Projectile Motion in 3D: PitchFX

Pre-Lecture Questions

Problem Set #8 (due next time)

Lecture Outline

1. A Perfect Game
2. Analyzing the Data

Pre-Class Summary:

http://www.sportvision.com/media/pitchfx-broadcast-reel

http://sanfrancisco.giants.mlb.com/video/play.jsp?content_id=22275431&c_id=sf

Link to Major League Baseball's Data Store

Here's the data from the last pitch:

<pitch des="In play, out(s)" id="548" type="X" tfs="005141" tfs_zulu="2012-06-14T04:51:41Z" x="100.43" y="126.06" sv_id="120613_215142" start_speed="93.6" end_speed="87.1" sz_top="3.67" sz_bot="1.75" pfx_x="-6.16" pfx_z="2.4" px="0.056" pz="3.232" x0="-2.212" y0="50.0" z0="5.792" vx0="8.341" vy0="-137.018" vz0="-1.899" ax="-11.835" ay="27.086" az="-27.489" break_y="23.9" break_angle="20.2" break_length="6.2" pitch_type="FF" type_confidence=".932" zone="2" nasty="32" spin_dir="248.403" spin_rate="1347.734" cc="" mt=""/>

Last pitch of Matt Cain's Perfect Game (6/13/2012)

Kinematic Data:

initial position (ft)	initial velocity (ft/s)	average acceleration (ft/s^2)
x_o = -2.212	v_{xo} = 8.341	a_x = -11.835
y_o = 50.00	v_{yo} = -137.018	a_y = 27.086
z_o = 5.792	v_{zo} = -1.899	a_z = -27.489

Initial Speed (mph): 93.6
Speed at the front of home plate (mph): 87.1
Position at the front of home plate (ft):
x = 0.056, y = 1.417, and z = 3.232

Example 1: Use the components of the initial velocity to verify the initial speed (y_o = 50.0ft).

initial position	initial velocity	acceleration
x_o = -2.212ft	v_{ox} = 8.341ft/s	a_x = -11.835ft/s^2
y_o = 50.0ft	v_{oy} = -137.018ft/s	a_y = 27.086ft/s^2
z_o = 5.792ft	v_{oz} = -1.899ft/s	a_z = -27.489ft/s^2

Example 2: Find (a)y-component of the final velocity of the pitch when it reaches the front of home plate (y = 1.417 ft) and (b)the time to get there.

initial position	initial velocity	acceleration
x_o = -2.212ft	v_{ox} = 8.341ft/s	a_x = -11.835ft/s^2
y_o = 50.0ft	v_{oy} = -137.018ft/s	a_y = 27.086ft/s^2
z_o = 5.792ft	v_{oz} = -1.899ft/s	a_z = -27.489ft/s^2

Example 3: Find (a)x-component and (b)the z-component of the final velocity of the pitch when it reaches the front of home plate (y = 1.417 ft).

position	velocity	acceleration
x_o = -2.212ft	v_{ox} = 8.341ft/s	a_x = -11.835ft/s^2
y_o = 50.0ft	v_{oy} = -137.018ft/s v_y = -127.05ft/s	a_y = 27.086ft/s^2
z_o = 5.792ft	v_{oz} = -1.899ft/s	a_z = -27.489ft/s^2
Time	t = 0.3680s	

Example 4: (a)Write the final velocity in unit vector notation and (b)find the final speed.

position	velocity	acceleration
x_o = -2.212ft	v_{ox} = 8.341ft/s v_x = 3.986ft/s	a_x = -11.835ft/s^2
y_o = 50.0ft	v_{oy} = -137.018ft/s v_y = -127.05ft/s	a_y = 27.086ft/s^2
z_o = 5.792ft	v_{oz} = -1.899ft/s v_z = -12.015ft/s	a_z = -27.489ft/s^2
Time	t = 0.3680s	

Example 5: Find (a)the x position and (b)the z position of the pitch when it reaches the front of home plate (y = 1.417 ft).

position	velocity	acceleration
x_o = -2.212ft	v_{ox} = 8.341ft/s v_x = 3.986ft/s	a_x = -11.835ft/s^2
y_o = 50.0ft	v_{oy} = -137.018ft/s v_y = -127.05ft/s	a_y = 27.086ft/s^2
z_o = 5.792ft	v_{oz} = -1.899ft/s v_z = -12.015ft/s	a_z = -27.489ft/s^2
Time	t = 0.3680s	

Lecture 08 - Summary

As we saw with two-dimensional motion, constant acceleration means that the kinematic equations apply separately to each direction.