Linking Laboratory Instruments for Simulation: Comma Separated Variable Files

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Abstract

This paper describes two workhorse electronic instruments, the function generator and the oscilloscope, and their use in recording and simulation applications in design and laboratory electronic courses. The paper also discusses the application of the recording and simulation techniques to performing experiments over the Internet

The oscilloscope used in the applications which are described is a portable, digital storage, battery operated, 100 MHz, two channel, Fluke Scopemeter[1] ®. The function generator used is a digital synthesized, arbitrary waveform generator, the Hewlett Packard HP33120A[2] ®. Both instruments have digital processing and RS232 interfaces for communication with software hosted on a Personal Computer (PC). It is this combination of analog and digital processing and easy interface with a PC that opens up the ability to use these instruments for acquiring data and later, transferring and using that data for simulation in a laboratory environment. There is another feature of these two products that enhances the ability to easily perform laboratory simulations for design projects or for laboratory course experiments. The common linking feature is the fact that both instruments can generate and use Comma Separated Variable (CSV) files. CSV files can also be read and processed by Microsoft ® Excel. In addition to spreadsheet compatibility, word processors or text editors can be used to generate CSV files. This feature provides students with easy access to the data and the ability to analyze and edit recorded data. Thus, simulated input for experiments or design projects can be accomplished by using a text editor to modify the scope CSV data files for input to the arbitrary waveform generator.

I. Introduction

Several yeas ago, in an effort to improve the quality of laboratory reports, and to overcome problems associated with collecting, reporting and analyzing oscilloscope data, the use of digital storage scopes was introduced in to upper division courses in electronic communications, Global Positioning Systems (GPS), and avionics.

A brief description of the pertinent Fluke Scopemeter and companion PC software is presented in Table 1.

Fluke Scopemeter 100
Dual trace, analog bandwidth of 100 MHz, 40 Megasamples/sec.
PC Software FlukeView for Windows
Transfer Protocol from scope to PC
RS232 up to 19200 baud
Recording For
512 Point Screen
Bitmap graphic *.bmp files
512 Point Sample Data Waveform
***.csv files**
Bitmap graphic *.bmp files

Table 1 Fluke Scopemeter Characteristics

Over the past five years, students unanimously endorse the benefits of being able to archive analog data in digital form on the Internet.

The introduction of the arbitrary waveform generator is the result of an effort to simulate arbitrary inputs to simulate sensor and other inputs in to laboratory experiments. The arbitrary waveform generator models noise and arbitrary signal and noise combinations, adding a valuable dimension to laboratory and design simulation. A brief description of the pertinent Hewlett Packard HP33120A Function /Arbitrary Waveform Generator and companion PC software is presented in Table 2.

Function/Arb Generator
Frequency Range – to 2 MHz
Internal Functions
Sine, Cosine, Square Wave, Ramp, Arbitrary Waveform
Modulation
Amplitude Modulation (AM)- internal and external
Frequency Modulation (FM)- internal only
PC Software – HP34811A BenchLink Arb
Transfer Protocol from generator to PC
RS232
Waveform Generation
Free Hand, Line, Noise, Sine, Cosine, etc.
Waveform Manipulation
Add, Subtract, Multiply, Invert, Mirror
Input File Format
***.csv files**

Table 2 Function/Arbitrary Waveform Generator Characteristics

The linking of real data recorded on an oscilloscope to simulation is via the PC software which accepts *.csv files from the scope. Simulation of recorded signals with varying signal to noise ratios can be performed using the mathematical add function.

Sections II and IV illustrate the value of the CSV file linkage to laboratory and design applications.

II. Laboratory Course Applications

The first experiment performed in the electronic communications laboratory is an introduction to the Fluke Scopemeter capabilities. The experiment deals with the importance of the Nyquist Sampling Theorem as it pertains to the sampling of the analog signal by the Scopemeter. While the intrinsic scope sampling rate is 40 Megasamples/sec., the graphical data transferred from the scope to the PC is based on 512 samples taken over the time interval presented on the scope display. Selection of the time/division scope parameter becomes crucial in obtaining data that is not aliased. Checking the number of samples per period of the highest frequency signal component determines if the Nyquist sampling criteria is satisfied.

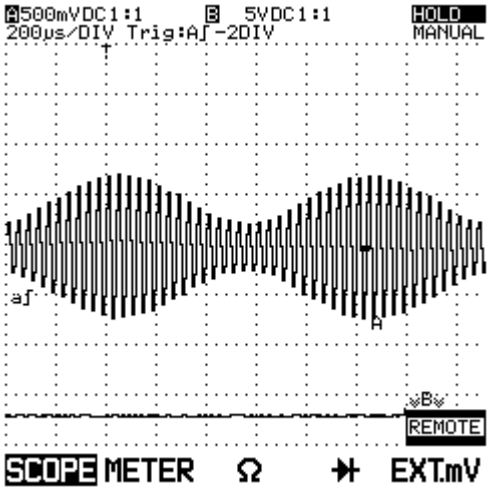

Figure 1 *.bmp File of AM Signal

Figure 1 is an example of a screen waveform for an Amplitude Modulated (AM) signal. The scope settings are shown and the amplitude, period and per cent modulation can be estimated from the *.bmp file[3].

```
  "Title         ","Memory 3"
       "ID            ",1
   "Type          ","Waveform"
    "Date          ",11/28/00
   "Time          ",2:21:30 PM
 "X Scale       ",2.000000E-04
"X At 0%       ",-4.000000E-04
 "X Resolution ",2.500000E+01
      "X Size        ",512
      "X Unit        ","s"
 "X Label       ","200 us/Div"
 "Y Scale       ",5.000000E-01
 "Y At 50%      ",4.000000E-02
 "Y Resolution ",2.500000E+01
      "Y Size        ",256
      "Y Unit        ","V"
     "Y Label       ","mV"

time in sec    amplitude in volts
   -4.000000E-04,8.000000E-02
   -3.920000E-04,2.200000E-01
   -3.840000E-04,6.000000E-02
  -3.760000E-04,-2.000000E-01
  -3.680000E-04,-2.000000E-01
   -3.600000E-04,1.600000E-01
   -3.520000E-04,3.400000E-01
   -3.440000E-04,8.000000E-02
  -3.360000E-04,-3.200000E-01
  -3.280000E-04,-2.800000E-01
   -3.200000E-04,2.000000E-01
   -3.120000E-04,4.800000E-01
   -3.040000E-04,1.000000E-01
  -2.960000E-04,-4.400000E-01
  -2.880000E-04,-4.000000E-01
   -2.800000E-04,2.400000E-01
   -2.720000E-04,5.800000E-01
   -2.640000E-04,1.200000E-01
  -2.560000E-04,-5.400000E-01
  -2.480000E-04,-4.800000E-01
   -2.400000E-04,2.800000E-01
   2.984000E-03,-9.600000E-01
   2.992000E-03,-5.200000E-01
    3.000000E-03,6.400000E-01
    3.008000E-03,9.200000E-01
   3.016000E-03,-8.000000E-02
   3.024000E-03,-9.200000E-01
   3.032000E-03,-5.000000E-01
    3.040000E-03,6.200000E-01
```

Fig 2 Scopemeter CSV data sample

Figure 2 is a sample of an Excel presentation of a CSV file of Scopemeter data. The first two columns are the time-amplitude samples of the scope data.

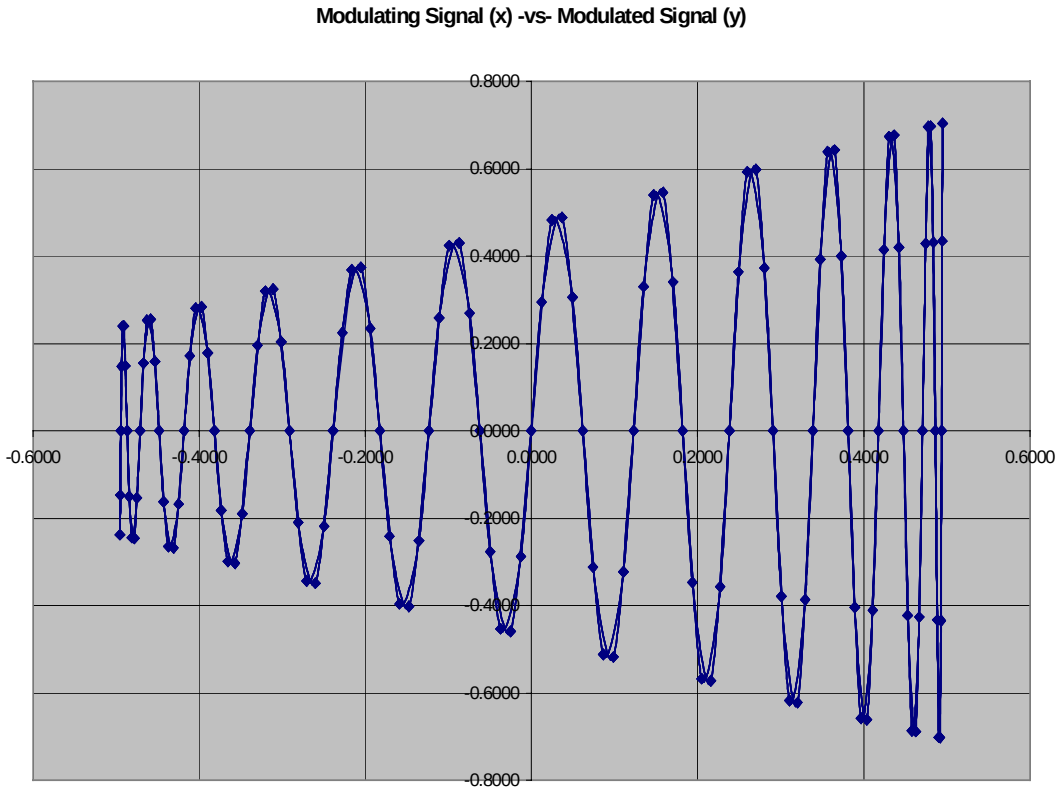

Fig 3 AM Signal from CSV Data

Figure 3 is an example of a trapezoidal representation of an AM signal, generated from a CSV file using Excel.

The data collected by the Scopemeter and saved in the CSV format can be used to simulate an AM input for an envelope detector or filtering experiment. By transferring the CSV file from the PC to the HP33120A Arbitrary waveform generator, simulated input becomes available for a new experiment. Additional information can be extracted from the experiment by using the HP PC software to add varying levels of noise to the data. The scope output of the new data in CSV format can be processed in Excel to obtain spectral information.

III. Internet Applications

Having developed a method for recording laboratory data in digital form, the next step is to find a means to archive and provide access to the information. At Saint Louis University a web-based tool, WebCT, was made available, campus wide, to provide a means for instructors to augment their courses using the World Wide Web. Students who register for courses utilizing WebCT get access, via a user-id and password, to an Internet web page for the particular course.

Welcome to AVNP351, Electronic Communications
This course was created by John Cremin, creminjd@slu.edu
Parks College of Engineering and Aviation,

contents Course Content | bulletins Bulletin Board | mail Private Mail | information Some F.A.Q.

quiz Online Quizzes and Surveys | bulletins LABNOTES | bulletins COURSE OBJECTIVES | bulletins COURSE NOTES

Check the Bulletin Board for assignments. Click on Show All instead of Unread in order to see all the assignments.
Check your Private Mail as well
This site covers the lab course AVNP352 Electronic Communications Laboratory also.

This page has been accessed times.
[my WebCT]

Fig 4 Internet Web Page

Figure 4 shows a sample of a WebCT page for one of the courses. In addition to the instructor's postings of syllabus, assignments and lecture notes, one of the most utilized features of WebCT is the Bulletin Board. Students can upload and download postings on the Bulletin Board. Lab reports are submitted via the Bulletin Board.

IV. Design Applications

The improvements in laboratory course quality along with the ability to use the Internet to exchange and archive information as described in sections II and III lead to improvements in quality and efficiency of design projects involving student teams. One design team took a battery operated Fluke Scopemeter and flew on a Tampico aircraft and recorded cabin acoustic noise data using a microphone attached to the scope input. Data was recorded during takeoff, cruise and landing using the ten scope memory

locations. After the flight the scope data was transferred to a PC, posted on the WebCT Bulletin Board and processed to determine the frequency content of the acoustic noise in the Tampico cabin. The data was available to the members of the design team and the instructor.

V. Conclusions and Future Applications

Lab data recorded by students and posted on the Internet in CSV format provides the instructor with lecture material that is pertinent and meaningful to the students. It also fosters classroom discussion on observed anomalies and measurement techniques as well as presentation techniques.

The use of simulation as part of the design process is recognized and used by industry as an integral part of product development. At Saint Louis University more effort will be spent on developing simulation techniques incorporating recorded data and arbitrary waveform generation.

Two areas in Internet applications will be developed. One effort will be to combine simulation and the use of WebCT to generate laboratory experiments in a distance learning environment. Once experiments have been developed, they can be used as a step in evaluating and developing laboratory Internet courses that have a basis in real data.

Bibliography

1. Fluke Scopemeter 100 User's Manual
2. Hewlett Packard HP33120A Function/Arbitrary Waveform Generator User's Manual
3. Tomasi, Wayne, *Electronic Communications Systems*,2nd Ed., Prentice Hall Career & Technology, Englewood Cliffs, NJ, 1994, pp106,111
4. URL:http://webctservice.slu.edu:8900/webct/SCRIPT/AVNP10001/scripts/designer/serve_home?.PUBLIC ,information on WebCT courses at Saint Louis University

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John Cremin is an Associate Professor, Avionics, at Saint Louis University, Parks College of Engineering and Aviation. He teaches Electronic Communications, GPS Theory and Applications and Avionics. His technical interest is in the areas of applications of electronic communications and avionics to communication disorders and also to novel applications of Global Positioning Systems (GPS).