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Phoenix Fighters: Virtual Flight Simulator for Air force Trainees

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Abstract: Flight Simulation is a very important area in the fields of engineering and air nautical science. Air nautical science is very dangerous in its nature. Air force training this is a very critical fact. At a time like this when a single air craft costs millions and the invaluable human resources should be protected. So in this scenario flight simulator is a very good solution. This research is about implementing an efficient and real world like virtual environment with dynamic/multiplayer learning for trainees. Unity3D was used as the engine for implementing the system.

***Keywords*: Air nautical science, Virtual, Simulator, Dynamic Learning, Multiplayer, combat simulator**

I. INTRODUCTION

The main purpose of this research is to create a real world simulated and dynamic learning environment with networking. As air nautical science is a field of engineering which uses the air craft technology this research supports the security for those who uses air craft technology and as a good learning material before getting the actual hands on experience which leads to a cost effective and efficient training procedure.

A combat flight simulator is a device that artificially re-creates aircraft flight and the environment in which it flies, for pilot training, design, or other purposes. Most simulators can only be played by a single player. With this, everything other than the player's own aircraft is controlled by the program's "AI". It is not a good technique to create a single player simulator because it simulates only the developer's perspective towards air craft strategy.

Multi-player games allow players to oppose one or many human players for a much more realistic and challenging experience. The goal is to provide the closest experience on real air planes. Rather than using many missions and levels to train with, in this research product focuses on the productivity per level. Two levels consisting different terrain and weather levels are included. A static content level to increase the awareness of flight technologies. This will allow a productive learning experience for the trainees. Mainly this is using for a flight training (mainly of pilots), the design and development

of the aircraft itself, and research into aircraft characteristics and control handling qualities.

Dynamic learning teaches trainees to learn with their own mistakes. With multiplayer capability they can train with team mates or officials those are supposed to train with. With that it gains much productivity and efficiency over a traditional static content based flight simulator creating a great advantage over static learning.

In upcoming sections of this document background of research, how it was implemented and results will be discussed in order.

II. BACKGROUND

F.Persiani et al talks about the heads up display system for flight simulator using a helmet system which is run by 320x200 pixels resolution at 256 color depth and gloves system to track down motion inputs from the pilot [1].
F.Bouton and O.Beavel'toni have designed a controller system for flight simulation. This system is essentially a keyboard emulator built with a key sequence address decoder logic interpreter. So what it does is arraying the key inputs where traditional keyboard fails. A standard keyboard and a key roll over limit of six. Due to that reason user can't press and actuate more than 6 keys in a single instance. So what this project gets additional inputs as a single signal from serial connection and translate them to keyboard inputs [2].

B.Beckman's research addresses the simulation rotations over X, Y, Z axis in a display for roll, yaw and pitch rotations. Which makes a 6 degree rotation. The innovative spherical apparatus helps the pilot to use the flight than a conventional joystick system. With six degree free controller coupled with the vivid display unit can simulate superimposed geometrical figures so the training pilot can actually feel that he/she is in the air craft with the sense of real world flips, banks and pinch up/ down maneuvers [3].

T.Nelson et al introduced alternative control tactics to enable users to control flight simulation without using their hands such as brain actuated body control system, employs a combination of EEG and EMG signals produced at the user's forehead to generate computer inputs that can be used for a variety of tasks. Brain signals inputs are accepted using a special apparatus and they are processed to check with a database of brain wave signal patterns which were recorded previously for specific commands. After matching a specific brain wave pattern the ideal command for simulation process can be executed [4].

B.J.Schachter's research is about generating computer images for simulation processes. This research talks about how to use brightness and contrast controls, cockpit simulation generations, screen update rates, ideal field of views, generating atmosphere effects and texture mapping in order to simulate day and night environments [5].

P.A.Platt et al describes the low cost approaches to flight simulations. The normal and most effective way is to use large monitor systems or projector systems to aid virtual flight simulations. They cost a very high amount. What this research suggests is the using HMDs (Head Mounted Displays) [6].

Alexander R. Perry's research is implementation of a virtual flight simulator using computer aided graphics. Talks about how the core structure of a flight simulator has to be completed and how to work the way up in the ladder adding necessary components to the core structure to make a near perfect virtual computerized flight simulator [7].

John C. Switzer's research project focuses on the synthetic environment usability to develop a realistic, distributed network, synthetic environment flight simulator. This project essentially focuses on using parallel computing and multiple processing to increase texture mapping capabilities and simulate the simulation with real world like throttle and handling systems [8].

Eugenia M. Kolasinski's research talks about hazards and symptoms that can occur using virtual simulation systems over a period of time [9].

Hongbin Gu et al focuses on giving the most perfect sensation of a virtual simulation for trainees. It uses a real air craft body to build up the simulation itself. Rather than using a monitor rendered cockpit switch board, trainees get to use a real cockpit controller system with windows replaced with vivid displays to simulate the atmosphere [10].

Daniel Cohen et al introduced the concept of rendering atmosphere in more realistic measures. Color corrections, contrast ratios, mip mapping, 3D object saturation, and parallel processing of graphics objects are the most widely discussed areas of them [11].

III. METHODOLOGY

For the implementation of the system a lot of resources and information were needed.

A. *Requirement gathering and Analysis (Primary)*

Ratmalana Air force academy in sri Lanka was the main information and resource facilitator for this research project. After gathering information was done, analysis was done in order to understand the balance and dependencies between facts that are going to be useful in the development stage. When analysing information those were divided in to separate parts. How different axis of an air craft are balanced, how the balancing mechanism works, how balancing mechanism in indicating changes in the atmosphere and manoeuvre changes of plane via the instruments in the cockpit, main instruments that helps to navigate an aircraft, how air craft behaves in different weather condition and temperatures and how firing mechanisms work with weapons in an air craft.

B. *REQUIREMENT GATHERING AND ANALYSIS (SECONDARY)*

As this research is built upon graphical basis, usage of a game engine was opted than program its way up using a more traditional graphics API like Microsoft DirectX or OpenGL. From all the graphic engines out there Unity3D engine which is based on NVidia PhysX, OpenGL and Ogre libraries are selected because of seamless integration and ability to use C# as a scripting language which helps to prototype quickly. NVidia PhysX is a physics library which emulates the gravitational forces and collision systems. OpenGL and Ogre are responsible in handling rendering, transformation and other 3D related tasks inside unity. Inside Unity3D every module are designed as scenes and components attached to those scenes.

C. *DESIGN*

Simulator is designed as separate scenes for maps and menu contents. Two main maps are included. One in a mountain terrain and one in a desert terrain. Featuring night and day weather cycles for stealth training and dog fight training. Two maps have different rules to adhere. In the night map all the players should operate under a certain distance to avoid detection. Likewise different maps have different rules. All players are briefed about the situation in help scene.

As for dynamic learning environment multiplayer with computer networking is used. Even though Lidgren library was the first choice of multiplayer networking later opted for unity built in networking API because of the seamless integration between network sessions with the help of NetworkView function that is also a built in feature of Unity3D which gives better results as they are matched and integrated with the core engine of Unity3D.
A server is created in the host machine and host machine is automatically elected as the commander to that session. Clients who connects afterwards are elected as trainees.

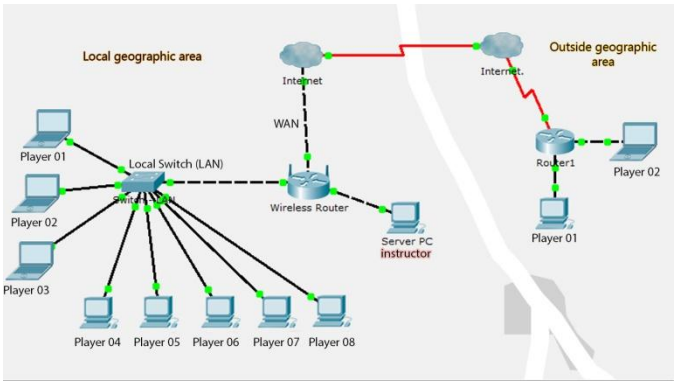

Figure 1. Architecture Diagram

D. *IMPLEMENTATION*

In the GUI simulator divided to main 2 parts. Menu screens and world scenes. Menu scenes include all the buttons and selection items to get the simulator start and running.

While world scenes presents the actual world to train with beautiful terrains. World scenes are again divided in to subsections as HUD and NetworkView. HUD is the central piece of intelligence giving all the battle awareness to the pilot and other information on flight instruments and the flight itself. Opted to use a HUD other than a set of instruments as screen real state is very important than using traditional cockpit system. NetworkView renders all other fellow trainee air ships, combat, explosions and whatnot with the help of Remote Procedure Calls (RPC) functions in Unity3D. Group communication system is implemented as a chat message synchronization in order to simulate group communication as in a real world scenario. Hints for the pilots to enhance their air manoeuvres are advertised in the upper left corner. Below that a small mini map is created to identify where exactly other players are. It's and top orthogonal view simulating a radar view.

E.*TESTING*

Testing phase was carried out in 3 phases. As in the implementation, single components were implemented by different developers they were unit tested if functionality is correct considering a single player mode. After integrating in to the networking functionality whole software was tested as in code quality and functionality. As this software product is developed as a prototype development public testing was not possible to achieve. Prototype software was tested with random people from university and students from Asian Institute of Technology. Testing was done as in prototype model testing. For white box testing whole code base was tested by developers and third party knowledge resource person outside the project. In optimal test cases for system with minimal lag and efficient lag compensation only 10 players were successful. Any more than 10 players caused very low network smoothing with jaggy movements.

IV. Results and Discussion

A.*Results*

Main screen in Figure 2 (After user presses enter on login screen player direct to main screen. Purpose of using a main screen is to get a simple idea about what are the main functionalities of this simulator and how to access them. Quality of this screen depends on user selected resolution. Recommended resolution is 1280 x 720. Session button direct to sever creating and server login area.

Figure 2. Screenshot of Main Menu

There are two types of planes F– 7 and MIG -27, user can select either one of these by clicking customize button. Get an idea about how controllers are working user has to click controls button. Help button goes to information about flight movements' screen (what happen when you turn elevator, rudder). Credit button goes to screen which is show information about development team. Exit button terminate the program)

Figure 3. Screenshot of Inputs Detail Screen

There are two types of input devices support for this simulator which are key board and joystick are shown in Figure 3 Controller screen. System recommends for control the flight use joystick because joystick gives real flight movement experiences by controlling it. Main Screen, controller button

direct in to two sections. This screen shows after selected joystick movement. Main idea about this page is how plane move according to joystick movements and what are the functions support for buttons (Ex: - Rotation camera button uses for look around cockpit. Fire button uses for shoot machine gun).

Customization screen (Purpose of this screen is for gives an idea about how to select plane according to the mission and identify the player from other players by creating profile. Most of the time F-7 uses for ground attack and MIG – 27 for sneak attack. After selecting one of these planes user has to enter name in to "Enter New Alias Here" area after that by clicking save profile button it save user preferences to their profile).

Figure 4. Screenshot of Simulator cockpit

Figure 4 screen show the inside view from the simulator. A 360 degree view pilot perspective view is accessible from the hat switch of the joystick apparatus which acts as the 5th Unity3D axis input system. In the left corner is a Knot meter indicator and in the right corner is a altitude indicator. These represents the HUD mount controls alongside with the center screen pitch meter. Analog meters are modeled in the center console. Knot meter, altitude meter, banking meter and altitude speed meter are implemented as the analog meters in the cockpit view. Left and right graphical knot and altitude graphics systems are implemented in order to give a quick idea about how faster and altitude the air craft is going on to the user. In the center console also represents the weapon lock and missile release icons in order to identify when weapon system is ready to use.

A. Discussion

Main target group of this simulator is for Air Force trainers. They don't have best performance machines always. This simulator has best 3D graphics under low level of computer software and hardware requirements. Multi-player games allow players to oppose one or many human players for a much more realistic and challenging experience.

This project goal is to provide the closest experience on real air planes and network synchronization to minimize lag time difference between clients (Two or more players are able to play the game at the same time. There must be a good connection between client and server in order to handle multiplayer connectivity. System guarantees each player's session that one can hack them and rewire their movements.

These are the problems faced that have been faced by development team. Smoothing network movement, Creating of Plane interior, Lag compensation, Creation of radar view, Target detecting on network environment, Missile follows the correct target on network environment. Solutions for the problems , Using extrapolation between points to make network smoothing easier, Outsourced plane models and used 2D models of meters for cockpit, Limiting number of players to 10, Radar view is unable to create using inbuilt Network View function due to fact that unique player positions cannot be identified referring to network name. Only possible with network IP and master server which is very unreliable, Code review.

V. *Conclusion*

"Phoenix Fighters" Virtual Flight Simulator is made for Air Force Training purposes. Sri Lankan air force trainees would not have a war any more to training under real war situation. Trainees will able to get real time experience by using Phoenix Fighters Virtual Flight Simulator. Training by using a real combat flight (F-7, MIG-27) was a huge cost but now "Phoenix Fighters" Virtual Flight Simulator made it easier. "Phoenix Fighters" is not only for air force trainees this can use as commercial purposes, such as day today life anyone who love to play flight games and if they are play games as a team "Phoenix Fighters" is the best solution for them. Because "Phoenix Fighters" compatible with the multiplayer function, this Flight Simulator comes up with the Local Area Connection (LAN) player connection and the online based multiplier functions.

There are several limitations in the "Phoenix Fighters" Virtual Flight Simulator. There are three types of user type that are normal mode, commander mode and pilot mode. Pilot mode for normal flight training. Commander Player is the master minded player who is controlling their crew and lead to the victory. Without these two, user can play free mode that is normal mode. Maximum number of playas are 10 and limited number of selectable war crafts available. User can select two types of planes either MIG-27 or F-7. F-7 normally use for ground attack and sometime it use for pilot training purposes. MIG-27 for bomb targeting and providing close air support. No player alias based radar support in this system. Session class use for handle timeout. For an example if user logout then session slot must be clear and free for other users who are currently playing. When connecting servers through the internet accuracy and the efficiency of the connection based on the internet bandwidth and the pin count of the connection. Mig-27 and F-7 have fixed amount of missile (a weapon that is sent through the air and that explodes when it hits the flight that it is aimed at).Start at the beginning, the players who need to connect they have to join to the server to play the session. End of session next mission can join the player who unable to

connect because of the limitation but no one can join at the middle of the session. If the flight destroyed no more life like other games and player will kick from the session.

There are much opportunities such a wildly distributed war flight simulation area like this. Very pleasant Recommendation can provide for the people who love to do such a research like this. End of the research who need to do he will be feel Complacent. For the People who love to do such a research like this is not easier what you they are thinking. They need deeper investigation even they harder to find combat flight functioning information based military. The project like these are very less number available in and these type of a project have much commercial valuable.

Future research might be much realistic graphics and realistic functions similar to original war crafts have. Multifunctional and efficient heads up display and the controller panel will gives reality of the real Mig-27, F-7 or whatever newest real life experience to the trainee and everything must same as realistic. Entering exact similar system must be much careful and there should be a security system like login function when attend to the special unites. Person identification system by using microchip based card and that include all the information about the trainee who allocated for this session and camera and identify the user by image processing. There will be a special surrounded flight dummy to get real time experience and it gives surround sound system to give real experience Not only but also special hardware devices to vibrate the trainee seat and trainee might have to put seat belts, acceding to that system identify trainee is safe with seat belts, at that time flight will have the function to rotate the virtual designed flight dummy inside laboratory.

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