. 2. Data flow diagram for single client.

Fig. 2 shows the data transfer between one client PC and the Bing Maps Server. The data transferred on the PC would be according to the flying location chosen by the user. For example, if the user is flying past Washington DC, then only images of Washington DC will be loaded on his/her PC.

However, users across the globe can access the Bing Maps servers at the same time during simultaneous flying. The block diagram (Fig. 3) shows the data flow in which multiple clients' access simultaneously the Bing Maps Server through the internet. The data transferred to each client will depend on the flying position chosen by the client. If the user (Client PC1) is flying from New York, then images of New York will be transferred to his/her PC, whereas for user (Client PC2) flying to Las Vegas at the same time, then images of Las Vegas will be transferred to his/her PC. The images transferred to each client PC will be processed by the Silverlight 3 Application and the output will be displayed as simulation.

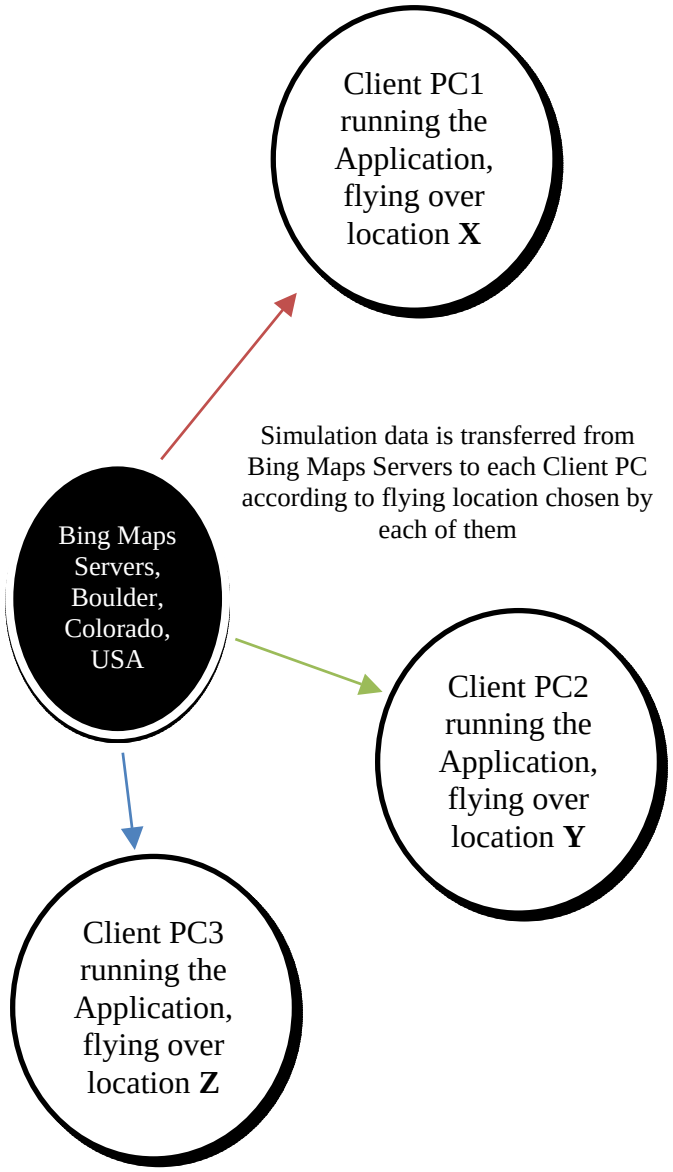

Fig. 3. Data flow diagram for multiple clients.

V. Functions of the Silverlight 3 Application

The basic functions considered in Silverlight 3 Applications development for flight simulation are listed below.

1) Take the input of flying location from the user and load initial data from Bing Maps Server.
2) Process the data to create a 3D environment.

3) Place an aircraft cockpit properly before the 3D environment. The application would preferably have cockpits of different aircrafts with all controls as in the real aircraft.
4) While flying the aircraft, the 3D environment should change as per the control command from the user.
5) The measurement and navigation instruments in the cockpit must also change according to control.
6) To have a complete flying experience, there must be an audio support which will respond with flying.

The simulation experience can be enhanced by including more real life scenarios, like engine failure, weather conditions, etc. Other feature that may be included is multiplayer like support, i.e., several users across the globe would fly their aircrafts in the same virtual world where one can see each other or even go for collision with the other aircraft. This would take the flight simulators to a new level.

VI. Experiment

To demonstrate some of the capabilities of the proposed idea, a basic simulator, with only a few vital controls and instruments, has been developed using Silverlight 3. Screenshots of an aircraft flying over New York is shown in Fig. 4 in which a Boeing 747 aircraft cockpit is used for simulation. The measurement and navigation instruments shown are non-functional and are not a part of the present experiment. However, for the advanced flight simulator development, these instruments should be included which needs a good understanding of the aerodynamic principles.

Fig. 5 is another screenshot of the same New York City in

Fig. 4. Screen shot from flight simulator using Boing 747 flight Deck.

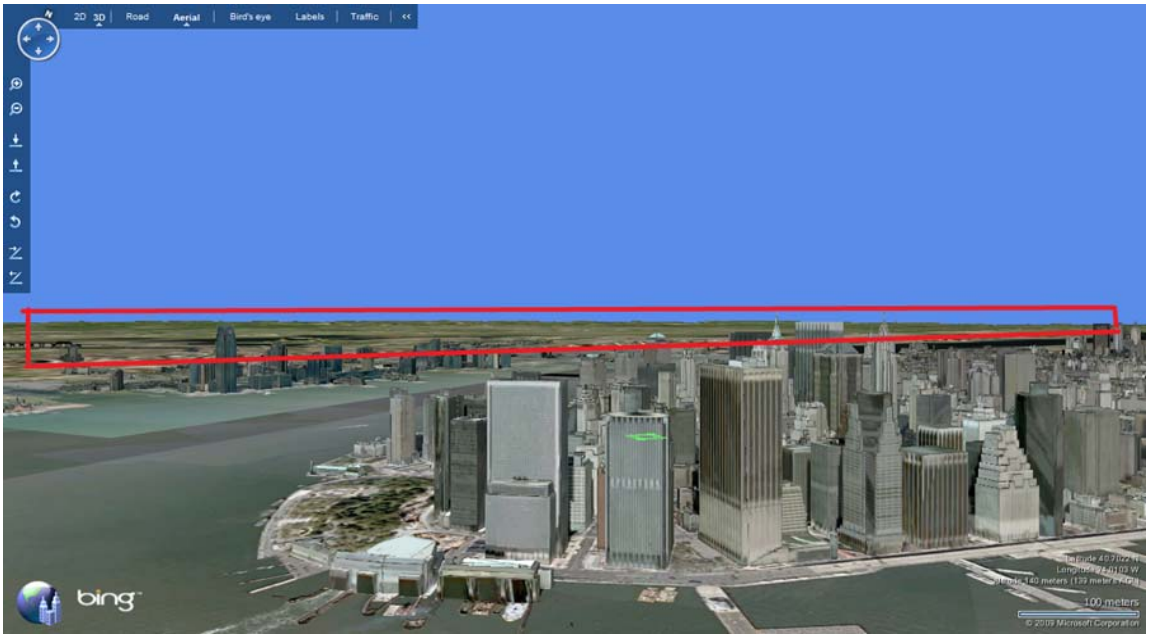

Fig. 5. Screen shot of Bing Maps from web browser in New York.

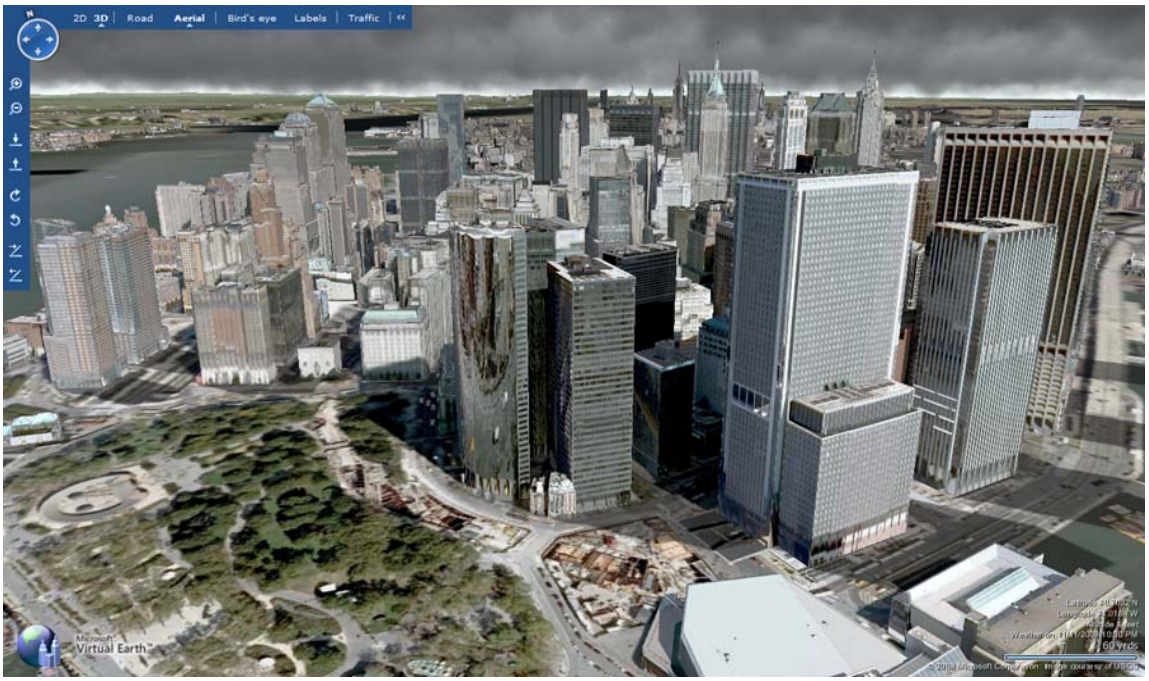

Fig. 6. Screen shot of Bing Maps from web browser showing weather feature.

a web browser. The marked area (red box in Fig. 5) is used to indicate one drawback of the Bing Maps when used in web browsers. In reality, the area is also full of numerous buildings. But due to cache limitations of the web browser, distant objects in a map do not get loaded. This may be resolved by using the Silverlight 3 application which can have sufficient cache memory to store and display distant objects as well. The experimental simulator developed does not address this problem.

The experimental application was developed with the help of the Bing Maps Silverlight Map Control CTP program available inside Microsoft Connect [6]. Since it is web browser based, modifications are made to make an out-of-the-browser experience in the experiment.

Next we consider the weather feature. Bing Maps supports live weather as shown in the screenshot in Fig. 6. The weather conditions need to be improved further with the use of artificial clouds and other natural phenomenon. Regarding the audio support, the Silverlight 3 application can store and play required audio file(s) at different phases of flying and the audio files may be stored locally on the client PC as they are limited in number and also size.

VII. Advantages

The present proposal of using Bing Maps 3D Web Map service for flight simulation has the following advantages:

1) Ultra-low cost PCs may be used as client PC for flight simulation and thus reduce the flight simulation cost.
2) No expense is involved towards the establishment and maintenance of servers and data.
3) No maintenance of the simulation data is required by the end users.
4) Possible inclusion of more real life experiences [7]. In general, major simulators available today make a limited mock up map (in high definition) to make the simulation look real which, however, has little or no resemblance with the real world.
5) The software installation procedure on the client PCs is much simpler and quicker.

VIII. Conclusion

A novel approach for flight Simulation in 3D Web Maps is demonstrated which is expected to take flight simulation to a new level. Further design and development of the application software is needed to transfer the proposed idea in an advanced flight simulator which may be employed for pilot training. Apart from the client software development, the web map servers also need to be updated to support such application in a better way. It would be interesting to see if any organization, such as Microsoft, would take initiative to develop a comprehensive product for commercial success.

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