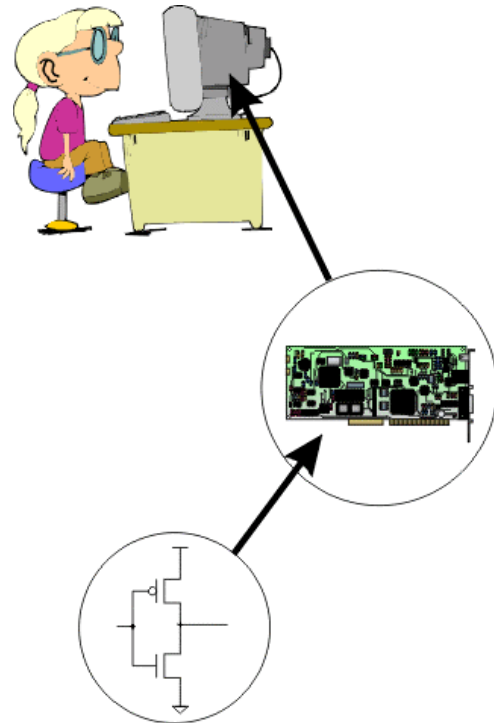


Special Topics: Simple Robots and Microprocessors

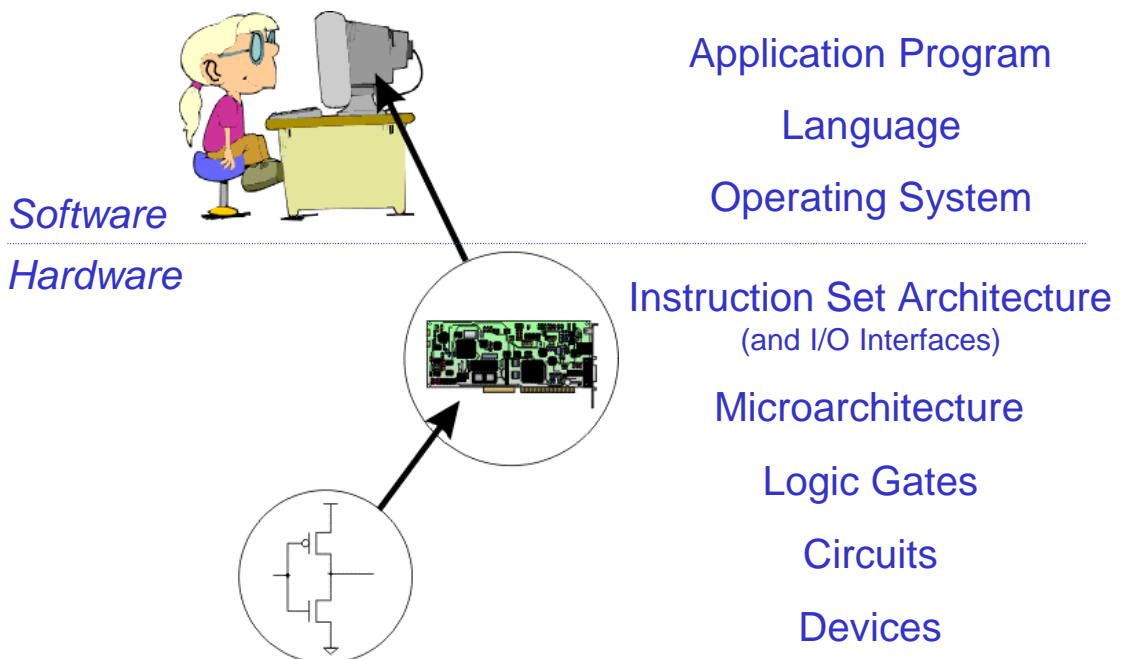
ECE 292
Lecture Notes 1



Reading: syllabus, Chapter 1, 5, 6

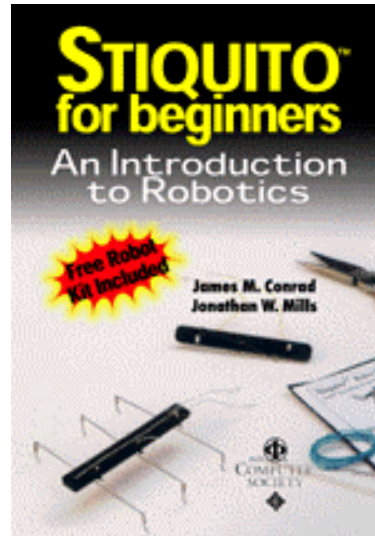
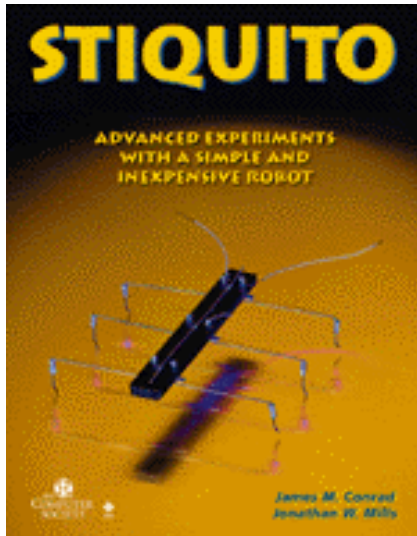
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Computer System: Layers of Abstraction



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Two Books



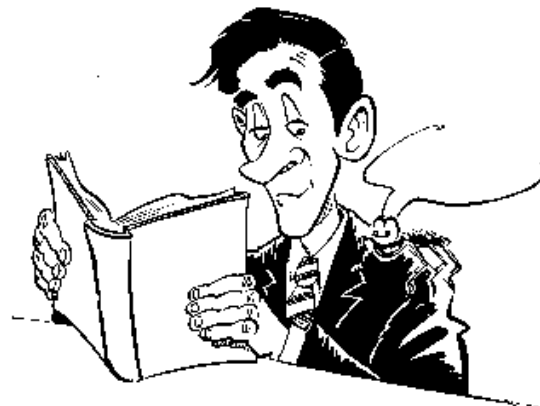
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ECE 292 - Notes 1 - Introduction

3

Course Outline

- Introduction to Embedded Computer Systems; Introduction to Stiquito
- Electronics, soldering skills, instrumentation, power supplies
- Basics of Computer control – Input/Output
- Controlling the Gait of Stiquito
- An examination of a small embedded Computer System
- Optimization of embedded system code
- Hardware/software co-design
- Testing Embedded Systems
- Building Stiquito/basic Stamp board
- Stiquito race/report due (Pizza Party??)



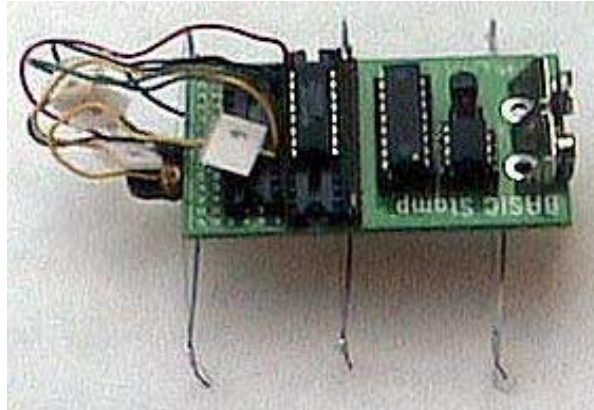
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ECE 292 - Notes 1 - Introduction

4

Class Activities

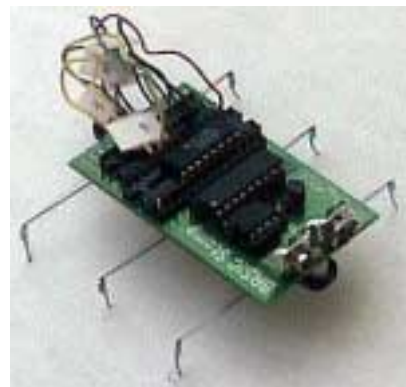
- 40% Laboratory demonstrations
- 10% Lab notebook
- 10% Quizzes
- 20% Final project/race results
- 20% Final report – Magazine Article



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Class Materials

- Each person: Book - Stiquito for Beginners, hobby knife, needle-nose pliers (hemostat helpful)
- Parallel port kit (from me, at cost - \$10)
- Other materials you may want:
 - Brass Screws
 - Your own Basic Stamp



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Computers are everywhere

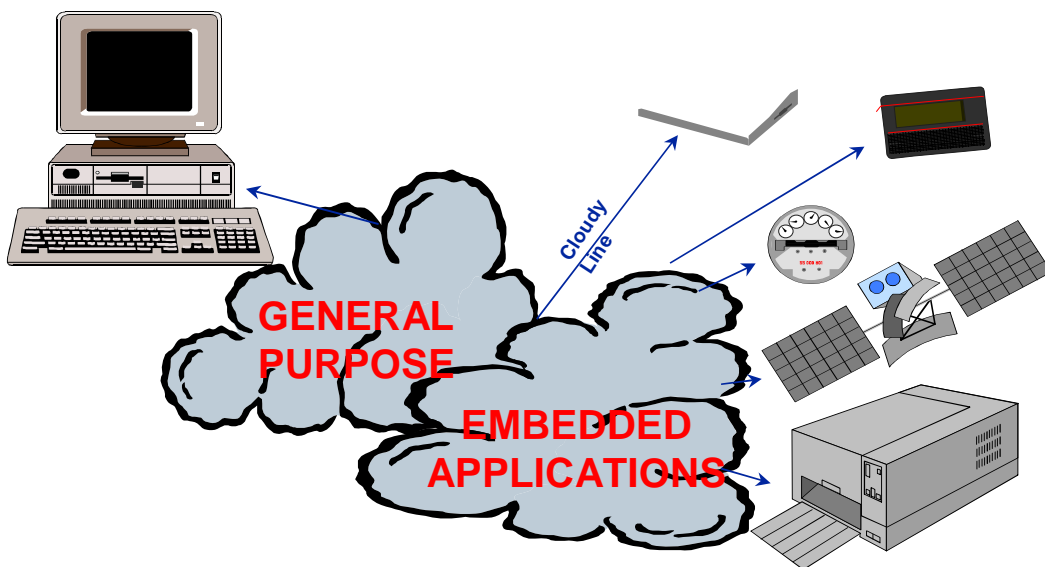
Q: *Where are computers today?*

- On your desktop (of course!)
- In your microwave oven
- Controlling automobiles
- In a Palm Pilot PDA
- In your pager
- In a cell phone
- In a Nintendo console
- In your Gameboy . . .
- Everywhere!



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What is Embedded?



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How Big is it?

Embedded is the largest and fastest-growing part of the worldwide microprocessor industry

Embedded is approximately 100 % of worldwide unit volume in microprocessors

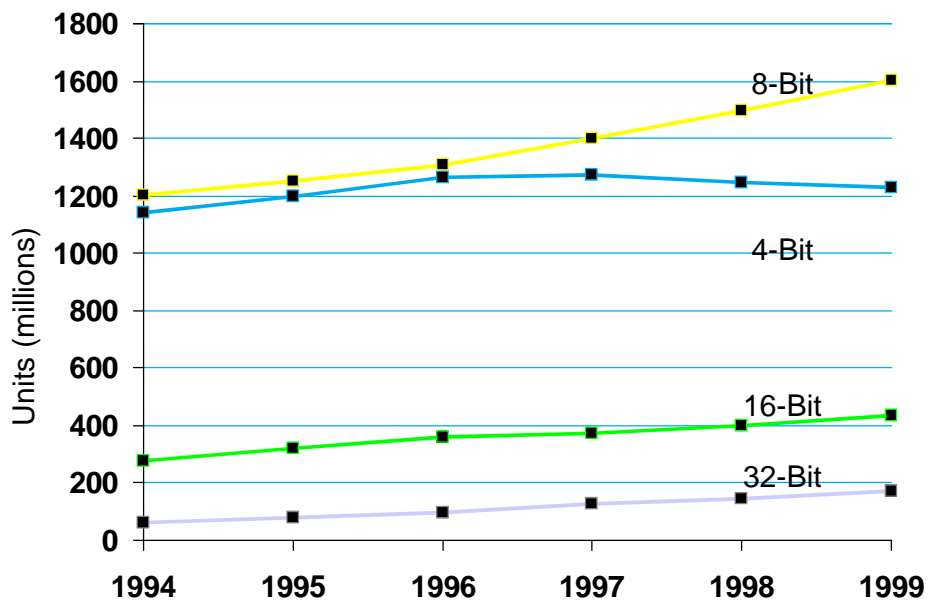
Average of 30-40 processors per home

- (only 5 are within the home PC)

“Turley’s Law”:

- “The amount of processing power on your person will double every 12 months

Microprocessor Shipments All types, all markets



Source: Information Architects

Home Entertainment Rules

Home entertainment and consumer electronics are the fastest-growing segment of the electronics industry

- \$6.5 billion in U.S. games in 1998
 - Mario Kart made more money than Oscar winners

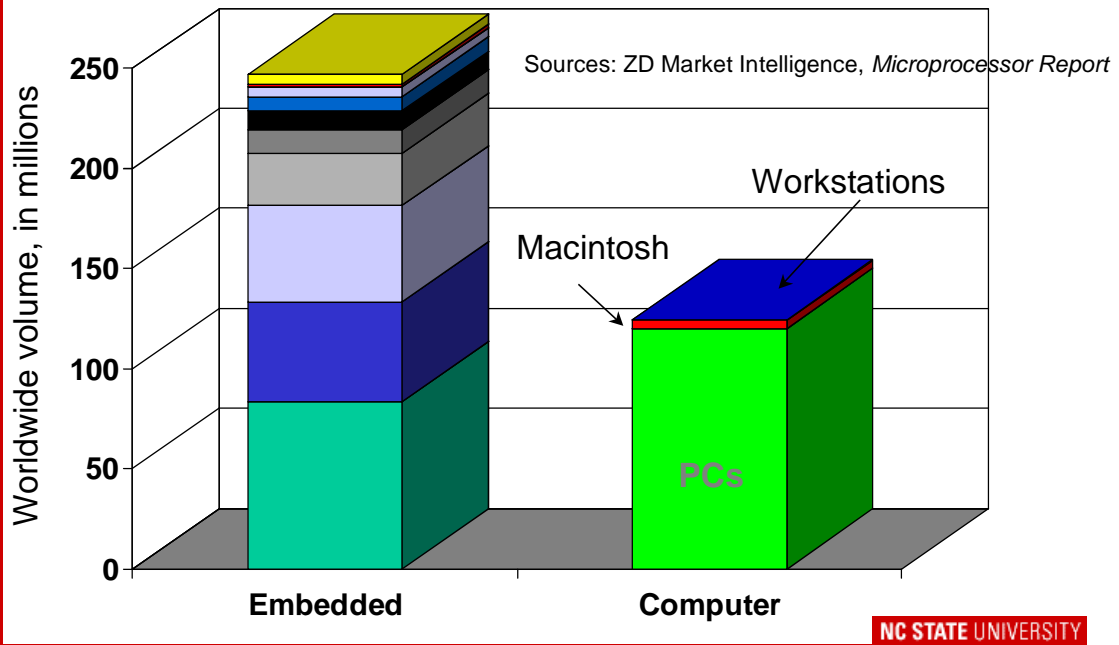
Falling cost of 32-bit processors has made this market the hot growth area for the next decade

Many home applications have a nearly infinite capacity to consume performance

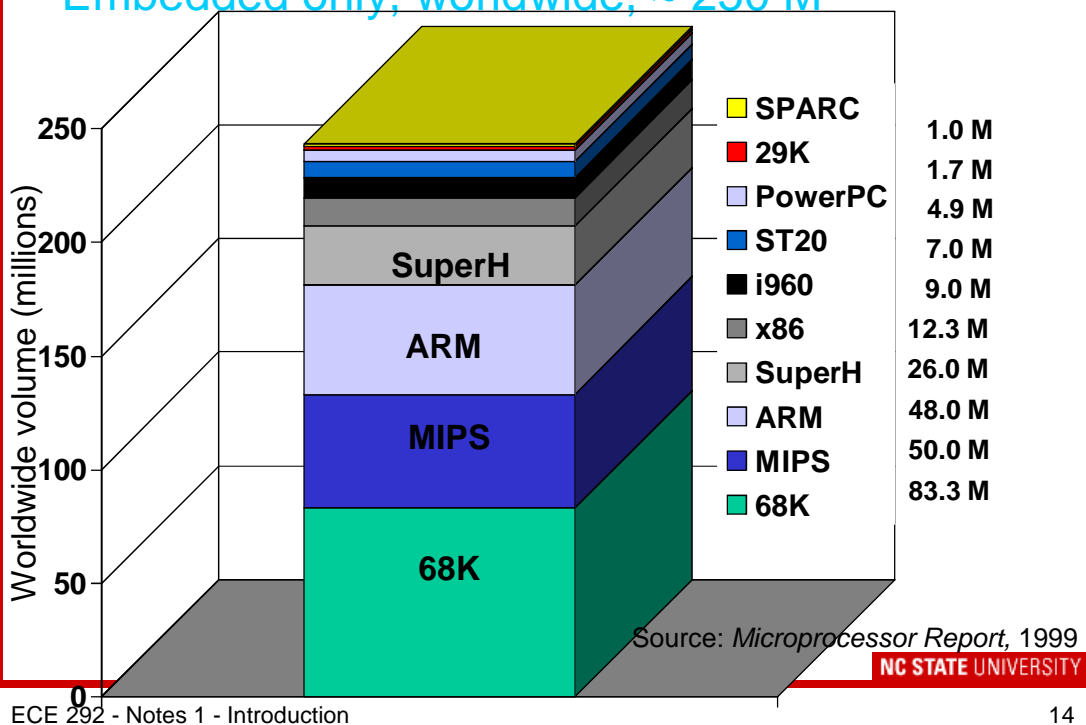
Consumer Electronics



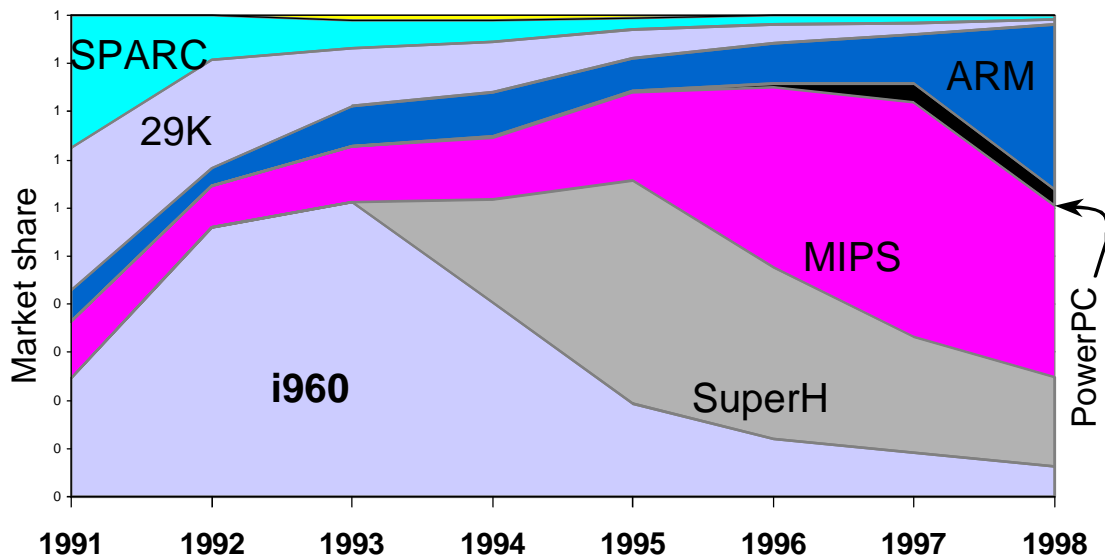
Microprocessors, 32-Bit Desktop and embedded, worldwide



Microprocessors, 32-Bit Embedded only, worldwide, ~ 250 M



The Shifting RISC Lead



Source: *Microprocessor Report*, 1999

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Memory

Memory is *INFORMATION DELAYED IN TIME*

Examples of memory devices:

- Flip-flops - Static memory
- Capacitors - Dynamic memory
 - They "forget" and must be periodically refreshed
- Metal oxides - Tapes, disks
 - Hold a magnetic field
- Transmission lines - Mercury delay lines
 - Used in early computers
- Optical patterns - CD, DVD, paper (barcodes)

Semiconductor memory has made large programs possible

Q: *How many megabytes of DRAM do you have in your computer?*

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Peripherals

Input devices

- Mechanical - strain gauges, keyboards, mice
- Electrical - Field probes, network cables
- Magnetic - Tape heads, disk heads
- Optical - wands, cameras
- Sound - microphones

Output devices

- Mechanical - impact printers, card punches
- Electrical - Network cables
- Magnetic - Tape heads, disk heads
- Optical - CRT, projectors
- Sound - speakers

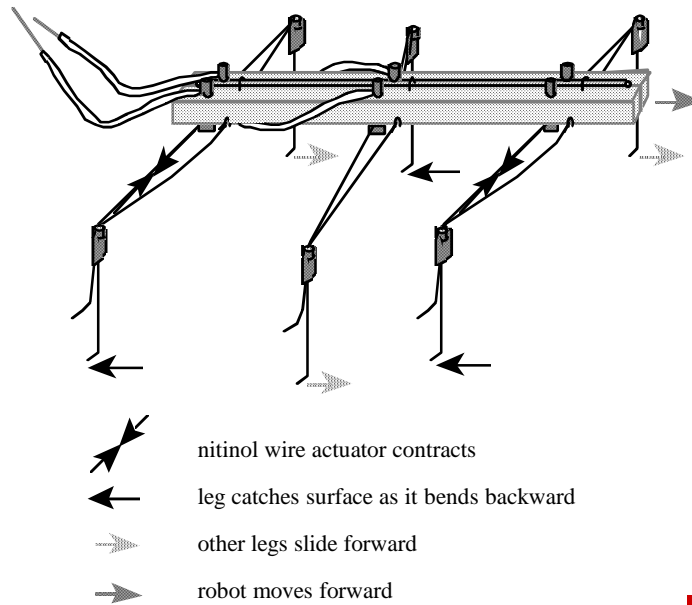
Input + output = Input/Output = I/O

Stiquito - What Is It?

- Invented by Jonathan Mills, CS Department, Indiana University, in 1992.
- Hexapod (six legs)
- Small - can sit on a credit card (75mm x 70mm x 25mm, 10g)
- Inexpensive (\$5.00 in mass quantities), easy-to-build
- Can carry about 50g of weight
- Travels using a "Nitinol" muscle

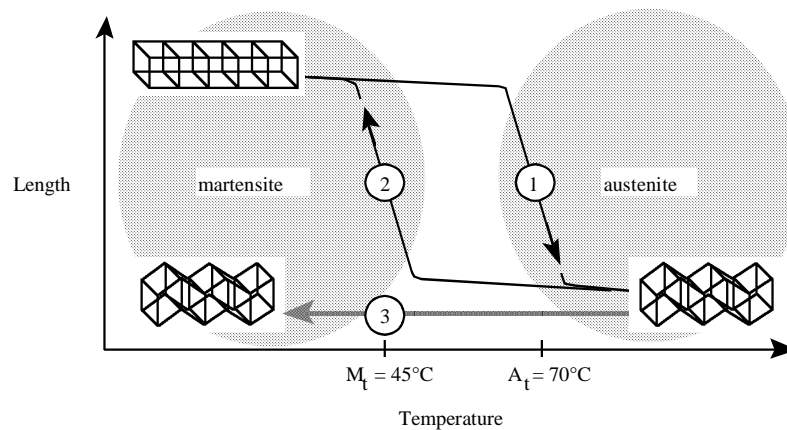


Stiquito - How Does It Work?



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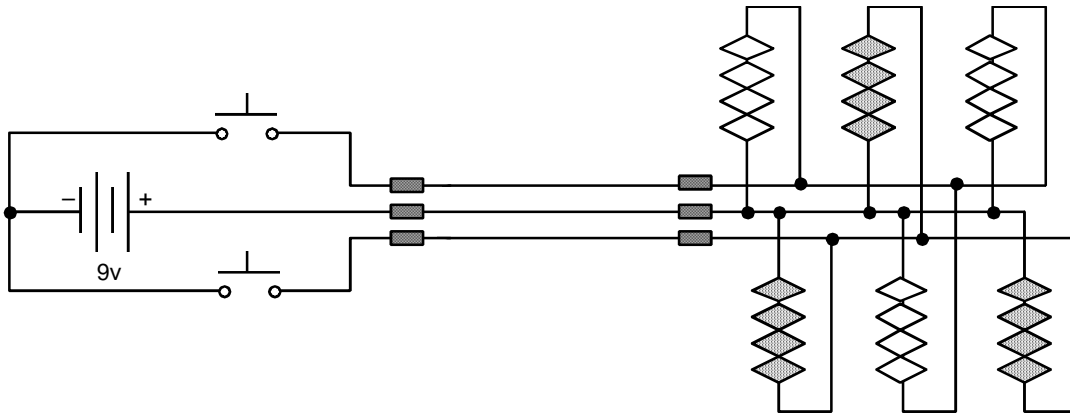
Nitinol - What Is It?



- Alloy of nickel and titanium
- Contracts when heated
- When cooled, must be “stretched” back to its original size
- Lasts millions of cycles

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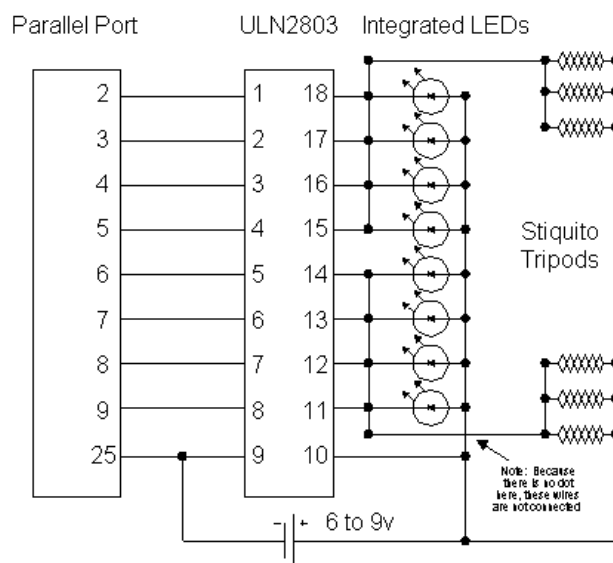
Controlling Stiquito Manually



Simple operation, no components, two switches, requires tether

Controlling Stiquito - PC Parallel Port

- Attach Stiquito to a PC's Parallel port via a tether
- Provide a separate power source from the PC
- Program via C, BASIC, or Assembler
- Simple circuit, easier to change program

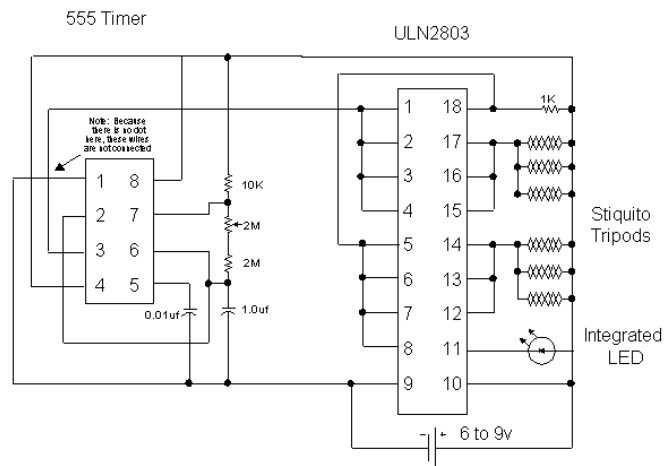


Controlling Stiquito - A Simple Analog Circuit

Comprised of:

- 4 resistors/Pots
- 8 “transistors”
- 2 capacitors
- 1 LED
- 555 timer

Battery and circuit sits on top - no tether



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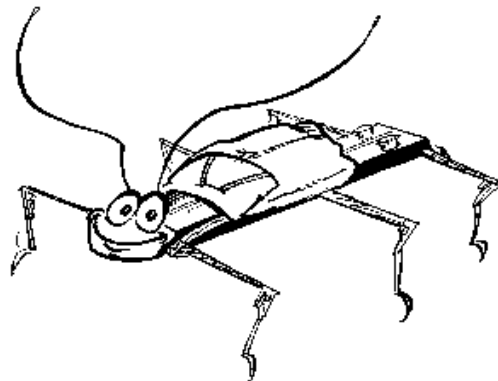
Controlling Stiquito -Complex Microcontroller

Uses a microcontroller

- PIC
- MC68HC11
- 80C32
- FPGA
- Basic Stamp

Programming &
hardware design

Difficult & advanced



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What Next?

- Monday's Lab - yes, Memorial Day!!!
- Over the weekend, start work on Stiquito.
- Contemplate the variations of the robot:
 - Two degrees of freedom?
 - Screws?
 - Control of each leg separately?
 - Build one together with your lab partner?
 - Make a plug for your Stiquito instead of crimping it to the manual controller?
- These require you to think ahead to the end-of-semester project, and what will make Stiquito walk best.