ME 135 SPRING 2008

ASSIGNMENT 1: COMPACT DISC SPECIFICATIONS
Due: Tuesday, February 5

Background

The compact disc player has become one of the most popular consumer electronics in use today. Tens of millions of players have been sold to date. However, as common as the CD player is, the beauty and complexity of its design and operation are underappreciated by most users. We will use the compact disc and audio applications as the topic for several labs this semester.

Developments Facilitating the Compact Disc Player [1]

As staggering as the release of the compact disc player was in 1982, the technology and theories which allowed it to be born were long in development. In 1841, the great mathematician Augustin-Louis Cauchy first proposes the sampling theorem. Nearly 80 years later J.R. Carson publishes a mathematical analysis of time sampling in communications. In a 1928 lecture at the American Institute of Electrical Engineers Harry Nyquist provides proof of the sampling theorem in "Certain Topics in Telegraph Transmission Theory". In 1937, A. Reeves proposes pulse code wave modulation (PCM). In 1948, John Bardeen, William Shockley, and Walter Brattain invent the bipolar junction transistor at Bell Labs—compact digital circuitry is a reality. Two years later, in 1950 Richard W. Hamming publishes significant work on error correction and detection codes. In 1958 C.H. Townes and A.L. Shawlow invent the laser. In 1960 R.C. Bose publishes binary group error correction codes. That same year I.S. Reed and G. Solomon publish error correction codes to be used in the CD player 22 years later. Also early computer music experiments take place at Bell Labs. Fifteen years before consumers see the first player, NHK Technical Research Institute publicly demonstrates a PCM digital audio recorder with a 30 kHz sampling rate and 12-bit resolution. Two years later, Sony Corporation demonstrates a PCM digital audio recorder with a 47.25 kHz sampling rate and 13-bit resolution. A hemisphere away, Dutch physicist Klaas Compaan uses a glass disc to store black and white holographic images using frequency modulation at Philips Laboratories. Four years later, in 1973 Philips engineers begin to contemplate an audio application for their "video" disc system. A prototype disc with a 44 kHz sampling rate is run through a 14-bit digital-to-analog converter and exhibits a signal-to-noise (S/N) ratio of 80 dB in monaural. Now a research frontier, Mitsubishi, Sony, and Hitachi all demonstrate digital audio discs at the Tokyo Audio Fair in 1977. One year later, Philips joins with its recording subsidiary Polygram Records to develop a worldwide digital audio standard. In March 1979, Philips demonstrates a prototype compact disc player in Europe. Sony joins the Philips/Polygram coalition after Matsushita declines. In June of 1980, the coalition formally proposes their CD standard. A year later in 1981, Sharp successfully mass produces the semiconductor laser. This step was crucial to delivering a consumer product. In Fall of 1982 nearly 150 years of work comes to fruition and Sony and Philips introduce their respective players to consumer in Europe. The following spring, the player is introduced in the United States. Twelve years later, the improvement of digital audio continues at a rapid pace and the analog format that was so prevalent in 1982 has all but disappeared.

Task

This first lab involves determining some of the servo requirements of a CD player. The specifications for a typical CD player are listed in reference [1], but many of these values will not be needed.

Your goal is to write a LabVIEW program that determines the amount of playing time as a function of speed and CD diameter.

You are working for a startup that, based on exhaustive market research, is interested in creating 12" (30.48 cm) LP size CD's. As part of the firmware development group you are to determine:

1) The playing time that can be achieved with the larger CD if
   a) the linear velocity is kept the same as current CD's and
   b) the angular speed is held constant such that the maximum linear velocity is kept the same as current CD's.

2) As a group discuss whether you would choose to scan the CD at constant angular velocity or constant linear velocity and describe why in the report.

3) The velocity profile in both position and time of
   a) optical scan head as it moves across the CD and
   b) the motor turning the CD.

Keep in mind that, in a heated meeting with the manufacturing group, it was made clear to your group that no parameter other than the outside diameter of the CD is to be changed. Since your group is also the servo group, you are at liberty to change any of the motor parameters.

Deliverables

Presentation is an important part of the grade. Remember the GUI is the first thing any user will see, and this first impression will color their judgment of the software.

To be turned in next Tuesday (February 5) by the start of class. All assignments are to be sent to me135hw@gmail.com . A report including both the quick start and power user guide, as described in the syllabus, as well as all of the necessary VI's should be attached to the e-mail.

Delivery time and functional performance are both important. If it is absolutely necessary to sacrifice one over the other, however, we would prefer to see a tardy but completed assignment. If this is the case, still turn in what you have by the deadline with an explanation of what needs to be completed and let us know when the final version will be turned in.

References

[1] Erickson, Grant. A Fundamental Introduction to the Compact Disc Player. Department of Electrical Engineering, University of Minnesota.
http://www.tc.umn.edu/~erick205/Papers/paper.html

[2] Pohlmann, Ken C. *The Compact Disc Handbook-The Computer music and digital audio series*. 2nd Ed. Madison, WI: A-R Editions, Inc. 1992.