



DISCOVER THE POSSIBILITIES

Electrical and Computing Systems

Computer Engineering

WORKING AT HOME

If you want to continue using your Arduino clone lab kit at home then you will need the software we used in class. All of the software products are free and can be downloaded from the internet.

Arduino IDE

The Arduino Integrated Development Environment (IDE) is used to write computer programs and download them to Uno and Uno clone embedded computer boards. You can always find the latest IDE installer and the on-line reference manual at:

<http://arduino.cc>

USB Drivers

The Arduino Uno and Uno clone embedded computers communicate with your personal desktop or laptop computer using a USB cable provided in your kit. The drivers for the board are installed when the Arduino IDE is downloaded and installed from

<http://arduino.cc>

Macintosh

All of the software used in class is also available for the Mac OS platform and runs on iMacs, MacBooks, and MacBook Airs. You can find the software at the various links provided above.



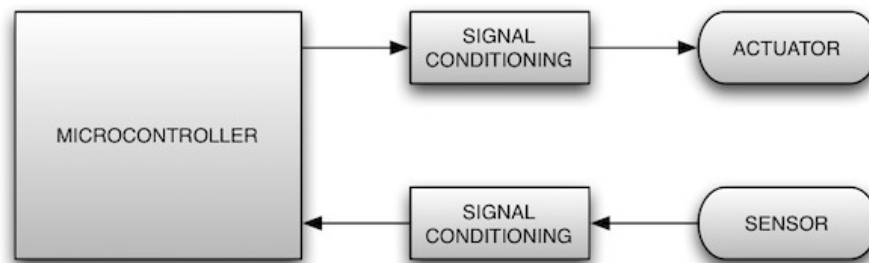
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HARDWARE REVIEW

Computer circuits **monitor** the environment using **sensors**. Sensed values are converted to binary numbers for use in the computer. The computer makes decisions and calculates numbers based on the input binary numbers. The results of those calculations are used to change the environment in some way through **actuators**. This process is summarized in the basic embedded computer systems model.



All computers have five required components: inputs, outputs, memory, arithmetic circuits, and control circuits. These requirements were developed during the early 1900s by the many researchers seeking electronic computing devices. One of the first formal papers documenting the basic architecture of a computer was written by John Von Neumann. The Von Neumann architecture still forms the basis of nearly all modern computers.

A single chip computer is called a **microcontroller**. This type of computer has all five parts integrated onto one microchip. Microcontrollers are commonly found in everything that doesn't typically look like a computer: microwaves, stereos, TVs, cars, pacemakers, elevators, etc. Another type of microchip is called a **microprocessor**. Microprocessors are not complete computers on a chip. Silicon space has been used to make wider arithmetic widths (64-bit is common today creating machines that work with a number line that extends past fifteen quintillion) and to optimize arithmetic performance. Microprocessors are mounted on larger motherboards and connected to the remaining chips that make up the computer such as memory and input/output interfaces. Microprocessors are high-speed devices and cost more than the typically slower microcontrollers.



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DIGITAL LOGIC REVIEW	We built digital logic circuits to control a robot. The robot had three <i>infrared line sensors H, G, and C</i> , as well as a <i>infrared collision sensor called D</i> . We used the binary numbers presented by these sensors to control motors of the robot to solve simple tasks.
EXAMPLE	Design a robot control circuit to follow a black line, reverse at speed bumps, and reverse at collisions.
SOLUTION	This task does not require turning the robot motors off. Only direction needs control. Thus the robot on/off signals B and I will be attached to the battery so that the motors are always powered on. The direction signals J and A must be controlled by a digital logic pattern matching circuit. The design work is shown below.

TRUTH TABLE

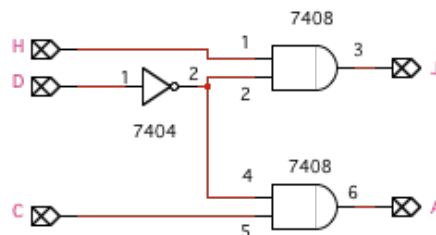
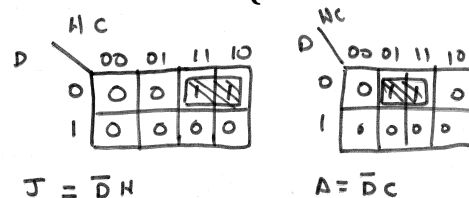
INPUTS			BEHAVIOR	OUTPUTS	
D	H	C		J	A
0	0	0	speedbump	0	0
0	0	1	turn left	0	1
0	1	0	turn right	1	0
0	1	1	forward	1	1
1	0	0	collision!	0	0
1	0	1	collision!	0	0
1	1	0	collision!	0	0
1	1	1	collision!	0	0

Canonical Boolean Equations (George Boole)

$$J = \bar{D}H\bar{C} + \bar{D}HC$$

$$A = \bar{D}H\bar{C} + \bar{D}HC$$

K-Map Reduced Circuit (Maurice Karnaugh)





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ARDUINO REVIEW

We built a handheld helicopter game using an Arduino Uno clone, a 16-column by 2-row LCD, and a piezo-speaker. The LCD and speaker serve as output devices (actuators) while the LCD panel pushbuttons serve as input devices (sensors).

The program we wrote consisted of functional blocks of codes (code-boxes or functions), for-loops, if-then-else statements, and memory variables. Numbers and objects were **constructed** in memory like this:

- `int left=0;`
- `LiquidCrystal lcd(8,9,4,5,6,7);`

and then used by the functional blocks throughout the storyboard of the game. The storyboard consisted of setup behavior and continual game play. Setup behavior included a welcome message, welcome music, and instructions. Game play consisted of a helicopter flying through a brick maze with blade animation and crash sounds.

Official Arduino and Arduino clone boards are programmed from the Arduino Integrated Development Environment (IDE) downloadable for free from the Arduino website (www.arduino.cc). Arduinos and Arduino clones are programmed in a subset of the C++ language.

FINAL PROGRAM

Dr. Meier makes his final version of the program available to all students electronically through his website. Choose the "Discover" link from

<http://faculty-web.msoe.edu/~meier>

A paper copy of the program for personal study immediately follows in this review packet.