



Announcements

- Chapter 9 for today
- No quiz this week
 - Instructor got behind....
- We'll be back in MGH389 on Friday



Announcements

- This week's GoPost topic was posted yesterday



Announcements

- No quiz this week in lab!
 - Instructor got behind....



Announcements

- Clicker scoring
 - 2 points for correct answers
 - Because you studied hard and got it
 - 1 point for incorrect answers
 - Because you're here and you tried



Announcements

- Guest speaker on Monday and Friday
 - Ian King, Curator of the Living Computer Museum
 - Paul Allen's computer museum!
 - History of computers and the various breakthroughs
 - Next week's schedule on the calendar will be rearranged a bit



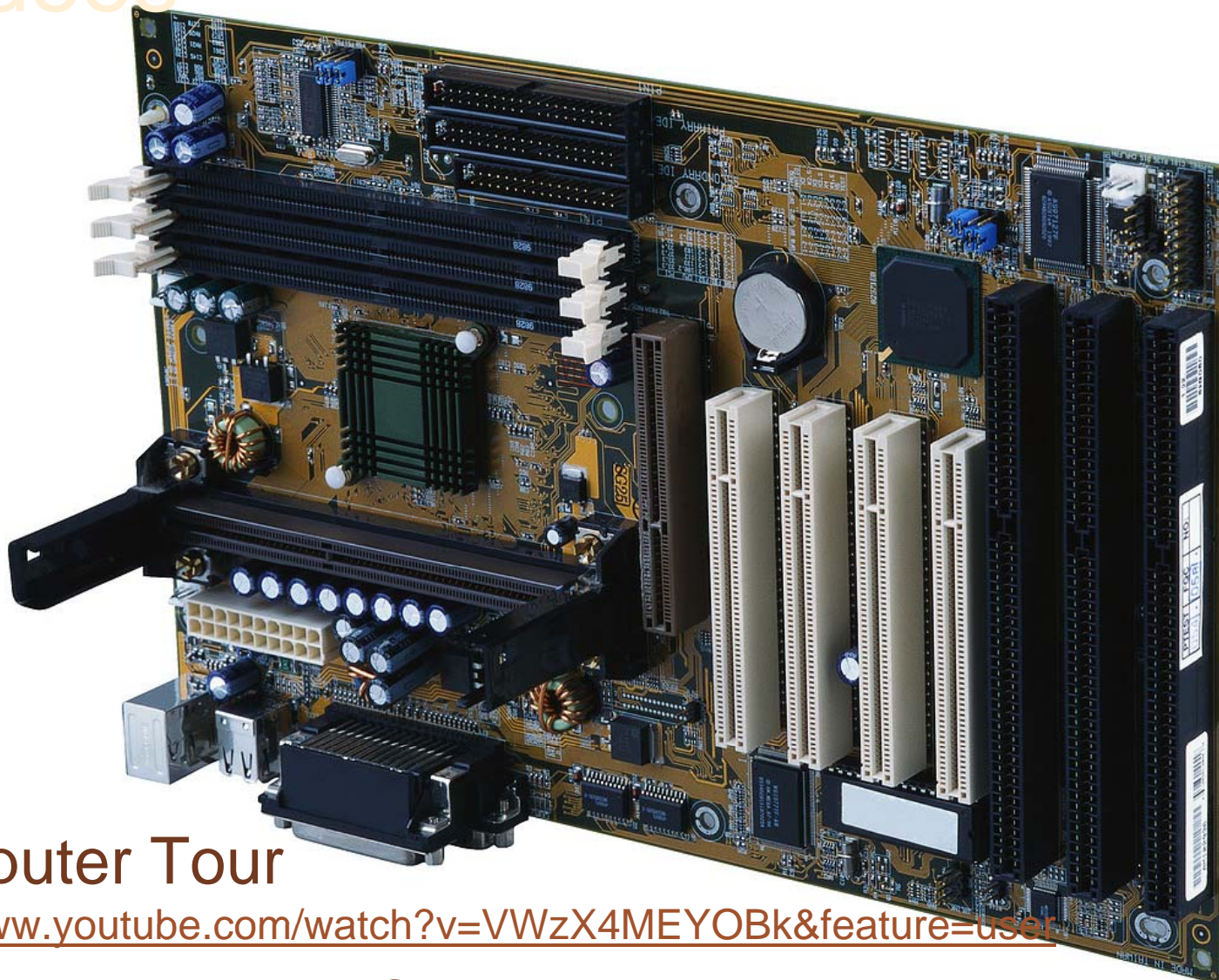
- Warriors of the Net



How Computers Work...



Videos



- **Computer Tour**

<http://www.youtube.com/watch?v=VWzX4MEYOBk&feature=user>

- **Build a computer: CPU, RAM, and Mobo**

<http://www.youtube.com/watch?v=YFrB3rC9Avs&feature=related>



Overflow

- Because computers use fixed-size bit sequences, what happens when there are not enough bits to represent the correct result of a binary addition?
- Called *overflow exceptions*
 - Computers report them when the computation they're told to perform overflows; programmer has to find way to recover



Digitizing Sound

- An object creates sound by vibrating in a medium such as air
 - Vibrations push the air
 - Pressure waves emanate from the object and vibrate our eardrums
 - The *force*, or intensity of the push determines the volume
 - The *frequency* (number of waves per second) is the pitch

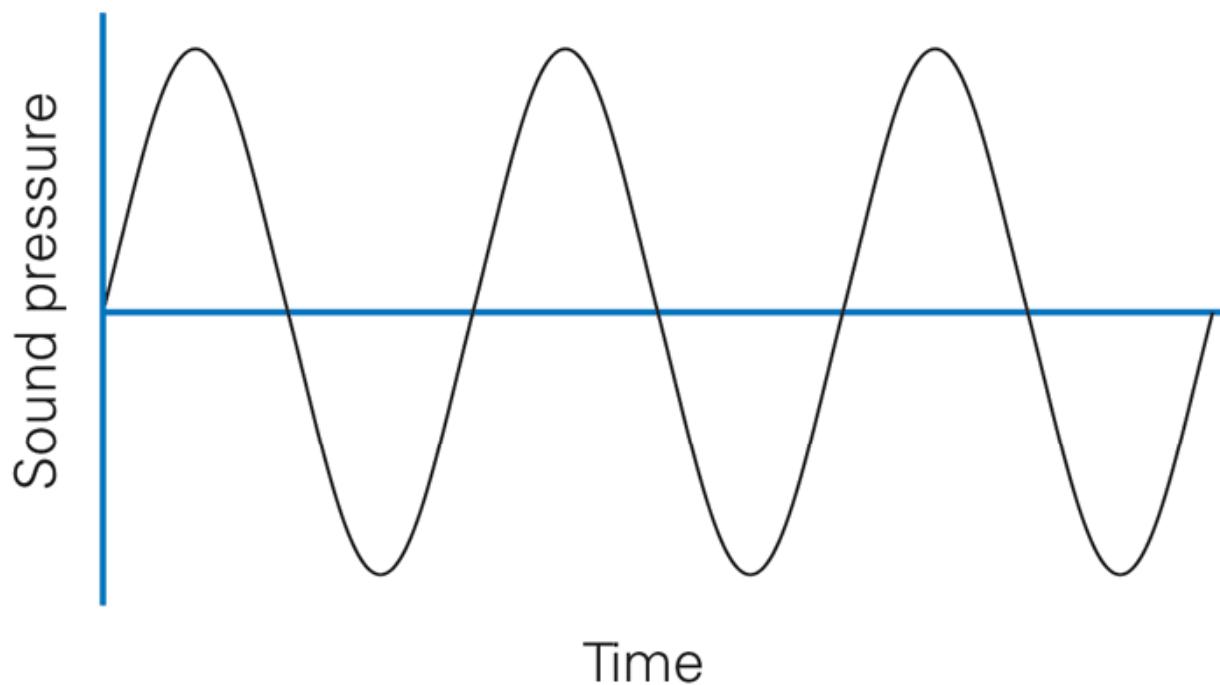


Figure 11.3. Sound wave. The horizontal axis is time; the vertical axis is sound pressure.



Analog to Digital

- To convert continuous information into discrete information, convert it to bits
- From zero line on graph, record with binary number the amount by which the wave is above or below it (positive or negative sound pressure)
- At what points do we measure? We can't record every position of the wave

Sampling

- Take measurements at regular intervals
- Number of samples in a second is the *sampling rate*
 - The faster the rate, the more accurate the recording

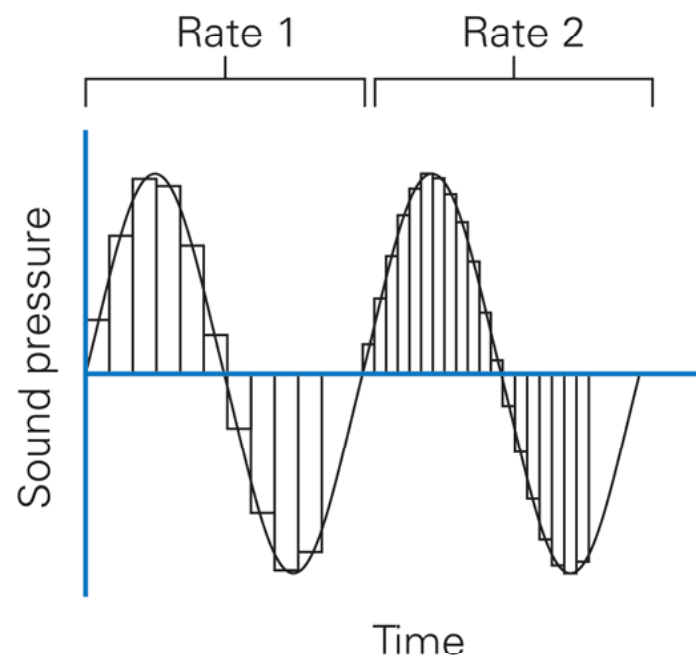


Figure 11.4. Two sampling rates; the rate on the right is twice as fast as that on the left.



How Fast a Sampling Rate?

- Sampling rate should be related to the wave's frequency
 - Too slow a rate could allow waves to fit between the samples; we'd miss segments of sound
 - Guideline is *Nyquist Rule*: Sampling rate must be at least twice as fast as the fastest frequency
 - Human perception can hear sound up to 20,000 Hz, so 40,000 Hz sampling rate is enough.
 - Standard for digital audio is 44,100 Hz (44.1 KHz)



ADC, DAC

- Digitizing Process:
 - Sound is picked up by a microphone (called a *transducer*)
 - The signal is fed into an *analog-to-digital converter (ADC)*, which samples it at regular intervals and outputs binary numbers to memory
 - To play the sound, the process is reversed
 - Numbers are read from memory into *digital-to-analog converter (DAC)*, which creates an electrical wave by filling in between the digital values
 - Electrical signal is output to speaker, which converts it to a sound wave

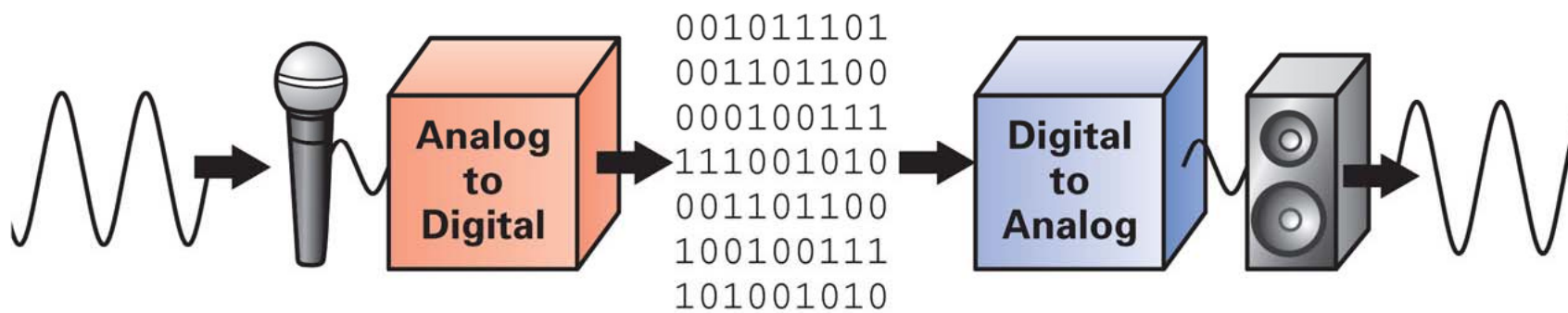
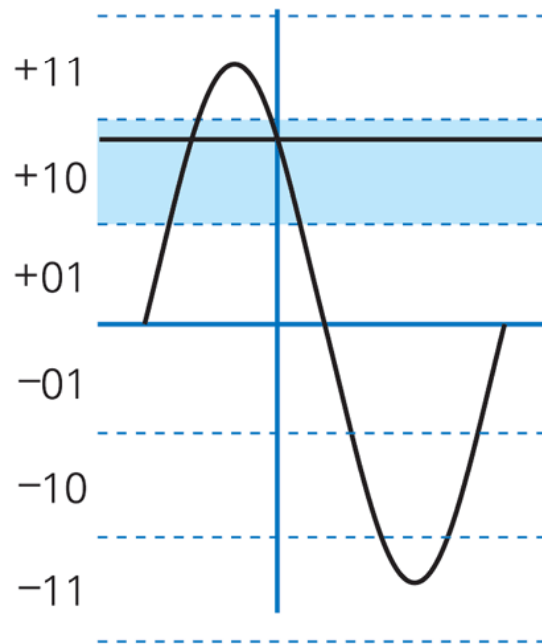


Figure 11.5. Schematic for analog-to-digital and digital-to-analog conversion.

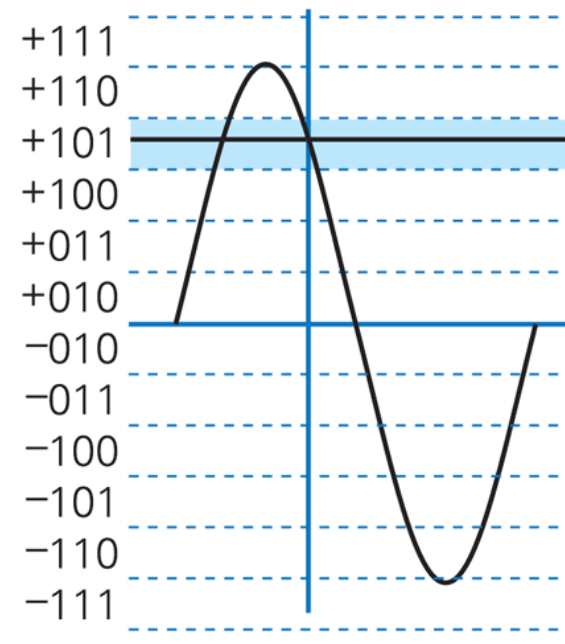


How Many Bits per Sample?

- How accurate must the samples be?
 - Bits must represent both positive and negative values
 - The more bits, the more accurate the measurement
 - The digital representation of audio CDs uses 16 bits (records 65,536 levels, half above and half below the zero line)



(a)



(b)

Figure 11.6. (a) Three-bit precision for samples requires that the indicated reading is approximated as +10. (b) Adding another bit makes the sample twice as accurate.



Advantages of Digital Sound

- We can compute the representation
- MP3 Compression
 - One computation is to compress the digital audio (reduce number of bits needed)
 - Remove waves that are outside range of human hearing
 - MP3 usually gets a compression rate of 10:1
 - Lower bandwidth requirements, popular for Internet transmission
- Reproducing the Sound Recording
 - Bit file can be copied without losing any information
 - Original and copy are exactly the same



Digitizing Images and Video

- It would take 51 minutes to display an 8 x 10 color image scanned at 300 pixels per inch (21.6 MB) with a 56kb/s modem
- How can we see screen-size pictures in second while surfing the web?
- Typical computer screen has under 100 pixels per inch
 - Storing picture digitized at 100 ppi saves a factor of 9 in memory (reducing resolution)
 - This would still take 5 1/2 minutes to send at 56kb/s
 - Solution: JPEG Compression scheme



Compression

- Changing the representation to use fewer bits to store or transmit information
 - Example: fax is a long sequence of 0's and 1's encoding where page is white or black. Run length encoding is used to specify length of first sequence of 0's, following sequence of 1's, etc.
 - Lossless compression—original representation can be perfectly reproduced



JPEG

- Used for still images
- Our eyes are not very sensitive to small changes in hue (gradation of color), but are sensitive to small changes in brightness
 - Store a less accurate description of hue (fewer pixels)
 - Gets a 20:1 compression ratio without eyes being able to perceive the difference



(a)



(b)

Figure 11.7. Detail from an image compressed using JPEG.

(a) 14:1 compression (b) 140:1. Check images at www.aw.com/snyder



MPEG Compression Scheme

- Same idea as JPEG, applied to motion pictures
- JPEG-like compression is applied to each frame
- Then "interframe coherency" is used
 - MPEG only has to record and transmit the differences between one frame and the next
 - Results in huge amounts of compression



Video

- Images and compression



Statistics—hehehe

- 10 people enjoy learning about binary

