TRIBHUVAN UNIVERSITY

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Department of Electronics and Computer Engineering

A Graphics Project

On

"**Bowling**"

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Submitted to:

Department of Electronics and Computer Engineering

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10/10/2007

Acknowledgement

We are very pleased to present this proposal for the graphics project. We extend our sincere appreciation and gratitude to our respected teachers- **Mr. Jaya Ram Timilsina**, **Mr. Bikash Shrestha**, **Mr. Deepen Chapagain** and **Mr. Aashish Adhikari** for encouraging us to do this project. We would also like to thank all our friends for their helpful support.

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Introduction

Bowling is a very popular sport played worldwide. Bowling allows for the participation of both genders, all ages, skill levels, and classes, is affordable and encourages a social camaraderie rare in other competitive sports.

In this sport players attempt to score points by rolling a bowling ball along a flat surface in order to knock down objects called pins. Most forms are played on a "lane", a flat surface made of wood or a synthetic imitation, which is several times longer than it is wide. Most forms of bowling may be categorized as either indoor or outdoor bowling.

The main objective of the game is to knock out as many pins as possible in each turn. The player hold the bowling ball , which has generally two or more drilled holes in which to insert fingers for gripping the ball, throws it towards the pins. The bowling ball rolls down the slick lane and hits the pins knocking it down. In next turn, the player will try to knock out the remaining pins.

Objectives achieved and platform used

All of the objectives mentioned for this project was achieved. A sphere was used as a bowling ball, so to give it a realistic look surface rendering was applied to it. Three circles were drawn on the top of the sphere as holes. Perspective projection technique was used to draw the lane. And at last, combination of polygons was used to give pin like appearance. The speed and angle of the ball was varied according to input value taken from user. The impact of the ball to the pin was detected and corresponding pin was removed. the ball rolls down the lane and if it goes out of lane, the ball rolls straight without hitting any pin.

The 'Borland C++ Builder 'was used to develop the project because of its familiarity, available drag and drop tool and easiness to use.

Literature Review

Translation

The sphere points are calculated, taking the center at the standard position(origin) and then translated to the required position.

x1=x + tx

y1=y + ty

z1=z + tz

where tx,ty,tz are the translation distance w.r.t. x,y &z axes respectively

Rotation w.r.t. co-ordinate axes

$P'=R_z(\theta).P$

x1=xcos(θ) - ysin(θ)

y1=xsin(θ) + ycos(θ)

z1=z

where x1, y1,z1 are the rotated coordinates with angle θ about z axis

Perspective Projection

To the purpose of giving the realistic look for the objects, objects are drawn with the perspective projection. For the perspective projection of point (x,y,z) with z_{prp} as the reference point and z_{vp} as the viewing plane.

$x_p = x(z_{prp} -z_{vp})/(z_{prp} -z)$
$y_p = y(z_{prp} -z_{vp})/(z_{prp}-z)$
$z_p = z$

Illumination

Illumination is the process of calculating the intensity of light at a given point on the surface of an object. Lighting calculation are based on the optical properties of surface ,the back ground lighting conditions, and the light source specifications. Optical parameters are used to set surface properties, such as glossy, matte, opaque and transparent. One fixed light source is kept on the left upper corner of screen .In this case total intensity is due to

Ambient Reflection model

The light intensity due to the combination of light reflection from various surface to produce a uniform illumination called ambient light or background light. Ambient light has no spatial or directional characteristics. The amount of ambient light incident on each object is a constant for all surfaces and for over all directions.

Intensity due to the ambient light is

$$I_A = Ka.Ia$$

Where Ka is a constant called ambient-reflection coefficient and its value lies between 0-1

Ia is ambient light intensity

Diffuse reflection model

The intensity due to the diffuse reflection is

$$I_D = K_d I_l (N.L)$$

where

K_d a constant called diffuse reflection coefficient (or diffuse reflectivity)

between 0-1

N- unit normal vector at the point

L – unit Vector from light source to the point on the surface point of body

$N.L = \cos \theta$ (θ is angle between N and L)

Specular reflection model

The intensity due to the specular reflection is

$$I_s = Ks.I_l(H.L)$$

Where

K_s is a specular reflection coefficient

H is halfway vector between viewing angle vector and light source vector

L unit Vector from light source to the point on the surface point of body

Hence the total light intensity at a point is given by.
$$I = I_A + I_D + I_s = Ka.Ia + K_d I_l \cos \theta + k_s.I_l(H.L)$$

Visible surface detection

The common method used image spaced approach for visible surface detection is depth buffer method. In this method it compares surface depth at each pixel position on the projection plane. This procedure is also known as Z- buffer method,

since object depth is measured from the view plane along the z-axis of viewing system.

With object descriptions converted to projection coordinates each(x, y, z) position on polygon surface corresponds to the perspective projection point(x, y) on the view plane

Therefore for each pixel position (x, y)on the view plane object depths is found by comparing by z values.

In this method generally it draws the each pixel of each polygon in sequence .But if it gets the value of z less than previous value for specified pixel it doesn't plot that pixel of polygon. So only visible surface are drawn.

Project Description:

Ball:

The ball was drawn using the sphere. To draw the ball the equation of sphere used was

$$X=r.\cos\theta.r\cos\varphi \quad 0<=\varphi<=\Pi$$

$$Y=r.\cos\theta.r\sin\varphi \quad 0<=\theta<= \Pi$$

To give the realistic look ambient, diffused and specular model was used for purpose of drawing holes. The algorithm of circle drawing was implemented for the drawing.Tthe equations used are

$$X=r.\cos\theta$$

$$Y=r.\sin\theta$$

$$\text{Where } 0<=\theta<=2\Pi$$

Rolling of the ball on the lane was done using the principle of rotation as well as perspective projection

Alley:

The perspective projection was used to draw the lane. The perspective projection was implemented using formula given below
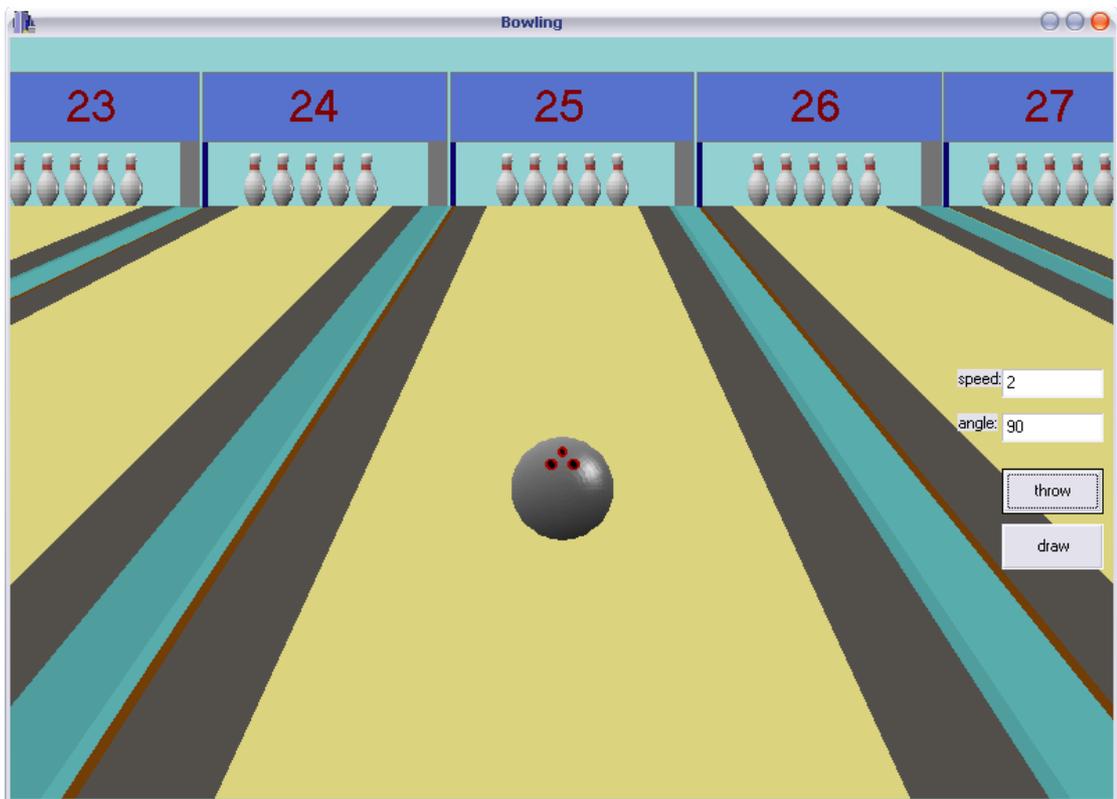
$$X_p=x.(z_{prp}-z_{vp})/(z_{prp}-z)$$

$$Y_p=y.(z_{prp}-z_{vp})/(z_{prp}-z)$$

Pin:

The pin was drawn adding the polygons. Similar concept like ambient, diffused and specular was used. The shape of the pin was drawn using the concept of circle by placing one on the top of previous with varying radius. The circle was divided into equal no of parts so that edge of polygon can be calculated

Output:

Limitation and further enhancement

The limitation of our project are as follows

- Only 5 pins were used due to complexity in drawing and determining the position of impact by the ball.

- Only one of the pin can be hit at a time.

- Unable to show knockdown of the pins

The further enhancements that can be added is

- There can be 10 pins

- Scoreboard can be displayed

- The impact of pin with each other can be shown.

Conclusion:

After completion of this project, we have learned the project management techniques along with implementation techniques of various graphics algorithms. Hence we are familiar with different surface rendering models like ambient, diffused, specular and also we are able to use the concept of different graphic topics like rotation, perspective projection and polygon implementation. From this project we knew the basic tools of c++ builder and we are able to implement these tools in different fields of our project development