Sonification of UCSD Campus Energy Consumption

Interactive Visual Data Interpretation
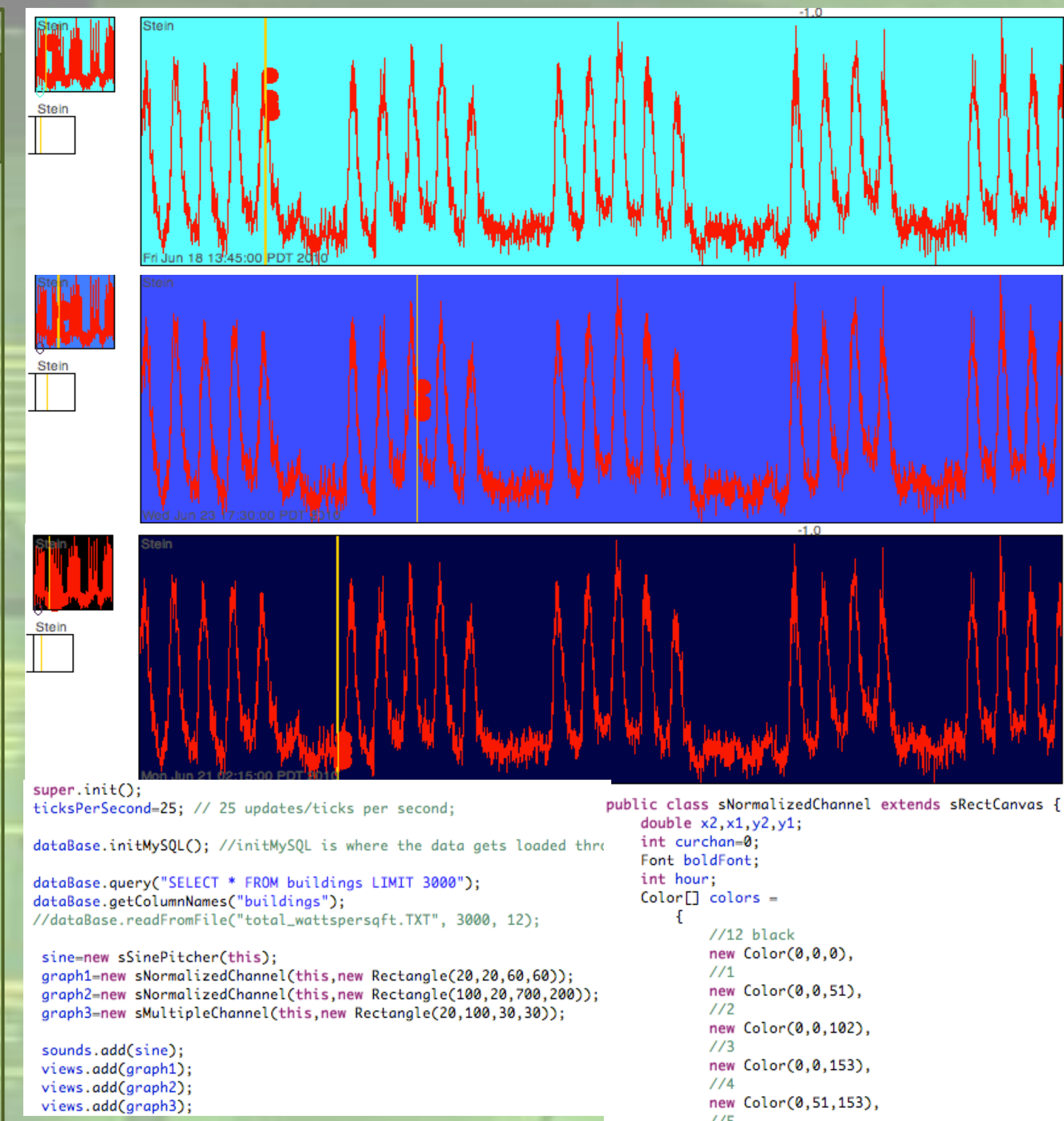
Gwendolyn Chang, Joachim Gossmann, San Diego Supercomputer Center, CREL, UCSD

Abstract

Our project focused on addressing this issue specifically in the context of energy consumption data in a novel way – sonification. We created applets in Eclipse that have the capability of displaying past and real time data using audiovisual display metaphors like clocks, graphs, and icons. The goal is to allow viewers to see the data in different contexts and scales, from a campus-wide comparison to an investigation of individual buildings.

Introduction

The University of California, San Diego (UCSD) is leading the way for a greener campus with more recycling bins, a green café, solar panels, and, now, a new way of monitoring energy data through sonification. The widespread availability of data sources have made the accumulation of data in extremely large databases an ubiquitous phenomenon. These large amounts of data are sometimes too hard to represent in a way that people can understand. Sonification is the use of audio to convey information about something. It is a relatively new way of representing things and provides an alternative to traditional visualization. It has become increasingly useful in certain disciplines, but has never been used before for energy data.

Team Members: Michelle Xiu, Hong Joo Kim, Jimmy Jiang
Mentors: Natasha Balac, San Diego Supercomputer Center, CREL, UCSD
Shlomo Dubnov, San Diego Supercomputer Center, CREL, UCSD

Methods

The use of sonification for time-oriented data sets was explored using a variety of strategies such as auditory graphs and tipping container metaphors, in combination with visual interfaces. In our experiments, the use of sound is a powerful tool for data representation because the ear can discern between minute changes in sound and provide a new perspective revealing different kinds of detail and features than the visual graph representation. Sound can not stand alone because it is always relative in terms of pitch, tone, and amplitude are mostly qualitative in nature. A graphic accompaniment can provide quantitative context that follows along with the qualitative sounds. The can help the viewer understand better what they are hearing as well as correlating the data to contextual processes. All of the applets were made in Eclipse.


```
super.init();
ticksPerSecond=25; // 25 updates/ticks per second;

dataBase.initMySQL(); //initMySQL is where the data gets loaded thru

dataBase.query("SELECT * FROM buildings LIMIT 3000");
dataBase.getColumnNames("buildings");
//dataBase.readFromFile("total_wattspersqft.TXT", 3000, 12);

sine=new sSinePitcher(this);
graph1=new sNormalizedChannel(this,new Rectangle(20,20,60,60));
graph2=new sNormalizedChannel(this,new Rectangle(100,20,700,200));
graph3=new sMultipleChannel(this,new Rectangle(20,100,30,30));

sounds.add(sine);
views.add(graph1);
views.add(graph2);
views.add(graph3);
```

```
public class sNormalizedChannel extends sRectCanvas {
    double x2,x1,y2,y1;
    int curchan=0;
    int hour;
    Font boldfont;
    Color[] colors =
        //12 block
        new Color(0,0,0),
        //11
        new Color(0,0,51),
        //12
        new Color(0,0,102),
        //13 load
        new Color(0,0,153),
        //14
        new Color(0,51,153),
```
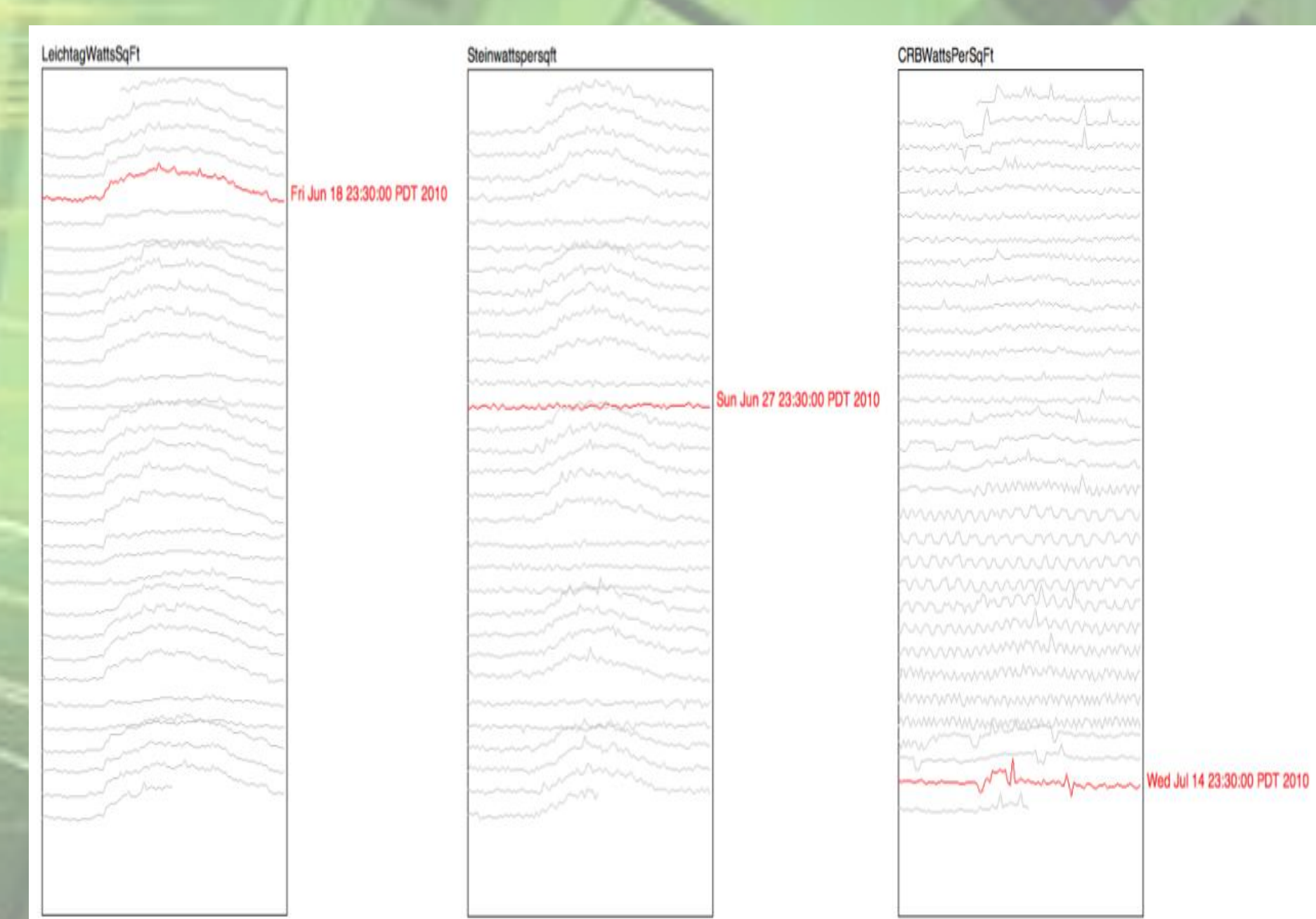
To display real time data as well as past data, graphs both stagnant and dynamic could be used. This applet shows a contextual way if displaying time: The time of the day. The background of the graph corresponds to the hour and represents it with a color. The colors correspond to the colors of the sky at those times, for example, midnight is black and noon is sky blue.


```
if (in<chanRect.length-1)
{
    int ind=ol[in];
    System.out.println("subdiv "+ind+" "+in);
    if (!(ind/2.0 > (int)(ind/2)) && (ind>-1))
    {
        System.out.println("a");
        chanRect[ind][0]=rect[0];
        chanRect[ind][1]=rect[1];
        chanRect[ind][2]=rect[2];
        chanRect[ind][3]=applet.dataBase.catalog[applet.rowIndex].chan[ind]/rect[2];
        pr[0]=rect[0];
        pr[1]=rect[1]+chanRect[ind][3];
        pr[2]=rect[2];
        pr[3]=rect[3]-chanRect[ind][3];
    }
    else
    {
        System.out.println("b");
        chanRect[ind][0]=rect[0];
        chanRect[ind][1]=rect[1];
        chanRect[ind][2]=applet.dataBase.catalog[applet.rowIndex].chan[ind]/rect[3];
        chanRect[ind][3]=rect[3];
        pr[0]=rect[0]+chanRect[ind][2];
        pr[1]=rect[1];
        pr[2]=rect[2]-chanRect[ind][2];
        pr[3]=rect[3];
    }
    in++;
    subdiv(pr,in);
}
```


This applet qualitatively displays the amount of energy consumed by one of the buildings on campus as the proportionate size of a rectangle. The overall box changes size to represent total campus energy use. This strategy could be made scalable by subdividing each rectangle into sub-rectangles for each floor or room.

]This applet displays regular patterns that occur in time-variant signals, such as "seasonal" ups and downs due to climate or other underlying cyclical processes. In this specific case, the seasons are the respective days. In this display they are separated and plotted vertically over each other. One of the slices is colored red and transformed into sound – the slice currently highlighted and heard depends on the mouse position on the screen.