Sports Performance Visualisation in Teaching Activities

Kristina Marasović  Kristina.Marasovic@pmfst.hr
Mile Dželalija Mile.Dzelalija@pmfst.hr

Faculty of Natural Sciences, Mathematics and Education
University of Split
Sports Performance Visualisation in Teaching Activities

• Sport and Biomechanics
• Biomechanics - From an Exercise in the Filming of Human Movement to Applied Science
Sports Performance Visualisation in Teaching Activities

INTRODUCTION

• Interest in Sport
• Multidisciplinaritity
• Application of Computer and Information Technologies
• Interactivity Problem in Teaching/Learning Process

• Result: Programmes Simulating Sport Activities
• Ski-Jumping Example
• Input Variables
• Forces Exerted on the Ski-Jumper
• Components of the Resultant Force
• Output Variables
Sports Performance Visualisation in Teaching Activities

INTRODUCTION

Motivation

Physical Background

Examples

Conclusion

- Ski-jumping is a very complex skill involving several phases such as:
  - inrun,
  - take-off,
  - flight,
  - landing.

- During the inrun and take-off phases ski-jumper tries to reach maximum velocity.

- In the flight phase ski-jumper tries to keep favorable body position angle.
Sports Performance Visualisation in Teaching Activities

- Ski-Jumping Example
- Input Variables
- Forces Exerted on the Ski-Jumper
- Components of the Resultant Force
- Output Variables

- Jumper's Position Angle
- Approach Velocity
- Take-Off Velocity

• Jumper's Position Angle
• Approach Velocity
• Take-Off Velocity

- Ski-Jumping Example
- Input Variables
- Forces Exerted on the Ski-Jumper
- Components of the Resultant Force
- Output Variables
The gravitational force: $F_g$

Dynamic fluid force:
• The drag force $F_D$ acts in opposition to the relative motion of the jumper with the respect to air tending to slow down the relative velocity.
• The lift force $F_L$ changes the direction of the relative motion of the jumper within air.

Ski-jumper's position angle: $\vartheta$

Flight path's angle: $\varphi$
Sports Performance Visualisation in Teaching Activities

**INTRODUCTION**

**MOTIVATION**

**PHYSICAL BACKGROUND**

**EXAMPLES**

**CONCLUSION**

---

**Ski-Jumping Example**

**Input Variables**

**Forces Exerted on the Ski-Jumper**

**Components of the Resultant Force**

**Output Variables**

---

The gravitational force:

\[ F_g = mg \]

The drag force:

\[ F_D = \frac{1}{2} C_D \rho v^2 [A_\perp + A_\parallel \sin^2(\vartheta) \sin(\vartheta)] \]

The lift force:

\[ F_L = \frac{1}{2} C_L \rho v^2 A_\parallel \sin^2(\vartheta) \cos(\vartheta) \]

- \( m = 65 \) kg ski-jumper's mass
- \( g = 9.8 \) m/s\(^2\) gravitational acceleration
- \( \rho = 1.0 \) kg/m\(^3\) air density
- \( C_D = 1 \) drag coefficient
- \( C_L = 1 \) lift coefficient
- \( A_\perp = 0.2 \) m\(^2\) frontal ski-jumper's surface
- \( A_\parallel = 1.0 \) m\(^2\) longitudinal ski-jumper's surface
The horizontal component $F_x$:

$$ F_x = \frac{1}{2} C_L \rho v^2 A_{\parallel} \sin^2(\vartheta) \cos(\vartheta) \sin(\varphi) $$

$$ - \frac{1}{2} C_D \rho v^2 [A_{\perp} + A_{\parallel} \sin^2(\vartheta) \sin(\vartheta)] \cos(\varphi) $$

The vertical component $F_y$:

$$ F_y = -mg + \frac{1}{2} C_L \rho v^2 A_{\parallel} \sin^2(\vartheta) \cos(\vartheta) \cos(\varphi) $$

$$ + \frac{1}{2} C_D \rho v^2 [A_{\perp} + A_{\parallel} \sin^2(\vartheta) \sin(\vartheta)] \sin(\varphi) $$
Using Newton's laws of motion, inrun and take-off velocities, the instantaneous jumper's velocity and position are being calculated:

\[
\frac{dv_x}{dt} = \frac{F_x}{m} \quad \frac{dv_y}{dt} = \frac{F_y}{m}
\]
\[
\frac{dx}{dt} = v_x \quad \frac{dy}{dt} = v_y
\]

In calculation fixed time step integration of 0.01 s is being used.
Sports Performance Visualisation in Teaching Activities

- About the Examples
- What We Need
- Ski-Jumping
- Basketball
- Projectil
Sports Performance Visualisation in Teaching Activities

INTRODUCTION

MOTIVATION

PHYSICAL BACKGROUND

EXAMPLES

CONCLUSION

They are Java Swing applets which run in a Java-enabled Web browser such as Microsoft Internet Explorer, HotJava, or Netscape Navigator.

Swing components are used to build graphical user interface.

Event handling is based on delegation event model in AWT.

Animation loop is created using the Swing Timer class which fires one or more action events after a specified delay.

About the Examples

What We Need

Ski-Jumping

Basketball

Projectil
Sports Performance Visualisation in Teaching Activities

[ INTRODUCTION ] [ MOTIVATION ] [ PHYSICAL BACKGROUND ] [ EXAMPLES ] [ CONCLUSION ]

• Running a Swing-Based Applet: Find a 1.1 or 1.2 browser or download Java Plug-in into a supported browser. Make sure you have the latest version of the browser and plug-in.
  http://java.sun.com/products/plugin/

• Compiling and Running Swing Programs: It is recommended that you use the latest release of the Java 2 Platform downloaded from http://java.sun.com/j2se/.

• About the Examples
• What We Need
• Ski-Jumping
• Basketball
• Projectil
Sports Performance Visualisation in Teaching Activities

[INTRODUCTION] [MOTIVATION] [PHYSICAL BACKGROUND] [EXAMPLES] [CONCLUSION]

• About the Examples
• What We Need
• Ski-Jumping
• Basketball
• Projectile

http://www.pmfst.hr/~kim/Java/SkiJumping/SkiJumping.html
• About the Examples
• What We Need
• Ski-Jumping
• Basketball
• Projectil

http://www.pmfst.hr/~kim/Java/BasketBall/BasketBall.html
Sports Performance Visualisation in Teaching Activities

[ INTRODUCTION ] [ MOTIVATION ] [ PHYSICAL BACKGROUND ] [ EXAMPLES ] [ CONCLUSION ]

Projectile Motion

- About the Examples
- What We Need
- Ski-Jumping
- Basketball
- Projectil

http://www.pmfst.hr/~kim/Java/Projectil/Projectil.html
Sports Performance Visualisation in Teaching Activities

- Sport Activities
- Physical Background
- Java Technology
- Programs:
  - Beyond the Traditional Learning Methods
  - Interactivity with Learning Environment
  - Visualisation
- Future Plans