Timers, Animation, Images, Bitmaps

Windows Timer
- Input device that periodically notifies an app each time a specified time interval has elapsed.
- Using a timer guarantees that a program can regain control periodically.
- Three different Timer classes in:
- We’ll use the last one – The same one that is available in Win32 API and MFC
  - It’s integrated with other Windows events and is easiest to use.

Timer applications
- Implementing a clock
- Multitasking
- Maintaining updated status report
- Implementing autosave feature
- Terminating demo versions of programs
- Activation of a screen saver after certain time
- Pacing movement – animation
- Others

The Timer Class
- Creating a Timer object:
  - Timer timer = new Timer();
- Timer class has one event:
  - Event: Tick
  - Delegate: EventHandler
- Defining the Timer Tick event handler:
  - Void TimerOnTick(object obj, EventArgs ea) {...};
- Attaching it to the Tick event:
  - timer.Tick += new EventHandler(TimerOnTick);
- Timer read/write Properties:
  - int Interval, Tick time in milliseconds
  - bool Enabled, True if timer is running
- Timer Methods:
  - void Start(); void Stop();

Some Timer Examples
- CloseInTen:
  - A program that sets a “one-shot” timer that closes the application after ten seconds
  - Could be used to implement a “demo” version of a program that allows the user to try it for a while
  - Note use of obj argument in TimerOnTick() handler to get the timer that sent the message
- RandomRectangles-timer:
  - Draws a new random rectangle once every 2 seconds
  - We must use CreateGraphics() to create a Graphics object to draw with
  - Note that a timer can be programmed manually...
- Or by using the Designer
  - Just drag a timer into the Form and double click on it to add the Timer Tick event handler
  - Set the Enabled and Interval properties in the Properties window

Animated Graphics
- Creating a moving picture
  - Give illusion of motion by continual draw/erase/redraw
  - If done fast, eye perceives moving image
- In a single-user (DOS) application, we could do the following:
  - Do Forever{
    - /* compute new location of object */
    - /* erase old object image */
    - /* draw object at new location */
  }
In Windows, other programs can’t run while this loop is executing

Need to keep giving control back to Windows so other programs can operate

Ways of doing it:
- Use PeekMessage() Loop (for Win32 API)
- Override OnIdle() (for MFC)
- Use a Windows Timer (any Windows platform)
  - Erase old frame and draw new frame each time there is a timer ‘tick’ event

Bouncing Ball Example Program
- Draws a red ball moving inside window’s client area at a given velocity
- Responds to form’s Resize event to reset ball’s position when window is resized
- Responds to Timer event to draw next animation frame

Class level variables (accessible to all class methods):
- xC, yC: current coordinates of ball’s center
- cxmove, cymove: x,y components of velocity
- iXSize, iYSize: dimensions of window’s client area

Helper function DrawBall()
- Uses the Form’s CreateGraphics() method to get a Graphics object
- Draws BackColor ellipse in old position and red one in new posn.
  - After each timer tick and after window is resized
  - Checks for collisions with sides of window and adjusts ball’s path

DateTime Structure in .NET
- To keep track of time and date

Some Constructors:
- DateTime(int year, int month, int day);
- DateTime(int year, int month, int day, int hour, int minute, int second);
- DateTime(int year, int month, int day, int hour, int minute, int second, int msec);

- year: 1 - 9999, month: 1 - 12, day: 1 - #days in month,
  hour: 0 - 23, minute: 0 - 59, second: 0 - 59, msec: 0 - 999

DateTime Properties
- Some Read-only Properties
  - Year, Month, Day, Hour, Minute, Second, Millisecond, DayOfWeek, DayOfYear

- An important Static Property
  - Now
    - Returns a DateTime structure filled with current local date and time
    - E.g., to get current date and time:
      DateTime dt = DateTime.Now;
      • dt then contains the current date/time

Some DateTime Methods
- string ToString()
  - dt.ToString();
  - Returns something like: “10/1/2004 10:30:01 A.M.”

- string ToString(string strFormat)
  - strFormat and returned values:
    - “d” 10/1/2004
    - “D” Friday, October 01, 2004
    - “F” Friday, October 01, 2004 10:30:01 A.M.
    - “g” 10/1/2004
    - “G” 10/1/2004 10:30:01 A.M.
    - “m” October 1
    - “t” 10:30 A.M.
    - “u” 2004-10-01 10:30:01

A Simple Digital Clock Program (SimpleClock)
- Uses a one-second timer
- Each timer tick the handler calls Invalidate() to force a Paint message
- Paint handler calls DateTime.Now Property to get a DateTime object containing the current time and date
- The DateTime object’s ToString() method converts it to the appropriate string format
- DrawString() draws the string at the top of the Form’s client area
Images and Bitmaps

- Video display images described by Images and/or Bitmaps
  - Rectangular arrays of “pixel values” stored in memory
  - Pixel value determines color of a pixel
  - Encapsulated in .NET Image and Bitmap classes
- Can be created and edited with almost any paint program
- Windows supports 4-bit, 8-bit (indirect) and 16 or 24-bit (direct) pixel values
- Can be stored/retrieved as .bmp files
  - Take up lots of space (no compression)
- Other common file formats (some compressed):
  - Jpg, Gif, Png, Tiff

- Can be displayed on a device using DrawImage() method of the Graphics object (gr-obj) associated with a device, e.g.:
  - gr-obj.DrawLine(image img, int x, int y);
  - gr-obj.DrawLine(image img, point pt)
  - Lots of other overloads available (as we'll see)
- Can be manipulated invisibly and apart from physical display device
- Fast transfer to/from physical device ==> flicker free animation
- Does not store information on drawing commands
  - Windows Metafiles do that
- You can also draw on an Image or Bitmap
  - Then transfer it to the screen
  - One screen access ==> no flicker in animations

System.Drawing.Image Class

- An abstract class
  - Can’t be instantiated with a constructor
  - But has overloaded static methods that return Image objects that can be displayed
  - Can load a bitmap or metafile from a file
    - Image img = Image.FromFile(strFilename);
    - Bitmap btmp = (Bitmap)Image.FromFile(strFilename);
  - Other overloads
    - Once you’ve loaded an Image, you can use DrawImage(img, …) to display

Two Example Programs

- ImgFromFile
  - Displays a jpg image on the window’s client area
  - But what if image file is not in right directory?
  - FromFile() method will throw an exception and program will die
  - Our program should be able to catch that exception
  - And do we need to retrieve the image – i.e. call FromFile() — every time there’s a Paint event?
- ImgFromFileBetter
  - Uses a try/catch block to avoid errors
  - Puts up a MessageBox if there is an exception
  - And makes the call to FromFile() in program’s constructor
  - Stores the Image in a class level variable so it’s accessible to the Paint handler

Other Image Class & Image Drawing Information

- Some Image Properties (read-only):
  - Size
    - Represents the size of the rectangular image (Width & Height members)
  - Members: int Width, int Height
  - Width and height of the image in pixels
- Other overloads of DrawImage() that specify a rectangular destination and/or source region for the image:
  - DrawImage(image img, int x, int y, int w, int h);
  - x, y = position; w, h = width, height of image on destination window
  - rectDest specifies rectangle on window image will be displayed in
    - Some read/write properties of Rectangle class:
      - X, Y Coordinates of upper left hand corner
      - Width, Height
  - DrawImage(image img, Rectangle rectDest, GraphicsUnit gu);
    - Arguments:
      - Destination and source Rectangles
      - GraphicsUnit enumeration value must be GraphicsUnit.Pixel
    - With these we can stretch or compress all or part of an image

More Image Examples

- ImgCenter
  - Maintains image in center of window’s client area
- ImgScaleToWindow
  - Scales image to fit in window’s client area
- ImgPart
  - Displays part of image
- ImgPartScale
  - Scales part of image to fit in window’s client area
Rotating & Shearing an Image

DrawImage(Image img, Point[] apt);
- apt is an array of three points:
  - apt[0] = destination of upper left corner of image
  - apt[1] = destination of upper right corner of image
  - apt[2] = destination of lower left corner of image
- 4\textsuperscript{th} point generated automatically completes parallelogram

DrawImage(Image img, Point[] aptDst, Rectangle rectSrc, GraphicsUnit gu);
- aptDst: an array of three points specifying three corners of the image (as in DrawImage)
- rectSrc: source rectangle of original image
- gu: Source rectangle unit of measure enumeration value
  - Display, Inch, Millimeter, Pixel, Point, etc.
- Depending on the points in the array, the image will be rotated and/or sheared
- Example Program: ImgAtPoints

Drawing on an Image

- Up to now we've drawn an image on a Graphics object
  - Refers to the video display
  - The GDI+ is really drawing on a huge bitmap stored in memory
  - Refers to the screen's video display adapter
- But we can draw on any bitmap
  - First must get a Graphics object that refers to the image
  - Use Graphics.FromImage(Image img) static method to get it:
    Graphics g = Graphics.FromImage(img);
  - Draw on it with GDI+ drawing functions
  - Display it by getting a screen Graphics object and using one of its DrawImage(img, ...) methods
  - Done typically in Paint handler
  - Must Dispose of image's graphics object after using it
    - g.Dispose();
  - Example: ImgDrawOn

“Shadow” Images

- We may want to compose a complex scene off screen – a "shadow bitmap" or "shadow image"
- Draw on a graphics object that refers to the shadow image as much as you like outside of Paint handler so you’re not accessing the physical screen
- Even draw other images on the shadow image!
- Then in Paint handler (or in response to timer tick), display it with a single call to DrawImage(bitmap, ...)
- See ImgShadowBitmap example
- Very useful in avoiding flicker in animations
  - “Compose” the next frame in the shadow image
  - Draw all the objects on it first
  - Then draw the “composed” image on the physical screen
  - Thus only one access per frame to the physical screen
  - This technique is called “double buffering”

Bitmap Class

- Like Image class, but you can do more with it
- Create a blank bitmap of a specified size with constructor:
  - Bitmap bm = new Bitmap(int width, int height);
- Used like Image objects in drawing pictures and in double buffering
- Nice for making parts of a sprite “transparent”
  - So there is no rectangular “halo” around the sprite when it is drawn over the background
  - For example for a sprite that has a white background:
    Bitmap sprite = (Bitmap)Image.FromFile(sprite-file.bmp);
    sprite.MakeTransparent(Color.White);
  - Then draw as usual onto a shadow bitmap’s graphic object
  - See ImgShadowBitmap2 example