Research on Three-Dimensional Virtual Reality Platform Based on Multiple Software Platform

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Abstract—**The Virtual Reality Platform's (VRP) secondary development always using other's programming software, the software with interface management and response ability is week about matrix transformation and scientific computing. In order to solve this problem, Three-Dimensional Virtual Reality Platform (TDVRP) was built, based on Multiple Software Platform (MSP). The MSP include Microsoft Visual Studio 2010 (MVS), MATLAB 2010, and XNA4.0. TDVRP can easily separate the interface design work, programming work and theory algorithm work. The three-Dimensional path planning's algorithm can be done in MATLAB alone. Programming development work can be done in MVS. XNA can show 3D object's motion in the sky. TDVRP is also can named Three-Dimensional Virtual Reality System (TDVRS). How to set up TDVRP was described, and how to using TDVRP was showed in a simple example. The example shows the correctness and effectiveness of TDVRP.**

Keywords-TDVRP; MSP; VRP; MVS;MATLAB; XNA

I. INTRODUCTION

There are many VRPs [1], and then XNA is a mature and beautiful technology in the VRPs. XNA is a Three-Dimensional game engine, created by Microsoft. XNA Game Studio Express is a powerful game tools in MVS based on .NET Framework, the developers can developments XNA games just using XNA Framework and C# language. MVS platform integrate a variety of programming language, C# is a fast visual development language, and it can reduce the time of development.

The WPF technology can develop desktop applications and wen applications using MVS, it needn't two sets of programs for web and desktop applications, so it is very convenient for developers. WPF interface can be built by XML language. WPF technology optimized the multi-thread mechanism. WPF can update the UI, and make the user feel a fluent interface at the same time.

MATLAB is computational software. It is also be a simulation tool for scientific worker. It is easy to make matrix calculation. It contains a lot of toolboxes, and is very convenient for real-time simulation.

Compared with MATLAB, MVS is not convenient to make matrix transformation, and XNA's matrix transformation ability is so weak. So, MVS is not suitable for matrix transformation and algorithm work.

In order to solve this problem, the TDVRP was built. The TDVRP was built by MVS, MATLAB and XNA. TDVRP also named Three-Dimensional Virtual Simulation (TDVS) or Three-Dimensional Virtual Reality System (TDVRS). Describe how to build and use TDVRP by a simple example.

II. MICROSOFT VISUAL STUDIO

A. Installaion of Microsoft Visual Studio

The software of MVS 2010 needs to be installed at first and the green version can't be used. Newest version is MVS 2013.

B. Description of Microsoft Visual Studio

The MVS supports the C# language programming, and WPF is better than Windows Form. There are many new graphics in the WPF. The WPF interface use the XML language, it is very likes HTML language, so the developer needn't to learn more language. The function of the software use C# language, so, interfacial work and functional work can be separated.

The WPF technology makes it is easy to rotate, move and zoom out or zoom in the graphic. It using DirectX engine, support accelerate the hardware using the CPU. It can check the device and monitor resolution automatically. It supports the multi-threading operation. The background threading can update the UI. It supports the .NET assemblies, DLL link library and COM components using the .NET Framework.

The WPF support the .NET assemblies which form the MATLAB. The C# developer needn't to know how to use MATLAB.

C. Code of Microsoft Visual Studio

The real-time graph can be created by the WPF technology, and the three-dimensional position's curve is displayed in the WPF. The user can input commands to the WPF windows, and the inputs used to control the three-dimensional objects. Main code for shows object's position is show as follows:

```
DataTable dt = new DataTable();//the bunding datatable.
dt.Columns.Add("time");//time columns
dt.Columns.Add("x");
dt.Columns.Add("y");
dt.Columns.Add("z");
```

```
DataRow dr;//the data table's row.datarow

int j = 0;

for (int i = 0; i < 99; i++){

        dr = dt.NewRow();dr["time"] = i;

        dr["x"] = dtold.Rows[i + 1]["x"];//get the 99 old point x

        dr["y"] = dtold.Rows[i + 1]["y"];//get the 99 old point y

        dr["z"] = dtold.Rows[i + 1]["z"];//get the 99 old point z

        dt.Rows.Add(dr);}

dr = dt.NewRow();dr["time"] = 99;

dr["x"] = p.X + speed[0]*steptime;//set the new point at the last point ,x

dr["y"] = p.Y + speed[1]*steptime;//set the new point at the last point ,x

dr["z"] = p.Z + speed[2]*steptime;//set the new point at the last point ,x

dt.Rows.Add(dr);

chart1.DataSource = dt;//bounding the data to the chart1,

chart1.DataBind(); //do the command line.
```

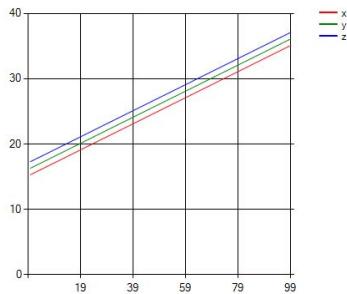The objects' position curve shows like Figure 1. The object's position is showed.

Figure 1.   Position curve (WPF)

III.   MATLAB

A.   Installation of MATLAB

The software of MATLAB 2010 needs to installed before using M language and the green version can't be used. Newest version is MATLAB 2014.

B.   Description of MATLAB

MATLAB is a great platform for the mathematical calculation, and it can make numerical simulation conveniently. It use M language to make numerical simulation and calculation, its programming model is different from the traditional interactive programming model. M language, a loosely type language, reduce the time of development. MATLAB can debug the code step by step. M language is closer to mathematical expressions, it is easy to develop.

MATLAB make the matrix serialization, it's reduce the time of calculation. There are many toolboxes in the MATLAB, such as data collection toolbox, fuzzy logic toolbox, LMI control toolbox, DSP and communications toolbox, robust control toolbox, maps toolbox, image engineering toolbox [2].

The .NET assemblies, COM components for MVS and java package for eclipse can be compiled by MATLAB.

C.   Code of MATLAB

MATLAB compile the .NET assemblies for MVS. The developer just needs to learn the M language, and the follows code shows in M language (save the code to *functiontest.m* file).

```
function [speed]=functiontest()

%return the speed of next step time

speed=[0.1 0.1 0.1;];%this is the return value of speed.vector3

end
```

These code can be real-time simulated, and it's effective to get the result when modify the code. It does not need the .NET assemblies when debugging these codes.

IV.   XNA

A.   Installation of XNA

Make sure the tool of XNA was installed before using XNA Game Express, and make sure that the MVS was installed.

B.   Description of XNA

XNA is the short name of XNA Game Studio Express. It's developed by the C# language. It can make two-dimensional and three-dimensional games for windows system, Xbox 360 [3] and win-phone system. It's also a game framework, can generate necessary code automatically, developer need to add codes to the framework. The framework code is instantiated from Microsoft.Xna.Framework.Game class.

It can generate many functions, such as the initialization function *Initialize()*, load the components function *LoadContent()*, uninstall the components function *UnloadContent()*, update the game UI function *Update(Gametime gameTime)*, and the shows UI function *Draw(GameTime gameTime)*. These codes' executive order shows in Figure 2.
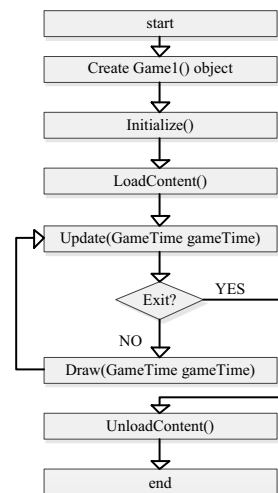

Figure 2.   Codes's executive order

XNA's three-dimensional game model is based on three-dimensional camera model. The object will be project to the two-dimensional screen [4-5], the theory is shows in Figure 3. XNA platform is better than the other platform, such as EON platform [6].
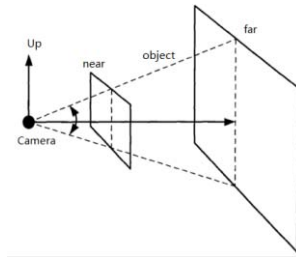

Figure 3.   XNA's project theory

Figure 3. shows the camera's the minimum and maximum distance of visible. XNA is suitable for display three-dimensional object and update the object's position [7-13]. Paper [7] shows a very beautiful boat by XNA.

C.   Code of XNA

XNA platform is the TDVRP's kernel, it can display three-dimensional object in the three-dimensional space, invoke the MATLAB engine (using M language), and invoke the WPF forms to shows path's curve. Code on XNA platform shows below:

```
public class Game1 : Microsoft.Xna.Framework.Game

{///the game class

GraphicsDeviceManager graphics;//every game class have one device.

public Camera camera;//three-dimensional camera

Matrix world = Matrix.Identity;//the matrix for 2D to 3D

Aircraft aircraft;//the aircraft

GetSpeedFromMatlab speed;//the speed

Form1 showRouteFormtest013;//the form show of xyz.

public Game1()

{//build the game.

graphics = new GraphicsDeviceManager(this);//check your device.

Content.RootDirectory = "Content";

}

protected override void Initialize()

{//initialize function

//new a camera for XNA

camera = new Camera(this, new Vector3(0, 0, -50),

Vector3.Zero, Vector3.Up);

Components.Add(camera);//load camera

aircraft = new Aircraft(this);//new a aircraft

Components.Add(aircraft);//load the aircraft

speed = new GetSpeedFromMatlab(this);//new a speed basemodel.

Components.Add(speed);//laod the speedmodel.

showRouteFormtest013 = new Form1();//new the form to show the path.
```

```
showRouteFormtest013.Show();//show the path's form.

base.Initialize();//the game's father class initialize function.

}

protected override void LoadContent(){}//LoadContent function

protected override void UnloadContent(){}//UnloadContent function

protected override void Update(GameTime gameTime)

{//update the model funcion

if (Keyboard.GetState().IsKeyDown(Keys.Escape))

{

this.Exit();//if press the esc key, exit the TDVRP

}

speed.Update(gameTime);//get speed form the matlab function.

aircraft.Update(gameTime);//update the aircfat model postion,60Hz

//update the show form of path ,WPF form.

showRouteFormtest013.ShowRouteFormtest013Update(game1spinposition);

base.Update(gameTime);//the game's father class update.

}

protected override void Draw(GameTime gameTime){//draw function.

aircraft.Draw(gameTime);//show the aircraft in the XNA form,60Hz

base.Draw(gameTime);//the game's father class draw.

}

}
```

The *aircraft* is the aircraft model, and it can be drawn by the Blender software. The *speed* is the aircraft speed vector, can obtained by the below code.

```
Type                matlabAppType                =
System.Type.GetTypeFromProgID("Matlab.Application");

MLApp.MLApp matlab = System.Activator.CreateInstance(matlabAppType) as
MLApp.MLApp;

string matlabExecute = @"cd D:\MATLAB\R2010b\bin\";

string result = matlab.Execute(matlabExecute);

matlabExecute = @"[speed]=functiontest();a(1,:)";

result = matlab.Execute(matlabExecute);

string[] strs = result.Split('\n');

string[] strs3 = strs[3].Split(' ');

float[] speed = (float)Convert.ToDouble(strs3[4]);
```

The MSP's relationship in the example is show in Figure 4. It shows that XNA is the kernel of MSP, and the data stream (game-time) from XNA platform to MATLAB platform, and then the speed form MATLAB platform to WPF form and XNA platform.

The game-time increased automatically by the XNA game framework. The data of game-time is obtained by MATLAB platform, and the data of object's speed is output from it. The object's path shows like Figure 1.
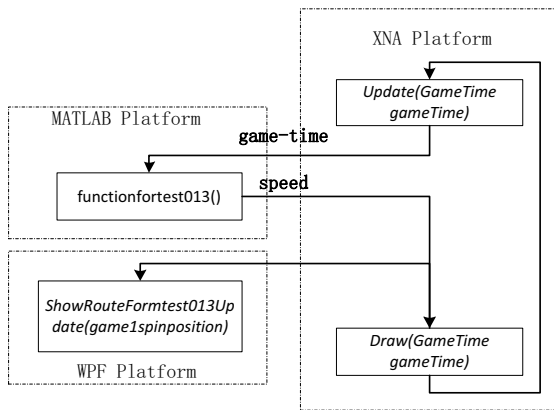
Figure 4. MSP's relationship

When the XNA platform execute the *draw()* function, the TDVRP shows the aircraft in the XNA forms, like the Figure 5.

Figure 5. TDVRP's aircraft

V. CONCLUSION

Through the simple example, the TDVRP was built by MSP. The example shows the correctness and effectiveness of TDVRP. TDVRP can easily separate the interface design work, programming work and theory algorithm work.

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