HTML5 Canvas

Drawing on a Web page

Summary

- The canvas element
- Basic shapes
- Images
- Colors and gradients
- Pixel manipulation
- Animations
- Video and canvas

Drawing on a Web page

- Possible just very recently
- SVG and canvas
  - Provide native drawing functionality on the Web
  - Completely integrated into HTML5 documents (part of DOM)
  - Can be styled with CSS
  - Can be controlled with JavaScript

Canvas

- HTML5 element and plugin-free 2D drawing API that enables to dynamically generate and render graphics, charts, images, animation
- Scriptable bitmap canvas
  - Images that are drawn are final and cannot be resized
  - Can be manipulated with JavaScript and styled with CSS
  - 2D Context
  - 3D Context (Web GL)
- Canvas was originally introduced by Apple to be used in Mac OS

Canvas

- The HTML5 <canvas> element is used to draw graphics, on the fly, via scripting (usually JavaScript)
- A canvas is a rectangular area, where it is possible to control every pixel
- The canvas element has several methods for drawing paths, boxes, circles, characters, and adding images
- The <canvas> element is only a container for graphics
  - You must use a script to actually draw the graphics

```
<canvas id="myCanvas" width="200" height="100">
</canvas>
```

Canvas features

- Canvas can draw text
  - Colorful text, with or without animation
- Canvas can draw graphics
  - Great features for graphical data presentation
- Canvas can be animated
  - Canvas objects can move: from simple bouncing balls to complex animations
- Canvas can be interactive
  - Canvas can respond to JavaScript events
  - Canvas can respond to any user action (key clicks, mouse clicks, button clicks, finger movement)
- HTML canvas can be used in games

Canvas

- The canvas is initially blank
- To display something a script needs to access the rendering context and draw on it
- The canvas element has a DOM method called getContext, used to obtain the rendering context and its drawing functions
  - getContext() takes one parameter: the type of context (2D or 3D)
  - getContext() is a built-in HTML object, with properties and methods for drawing (paths, boxes, circles, characters, images, and more)

```
var canvas = document.getElementById('example');
var ctx = canvas.getContext('2d');
```

Canvas

- Skeleton template

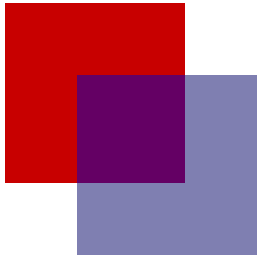
```
<html>
  <head>
    <title>Canvas</title>
    <script type="application/javascript">
      function draw(){
        var canvas = document.getElementById('example');
        if (canvas.getContext){
          var ctx = canvas.getContext('2d'); } }
    </script>
    <style type="text/css">
      canvas { border: 1px solid black; }
    </style>
  </head>
  <body onload="draw();">
    <canvas id="example" width="150" height="150"></canvas>
  </body>
</html>
```

Example: basic shape

- All drawing must be done in JavaScript

```
<html>
  <head>
    <script type="application/javascript">
      function draw() {
        var canvas=document.getElementById("canvas");
        if (canvas.getContext) {
          var ctx = canvas.getContext("2d");
          cxt.fillStyle="#FF0000";
          cxt.fillRect(0,0,150,75); } }
    </script>
  </head>
  <body onload="draw();">
    <canvas id="canvas" width="200" height="100">
    </canvas>
  </body>
</html>
```

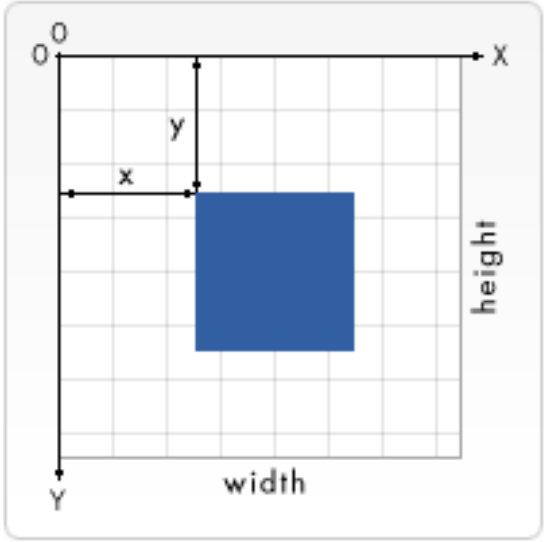
Example



```
<html>
  <head>
    <script type="application/javascript">
      function draw() {
        var canvas=document.getElementById("canvas");
        if (canvas.getContext) {
          var ctx = canvas.getContext("2d");
          ctx.fillStyle = "rgb(200,0,0)";
          ctx.fillRect (10, 10, 55, 50);
          ctx.fillStyle = "rgba(0, 0, 200, 0.5)";
          ctx.fillRect (30, 30, 55, 50); } }
    </script>
  </head>
  <body onload="draw();">
    <canvas id="canvas" width="150" height="150">
    </canvas>
  </body>
</html>
```

Rectangles functions

- fillRect(x,y,width,height)
  - draws a filled rectangle
- strokeRect(x,y,width,height)
  - draws a rectangular outline
- clearRect(x,y,width,height)
  - clears the specified area and makes it fully transparent



- Canvas coordinate space

Path functions

- beginPath():
  - creates a path (list of lines, arcs, …)
- closePath()
  - closes the path by drawing a straight line from the current point to the start
- stroke()
  - draws an outlined shape
- fill()
  - paints a solid shape
- moveTo(x,y)
  - move the pencil to the x and y coordinates
- lineTo(x,y)
  - draws a straight line to the specified ending point
- arc(x, y, radius, startAngle, endAngle, anticlockwise)
  - draws an arc using a center point (x, y), a radius, a start and end angle (in radians), and a direction flag (false for clockwise, true for counter-clockwise
  - to convert degrees to radians: var radians = (Math.PI/180)*degrees

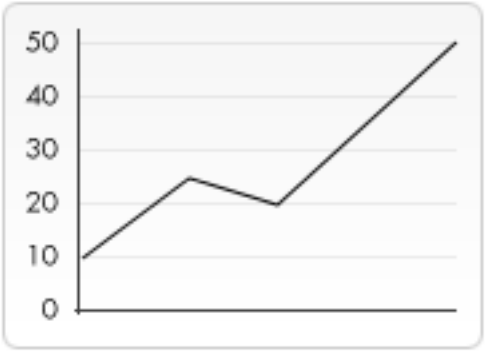
Example: path

```
function drawShape() {
  var canvas = document.getElementById('tutorial');
  if (canvas.getContext){
    // use getContext to use the canvas for drawing
    var ctx = canvas.getContext('2d');
    // Draw shapes
    ctx.beginPath();
    ctx.arc(75,75,50,0,Math.PI*2,true);
    ctx.moveTo(110,75);
    ctx.arc(75,75,35,0,Math.PI,false);
    ctx.moveTo(65,65);
    ctx.arc(60,65,5,0,Math.PI*2,true);
    ctx.moveTo(95,65);
    ctx.arc(90,65,5,0,Math.PI*2,true);
    ctx.stroke(); }
  else { ... }
}
```

Examples: image

- drawImage(image, x, y)
  - renders an image

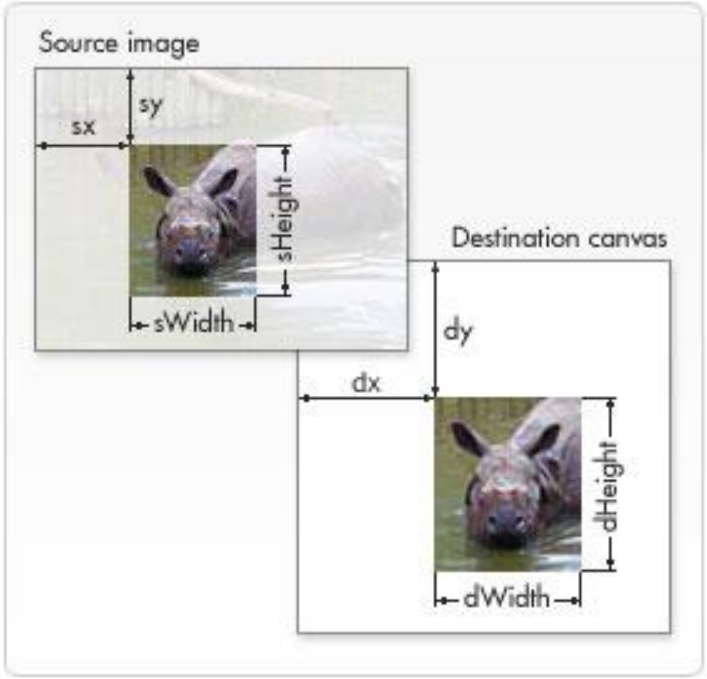
```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  var img = new Image();
  img.src = "img_flwr.png";
  img.onload = function(){
    ctx.drawImage(img,0,0);
  }
}
```




```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  var img = new Image();
  img.src = 'images/backdrop.png';
  img.onload = function(){
    ctx.drawImage(img,0,0);
    ctx.beginPath();
    ctx.moveTo(30,96);
    ctx.lineTo(70,66);
    ctx.lineTo(103,76);
    ctx.lineTo(170,15);
    ctx.stroke(); }
```

Images

- Images can be scaled…
  - drawImage(image, x, y, width, height)
- … and sliced
  - drawImage(image, sx, sy, sWidth, sHeight, dx, dy, dWidth, dHeight)



Example

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  var img = new Image();
  img.src = 'images/rhino.jpg';
  img.onload = function(){
    for (i=0;i<4;i++) {
      for (j=0;j<3;j++) {
        ctx.drawImage(img,j*50,i*38,50,38);
      }
    }
  }
}
```

Example

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  ctx.drawImage(document.getElementById('source'),
                33,71,104,124,21,20,87,104);
  ctx.drawImage(document.getElementById('frame'),0,0);
}
```

Example: colors and interaction

Click on the buttons below to change the color of the rectangle.

Blue | Green | Yellow | Red | Click to clear canvas

```
<body>
  <canvas id="drawing" style="" > </canvas>
  <p>Click on the buttons below to change the color of the
     rectangle. </p>

  <input type="button" value="Blue" id="blue" onclick="BlueRect()" />
  <input type="button" value="Green" id="green" onclick="GreenRect()" />
  <input type="button" value="Yellow" id="yellow" onclick="YellRect()" />
  <input type="button" value="Red" id="red" onclick="RedRect()" />
  <input type="button" value="Click to clear canvas" id="clear"
         onclick="ImgClr()" />
</body>
```

Example: colors and interaction

```
<script type="text/javascript">
  var canvas=null;  var context=null;
  window.onload = function() {
         canvas=document.getElementById("drawing");
         context=canvas.getContext("2d");
         // Border
       context.beginPath();   //This initiates the border
         context.rect(100,60,175,70);
         context.fillStyle="#ffffff";
         context.fill();
         // Border width
       context.lineWidth=1; //This sets the width of the border
         // Border color
       context.strokeStyle="#000000";
       context.stroke();  }
  function BlueRect () {
         context.fillStyle="#701be0"; // Changes the rectangle to blue
         context.fill();
         context.strokeStyle="#000000";
         context.stroke();  }
  function GreenRect () { ... }
  function ImgClr () {
         context.clearRect(0,0, canvas.width, canvas.height); }
</script>
```

Gradients

- createLinearGradient(x1,y1,x2,y2)
  - starting point (x1,y1) and end point (x2,y2) of the gradient
- createRadialGradient(x1,y1,r1,x2,y2,r2)
  - starting circle (x1,y1, r1) and end circle (x2,y2, r2)
- addColorStop(position,color)
  - position: a number between 0.0 and 1.0 that defines the relative position of the color in the gradient
  - color: string

```
var lineargradient = ctx.createLinearGradient(0,0,150,150);
lineargradient.addColorStop(0,'red');
lineargradient.addColorStop(1,'green');
```

Example: linear gradients

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  // Create gradient
  var lingrad = ctx.createLinearGradient(0,0,0,150);
  lingrad.addColorStop(0, '#00ABEB');
  lingrad.addColorStop(0.5, '#fff');
  lingrad.addColorStop(0.5, '#66CC00');
  lingrad.addColorStop(1, '#fff');
  // assign gradients to fill style
  ctx.fillStyle = lingrad;
  // draw shape
  ctx.fillRect(10,10,130,130);
}
```

Example 14
Radial gradients

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');

  // Create gradients
  var radgrad = ctx.createRadialGradient(45,45,10,52,50,30);
  radgrad.addColorStop(0, '#A7D30C');
  radgrad.addColorStop(0.9, '#019F62');
  radgrad.addColorStop(1, 'rgba(1,159,98,0)');

  var radgrad2 = ctx.createRadialGradient(105,105,20,112,120,50);
  radgrad2.addColorStop(0, '#FF5F98');
  radgrad2.addColorStop(0.75, '#FF0188');
  radgrad2.addColorStop(1, 'rgba(255,1,136,0)');
  ...
```

Example: radial gradients

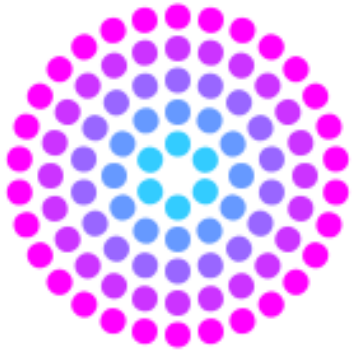
```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  // Create gradients
  var radgrad = ctx.createRadialGradient(45,45,10,52,50,30);
  radgrad.addColorStop(0, '#A7D30C');
  radgrad.addColorStop(0.9, '#019F62');
  radgrad.addColorStop(1, 'rgba(1,159,98,0)');
  var radgrad2 = ctx.createRadialGradient(105,105,20,112,120,50);
  radgrad2.addColorStop(0, '#FF5F98');
  radgrad2.addColorStop(0.75, '#FF0188');
  radgrad2.addColorStop(1, 'rgba(255,1,136,0)');
  var radgrad3 = ctx.createRadialGradient(95,15,15,102,20,40);
  radgrad3.addColorStop(0, '#00C9FF');
  radgrad3.addColorStop(0.8, '#00B5E2');
  radgrad3.addColorStop(1, 'rgba(0,201,255,0)');
    var radgrad4 = ctx.createRadialGradient(0,150,50,0,140,90);
  radgrad4.addColorStop(0, '#F4F201');
  radgrad4.addColorStop(0.8, '#E4C700');
  radgrad4.addColorStop(1, 'rgba(228,199,0,0)');
    // draw shapes
  ctx.fillStyle = radgrad4; ctx.fillRect(0,0,150,150);
  ctx.fillStyle = radgrad3; ctx.fillRect(0,0,150,150);
  ctx.fillStyle = radgrad2; ctx.fillRect(0,0,150,150);
  ctx.fillStyle = radgrad;  ctx.fillRect(0,0,150,150);
}
```

Example: save and restore

- Canvas states can be stored on a stack
- Methods save() and restore()

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  ctx.fillRect(0,0,150,150); // default settings
  ctx.save(); // Save the default state
  ctx.fillStyle = '#09F' // Make changes to the settings
  ctx.fillRect(15,15,120,120); // Draw with new settings
  ctx.save(); // Save the current state
  ctx.fillStyle = '#FFF' // Make changes to the settings
  ctx.globalAlpha = 0.5;
  ctx.fillRect(30,30,90,90); // Draw with new settings
  ctx.restore(); // Restore previous state
  ctx.fillRect(45,45,60,60); // Draw with restored settings
  ctx.restore(); // Restore original state
  ctx.fillRect(60,60,30,30); // Draw with restored settings
}
```

Example: trasformations



- translate(x,y)
- rotate(angle)
- scale(x,y)
- transform(m11,m12,m21,m22,dx,dy)

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  ctx.translate(75,75);
  for (i=1;i<6;i++){
    ctx.save();
    ctx.fillStyle = 'rgb('+(51*i)+','+(255-51*i)+',255)';
    for (j=0;j<i*6;j++){
      ctx.rotate(Math.PI*2/(i*6));
      ctx.beginPath();
      ctx.arc(0,i*12.5,5,0,Math.PI*2,true);
      ctx.fill(); }
    ctx.restore(); }
}
```

Compositing

```
globalCompositeOperation = type
```

- source-over (default)
  - draws new shapes on top of the existing canvas content

- destination-over
  - new shapes are drawn behind the existing canvas content

- source-in
  - the new shape is drawn only where both the new shape and the destination canvas overlap; everything else is transparent

- destination-in
  - the existing canvas content is kept where both the new shape and existing canvas content overlap; everything else is transparent

Compositing

```
globalCompositeOperation = type
```

- source-out
  - the new shape is drawn where it doesn't overlap the existing canvas content

- destination-out
  - the existing content is kept where it doesn't overlap the new shape

- source-atop
  - the new shape is only drawn where it overlaps the existing canvas content

- destination-atop
  - the existing canvas is only kept where it overlaps the new shape; the new shape is drawn behind the canvas content

Compositing

```
globalCompositeOperation = type
```

- lighter
  - where both shapes overlap the color is determined by adding color values

- darker (unimplemented)
  - where both shapes overlap the color is determined by subtracting color values

- xor
  - shapes are made transparent where both overlap and drawn normal everywhere else

- copy
  - only draws the new shape and removes everything else

Example: clipping path

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  ...

  // Create a circular clipping path
  ctx.beginPath();
  ctx.arc(0,0,60,0,Math.PI*2,true);
  ctx.clip();

  ...
```

Canvas pixel manipulation

- It is possible to access the individual pixels of a canvas, by using the ImageData object
- The ImageData object has three properties: width, height and data
  - The width and height properties contain the width and height of the graphical data area
  - The data property is a byte array containing the pixel values
- The 2D context API provides three methods to draw pixel-by-pixel
  - createImageData()
  - getImageData()
  - putImageData()

Pixel manipulation

- Example: create a 100 x 100 pixels ImageData object

```
var canvas = document.getElementById("ex1");
var context = canvas.getContext("2d");
var width = 100;
var height = 100;
var imageData = context.createImageData(width, height);
```

- Each pixel in the data array consists of 4 bytes values: one value for the red color, green color and blue color, and a value for the alpha channel
  - Each of the red, green, blue and alpha values can take values between 0 and 255
- Example: sets the color and alpha values of the first pixel

```
var pixelIndex = 0;
imageData.data[pixelIndex ] = 255;     // red color
imageData.data[pixelIndex + 1] = 0;    // green color
imageData.data[pixelIndex + 2] = 0;    // blue color
imageData.data[pixelIndex + 3] = 255;  // alpha
```

Pixel manipulation

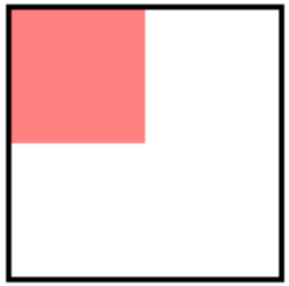
- Once you have finished manipulating the pixels, you can copy them onto the canvas using the function putImageData()

```
var canvasX = 25;
var canvasY = 25;
context.putImageData(imageData, canvasX, canvasY);
```

- It is also possible to grab a rectangle of pixels from a canvas into an ImageData object, by using the getImageData() function
  - x and y: coordinates of the upper left corner of the rectangle to grab from the canvas
  - width and height: width and height of the rectangle to grab from the canvas

```
var x = 25;
var y = 25;
var width = 100;
var height = 100;
var imageData2 = context.getImageData(x, y, width, height);
```

Example: pixel manipulation

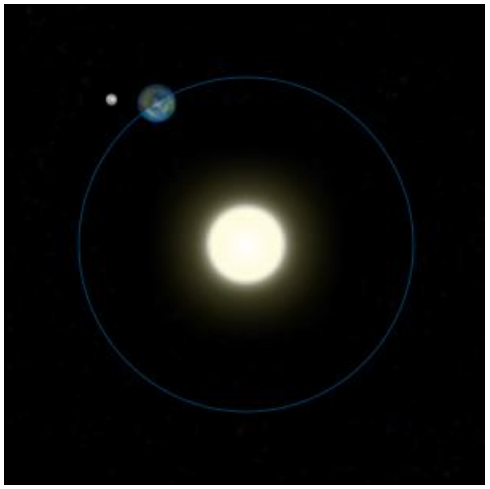


```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  var imgd = false;
  var w = 50, var h = 50, x = 0, y = 0;

  imgd = ctx.createImageData(w, h);
  var pix = imgd.data;

  // Loop over each pixel
  for (var i = 0, n = pix.length; i < n; i += 4) {
    pix[i  ] = 255; // the red channel
    pix[i+3] = 127; // the alpha channel
  }

  // Draw the ImageData object.
  ctx.putImageData(imgd, x, y);
}
```

Example: pixel manipulation

```
function draw() {
  var ctx = document.getElementById('canvas').getContext('2d');
  var x = 0, y = 0;
  // Create a new image
  var img = new Image();
  img.src = 'tree.jpg';
  // Draw the image on canvas
  img.onload = function(){
    ctx.drawImage(img,0,0);
    // Get the pixels
    var imgd = ctx.getImageData(x, y, this.width, this.height);
    var pix = imgd.data;
    // Loop over each pixel and invert the color.
    for (var i = 0, n = pix.length; i < n; i += 4) {
      pix[i  ] = 255 - pix[i  ]; // red
      pix[i+1] = 255 - pix[i+1]; // green
      pix[i+2] = 255 - pix[i+2]; // blue
      // i+3 is alpha (the fourth element)
    }
    // Draw the ImageData object
    ctx.putImageData(imgd, x, y);
  }
}
```

Animations



- Since scripts can control canvas elements, it's easy to make animations
- Unfortunately there are limitations: once a shape gets drawn it stays that way
  - To move it we have to redraw it and everything that was drawn before it
- It takes a lot of time to redraw complex frames and the performance depends highly on the speed of the computer it's running on

Basic animation steps

- Clear the canvas
  - Unless the shapes you'll be drawing fill the complete canvas (for instance a backdrop image), you need to clear any shapes that have been drawn previously
  - The easiest way to do this is using the clearRect method
- Save the canvas state
  - If you're changing any setting (styles, transformations, etc) which affect the canvas state and want to make sure the original state is used each time a frame is drawn, you need to save it
- Draw animated shapes
  - The step where you do the actual frame rendering
- Restore the canvas state
  - If you've saved the state, restore it before drawing a new frame

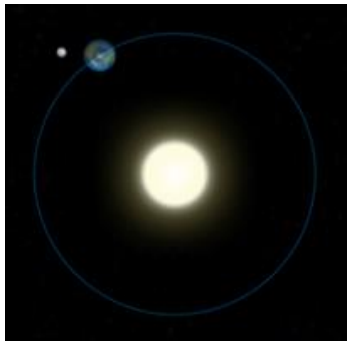
Controlling animations

- Two ways
  - Execute the drawing functions over a period of time

```
// execute every 500 milliseconds
setInterval(animateShape,500);

// execute once after 500 milliseconds
setTimeout(animateShape,500);
```

  - User input: by setting eventListeners to catch user interaction

- Examples



Example: video and canvas

Example: video timeline viewer

- Autoplay attribute: the video starts as soon as the page loads
- Two additional event handler functions, oncanplay (when the video is loaded and ready to begin play) and onended (when the video ends)

```
<video id="movies" autoplay oncanplay="startVideo()"
       onended="stopTimeline()" autobuffer="true"
       width="400px" height="300px">
  <source src="Intermission-Walk-in.ogv"
       type='video/ogg; codecs="theora, vorbis"'>
  <source src="Intermission-Walk-in_512kb.mp4"
       type='video/mp4; codecs="avc1.42E01E, mp4a.40.2"'>
</video>
```

- Canvas called timeline into which we will draw frames of video at regular intervals

```
<canvas id="timeline" width="400px" height="300px">
```

Example: video timeline viewer

- Variables declaration

```
// # of milliseconds between timeline frame updates (5sec)
var updateInterval = 5000;
// size of the timeline frames
var frameWidth = 100;
var frameHeight = 75;
// number of timeline frames
var frameRows = 4;
var frameColumns = 4;
var frameGrid = frameRows * frameColumns;
// current frame
var frameCount = 0;
// to cancel the timer at end of play
var intervalId;

var videoStarted = false;
```

Example: video timeline viewer

- Function updateFrame: grabs a video frame and draws it onto the canvas

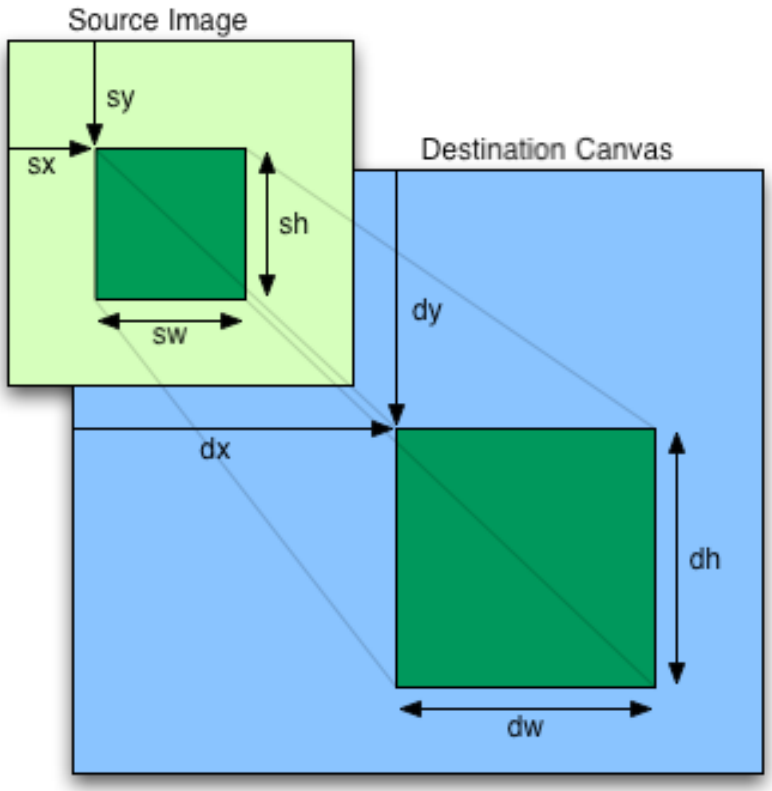
```
// paints a representation of the video frame into canvas
function updateFrame() {
  var video = document.getElementById("movies");
  var timeline = document.getElementById("timeline");
  var ctx = timeline.getContext("2d");
  // calculate out the current position based on frame
  // count, then draw the image there using the video
  // as a source
  var framePosition = frameCount % frameGrid;
  var frameX = (framePosition % frameColumns) * frameWidth;
  var frameY = (Math.floor(framePosition / frameRows)) *
               frameHeight;
  ctx.drawImage(video, 0, 0, 400, 300, frameX, frameY,
  frameWidth, frameHeight);
  frameCount++;
}
```

Example: video timeline viewer


```
frameCount = 25
framePosition = 25 % 16 = 9
frameX = (9 % 4) * 100 = 100
frameY = (Math.floor(9 / 4)) * 75 = 150
ctx.drawImage(video, 0, 0, 400, 300, 100, 150, 100, 75)
```

Canvas: drawImage

```
cxt.drawImage(image, dx, dy)
cxt.drawImage(image, dx, dy, dw, dh)
cxt.drawImage(image, sx, sy, sw, sh, dx, dy, dw, dh)
```



- The first argument can be an image, a canvas or a video element
- When a canvas uses a video as an input source, it draws only the currently displayed video frame
  - Canvas displays will not dynamically update as the video plays
  - If you want the canvas content to update, you must redraw your images as the video is playing

Example: video timeline viewer

- Function startVideo: updates the timeline frames regularly
  - The startVideo() function is triggered as soon as the video has loaded enough to begin playing

```
function startVideo() {
  // only set up the timer the first time the video starts
  if (videoStarted) return;
  videoStarted = true;
  // calculate an initial frame, then create
  // additional frames on a regular timer
  updateFrame();
  intervalId = setInterval(updateFrame, updateInterval);
  ...
```

- setInterval: calls a function repeatedly, with a fixed time delay between each call to that function

```
var intervalID = window.setInterval(func, delay);
```

Example: video timeline viewer

- Function startVideo: handles user clicks on the individual timeline frames

```
// set up a handler to seek the video when a frame
// is clicked
var timeline = document.getElementById("timeline");
timeline.onclick = function(evt) {
  var offX = evt.layerX - timeline.offsetLeft;
  var offY = evt.layerY - timeline.offsetTop;
```

- offsetLeft: returns the number of pixels that the upper left corner of the current element is offset to the left within the parent node
- offsetTop: returns the distance of the current element relative to the top of the parent node
- layerX: returns the horizontal coordinate of the event relative to the current layer
- layerY: returns the vertical coordinate of the event relative to the current layer

Example: video timeline viewer

```
// calculate which frame in the grid was clicked
// from a zero-based index
var clickedFrame = Math.floor(offY/frameHeight)* frameRows;
clickedFrame += Math.floor(offX/frameWidth);
// find the actual frame since the video started
var seekedFrame = (((Math.floor(frameCount/frameGrid))*
  frameGrid) + clickedFrame);
```

- The clicked frame should be only one of the most recent video frames, so seekedFrame determines the most recent frame that corresponds to that grid index

Example: video timeline viewer


```
offX= 120
offY= 60
clickedFrame = Math.floor(60/75)* 4 = 0
clickedFrame += Math.floor(120/100)= 1
seekedFrame = (((Math.floor(25/16))* 16) + 1 = 17
```

Example: video timeline viewer

- Function startVideo: handles user clicks on the individual timeline frames

```
      // if the user clicked ahead of the current frame
      // then assume it was the last round of frames
      if (clickedFrame > (frameCount%16))
        seekedFrame -= frameGrid;
      // can't seek before the video
      if (seekedFrame < 0) return;
      // seek the video to that frame (in seconds)
      var video = document.getElementById("movies");
      video.currentTime = seekedFrame * updateInterval / 1000;
      // then set the frame count to our destination
      frameCount = seekedFrame;
    }
  }
```

Example: video timeline viewer

- Function stopTimeline: stops capturing frames when the video finishes playing
  - The stopTimeline handler is be called when the “onended” video handler is triggered, i.e. by the completion of video playback.

```
 // stop gathering the timeline frames
function stopTimeline() {
  clearInterval(intervalId);
}
```

- clearInterval: cancels repeated action which was set up using setInterval()

License

- This work is licensed under the Creative Commons “Attribution-NonCommercial-ShareAlike Unported (CC BY-NC-SA 3,0)” License.
- You are free:
  - to Share - to copy, distribute and transmit the work
  - to Remix - to adapt the work
- Under the following conditions:
  - Attribution - You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work).
  - Noncommercial - You may not use this work for commercial purposes.
  - Share Alike - If you alter, transform, or build upon this work, you may distribute the resulting work only under the same or similar license to this one.
- To view a copy of this license, visit http://creativecommons.org/license/by-nc-sa/3.0/