Paper plane
An investigation of educational game for horizontal-projectile motion using Empirical Modelling

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Abstract

Horizontal-projectile motion is one of the most traditional branches of the classical mechanics, which will be usually taught in secondary school. However, horizontal-projectile motion is difficult to understand because, it is concerning to some of the other physical factors, such as vector, speed, displacement and etc. Educational game, a new area in computer programming, can simplify the difficult problem into an educational visual game, so that the problem can be learnt while playing. The model of paper plane is an educational game which using empirical modelling to performance horizontal-projectile motion. The game will involve most of the factors which may influence the motion track. This paper will introduce the educational game of paper plane and explores the investigation how empirical modelling will be adopted in the educational game.

Key words: Horizontal-projectile motion, educational game, empirical modelling

1 Introduction

Paper plane is design as an educational game using empirical modelling. However, the model is not a complex game with much playability; instead the aim of the game is to create software for visualization of the horizontal-projectile motion for educational use.

1.1 Background

Projectile motion is one of the common phenomenons in everyday life, for instance, basketball game, airplane falling, and even a bullet flying and etc. Projectile motion can be defined as the motion of an object whose path is affect by the force of gravity. [1] Gravity is a force that acts on objects, which makes objects accelerate downward. [1] Gravity sis different in some areas of Earth, but it is more or less 9.8m/s^2. The path followed by a projectile is called its trajectory. This project aims to track the trajectory, and visualize the process of the motion.

1.2 Game design

1.1.1 Educational game

With the development of game industry, educational game is becoming a popular issue and draw more and more attention not only game developer but also some parents. Educational game can be defined as the games which design to teach people some knowledge or learning a skill when playing. [2] Educational game is an easy way for young children to learning knowledge. In order to satisfy the requirement of the parents and young children, the game is designed as an educational game.

1.1.2 Prototype of paper plane

The idea of paper plane comes from a traditional game ‘Tank game’. The game is simple and easy to play. Two tanks will fire to each other by turn and

destroy the other finally.

Figure 1: tank game

There are plenty of similar games on the internet; however most of the games are designed for entertainment. In other words, these games are much playable rather than educational. Paper plane aims to teach young students about the projectile motion for educational use, which makes the game more significant.

1.1.3 Empirical modelling

Empirical modelling (EM) is a field of study with a great affinity for application in Educational Technology. [3] Empirical Modelling is first and foremost concerned with sense-making activity in all its aspects. Where the use of computer technology is involved, thinking with computers is an informal characterisation of EM that clearly embraces more than the classical theory of computation takes into account. [4] Empirical Modelling describes the characteristics of a construal with reference to three key concepts: observables, dependencies and agents. [5] Observable is just the basic requirement of educational game, while dependencies can make the model more complex and educational.

2 Creating the Model

Paper plane is an educational game coding in Eden with the application tool tkeden. The model has three main panels- a control panel, a side-view panel and a top-view panel. Side-view and top-view is required to determine if or not the paper plane hit the target, because the wind direction can be divided in to three directions in the 3-D coordinate axis.

2.1 Control panel

The control panel will initial the variable of the model for the game.

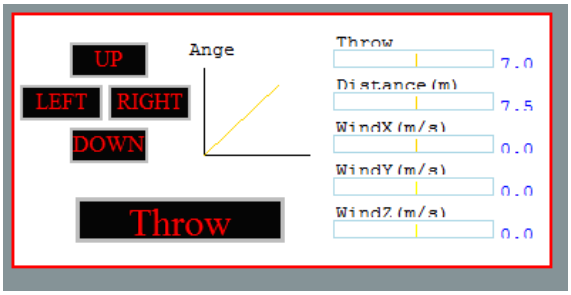

Figure2: control panel

Control panel contains 5 buttons, 5 slider bars and one quarter-clock. These functionalities are the elements which will influence the motion trajectory. Up and down button will control the start high of the motion in the side-view panel. And the height has a range of zero (on the ground) to 2.4 metres (height of a person including the length of the arm). Left and right buttons will initialize the position of the paper plane in the Z direction in the top-view. (Set x direction is the direction to the target, y is the direction to the sky, and z is the direction vertical to the target). The quarter–clock will initialize the throw angel of the motion. Throw speed slider bar will initialize the throwing speed. The throwing angel and the initial throwing speed are the two main elements for the trajectory in side-view. And the wind in x and y direction will appreciably change the trajectory in the side-view panel. The slider bar of distance will initialize the distance of the target to the throwing point. There will be a dash line in the coordinate axis stands for the target high in the side-view panel.

2.2 Side-view panel

The side view is the main screen to display the motion trajectory. Side view panel mainly displays the trajectory in a 2-D coordinate axis of X and Y. There is a ball stands for the paper plane to show the real-time position for observation.

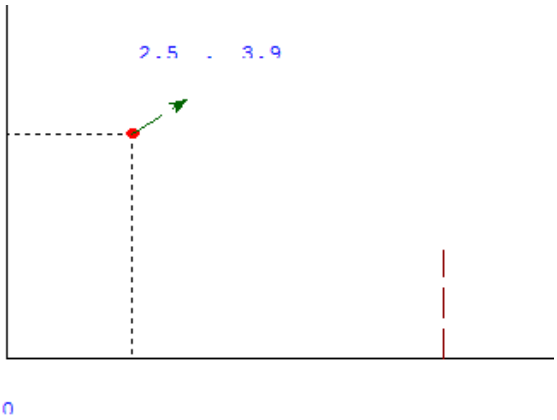

Figure 3: side view

Not only observable can be seen from the side-view, but also the complex dependencies can be found thought the real-time numbers. The pair numbers above the ball show the real-time displacement of the object. Displacement in X direction is

$$\Delta x = (v_{0x+}v_{windx})*t$$

Displacement in Y direction is

$$\Delta y = (v_{0y+}v_{windy})*t\text{-}0.5*g*t^2$$

In the above formulates, V_{0x} and V_{0y} are depends on the initial throwing speed and the initial throwing angel. V_{windx} and V_{windy} depend on the user input value from the wind slider bars. If any of the values changes, the position on a certain time will change, and the trajectory will change because of the positions. The green arrow in the screen will show the current speed direction. There is some dependency in the speed formulates.

$$tan(\theta) = v_y / v_x$$

where

$$v_y = v_{0y}+v_{windy}\text{-}g*t$$

$$v_x = v_{0x}+ v_{windx}$$

Similarly, the arrow direction depends on the initial throwing speed and throwing angel. The direction of the arrow will change real-timely.

2.3 Top-view panel

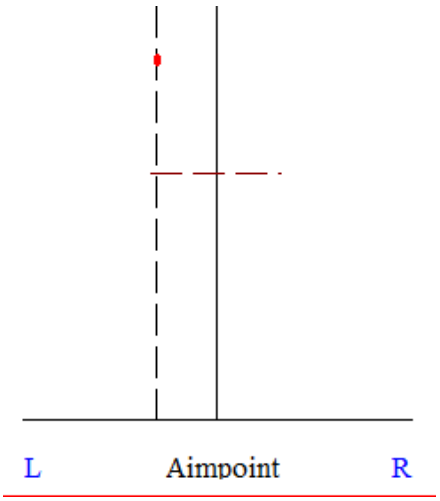

Figure 4: side view

Much simpler than the side-view panel, the panel will display the 2-D coordinate of X and Z. The trajectory in this screen is made up by two simple displacements.

$$\Delta x = (v_{0x+}v_{windx})t$$

$$\Delta z = z_0 + v_{windz}*t$$

The position in side view X coordinate depends on the initial throwing speed and the throwing angel. And the Z coordinate location only depends on the initial wind speed in z direction.

2.4 Target determine dependency

Like every game, there is a result to show how the player plays. In paper plane, there is an method to determine whether or not the player miss the target. If the position of the ball is on both of the target line in side-view panel and top-view panel, player hit the target, and a string of "target!!" will display on the side view panel. In summary, the condition is depends all the variables that the player input from the control panel.

3 Evaluation and future work

There are some potential which need to improve in the future. The main drawback is the accuracy of a decimal. This will cause some error in the coordinate system. For instance, the height should be 0, when the ball falling on the ground, instead of -0.00034 in the game. And the accuracy problem may also ignore some weak changes in the coordinate system. In addition, the interface of game model is simple and using ball and lines to stand for the objects. Although the simple interface doesn't influence the educational purpose, it will make the game less playable and users may lose interest after some tries. In future, these two drawbacks can be overcome. And the programming tool of cadence may handle these two problems better.

4 Conclusion

The game paper plane is an exploration of the combination of the educational game and empirical modeling. The educational purpose has gained and the strength of the empirical modeling has been fully expressed. However, there still exist some drawback such as the accuracy problem and the poor user interface. The game of paper plane will be improved according to the drawbacks in the future.

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References

[1] Jacob Filipp, the Physics Learning site: Learning About Projectile Motion, 2003, URL: http://physicslearningsite.com/projectile.html

[2] Dostál, J. *Educational software and computer games - tools of modern education*, Journal of Technology and Information Education. 2009, Palacký University, Olomouc, Volume 1, Issue 1, p. 24 - 28.

[3] Warwick research group, *An Investigation into the Tuition of Music Theory using Empirical Modelling*, the Fifth Warwick Empirical Modelling Bulletin (WEB-EM-5), 2010, ID:0503985.

[4] Beynon.M, *Introduction of Empirical Modeling*, 2006, URL: http://www2.warwick.ac.uk/fac/sci/dcs/research/em/intro

[5] Beynon.M, *Principles and tools*, 2006, URL: http://www2.warwick.ac.uk/fac/sci/dcs/research/em/intro/principles