Visualizing Concepts with Interactive Java Animation on Internet

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Abstract

We have developed a web site with a series of Java applets (small programs) for calculus, trigonometry, and linear transformations. Those programs are animation-oriented and used for visualizing mathematical concepts and provides on-line laboratory. The strong point of java applets is that any students and educators can interactively operate programs by connecting to the web site and make mathematical experiments. This paper will demonstrate interactive animation with several examples of Java applets and will discuss the possibility of interactive educational materials on internet.

Keywords

visualization;animation;internet;world wide web;java;calculus;trigonometry;high school

1. INTRODUCTION

World Wide Web provides great opportunities to math educators to utilize and create on-line educational materials. Not only text and picture, but also animation and sound can be used in educational materials on internet. Moreover, some mathematics software are now web-ready. For example, using MathView by Waterloo Maple Inc, we can manipulate mathematical symbols and draw 2D and 3D graphs in browser windows.
Also various kinds of interactive java applets are now available. Our web site (http://www.campusnet.or.jp/~tsuyuki/java/iesjava.html) has over 30 applets for high school and college students. Those applets are mainly used for visualization of concepts. All programs are animation oriented and controlled interactively. We will introduce our programs, and discuss the possibilities of interactive math education materials on internet.

2. VISUALIZING CONCEPTS WITH INTERACTIVE ANIMATION

Animation is powerful for showing the image of concepts. All of our program have animation features. Figure 1 shows the generation of cosine curve from circular motion and figure 2 depicts the derivative of y=sin x. In each case, motion has a vital role.

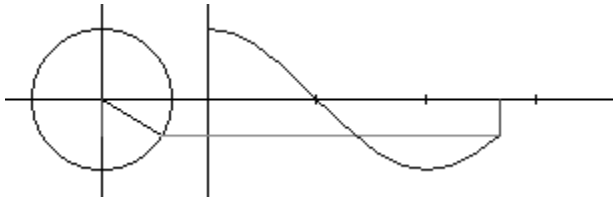

Figure 1. Graph of y=cos x

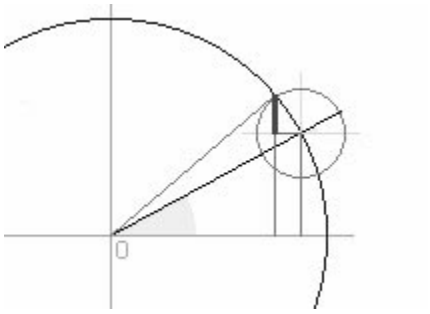

Figure 2. Derivative of sin x

Although it is possible to create animation by using GIF animation tool or Quicktime Movie, we sometimes need to change parameters interactively. In figure 3, we can move the cross-section and change the number of cross-sections.

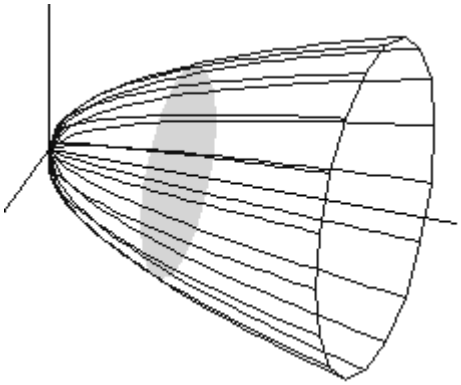

Figure 3. Volume of a solid of revolution

Animation is not so flexible as "interactive" animation. In other words, motion is always fixed in simple animation. We cannot change multiple parameters interactively. Even if we use general-purpose math software, it is still difficult to create it. In this sense java is a excellent environment to develop interactive animation.

3. ON-LINE MANIPULATIVES AND LABORATORIES

We can make replicas of manipulatives on internet. For example, figure 4 is a real gage to record shapes and figure 5 is a java applet of the gage. I use it to teach Cavalieri's theorem.

Figure 4. Gage to record shape

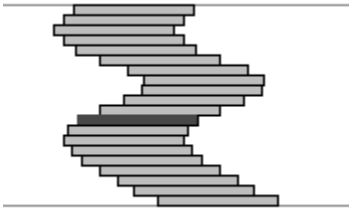

Figure 5. Gage on a screen

We can also create imaginary manipulatives that are impossible without computers. Figure 6 is a puzzle game to teach conservation of area. Students drag each vertices and transform the triangle ABE into ADF. The area of the triangle does not change during the transformation, so students need to consider how to move the vertices.

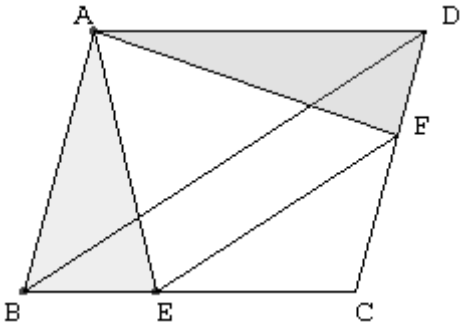

Figure 6. Conservation of area

We are planning to create on-line laboratories where students can make various experiments. Figure 7 is the screen shot of a linear transformation program. Changing the elements of matrix, students observe various transformations and make conjectures.

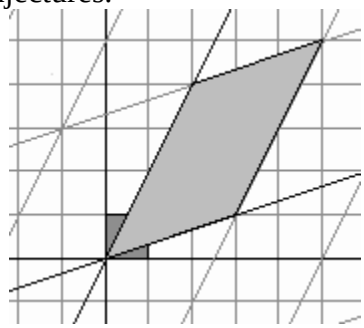

Figure 7. Linear transformation

Figure 8 is a billiards game for middle school students to learn LCM and GCM. A ball is shot at the bottom-left corner to the direction of 45 degrees from each side of billiards table. Students predict which of the corner the ball will exit.

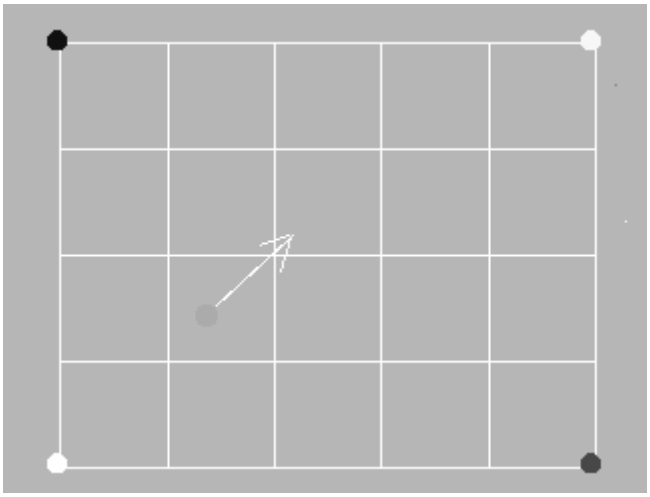

Figure 8. Billiards game

4. INTERACTIVE EDUCATIONAL MATERIALS ON INTERNET

- Utilize company-made web-ready software. We will soon be able to use various kinds of math software on internet.
- We recommend teachers to create java applets. It is not so hard to learn Java if one is familiar with some programming languages. Java is the most easiest way to create original interactive materials with graphics.
- Utilize other person's java applets by making links. The number of applets are now growing rapidly. We might be able to find what we need in near future.