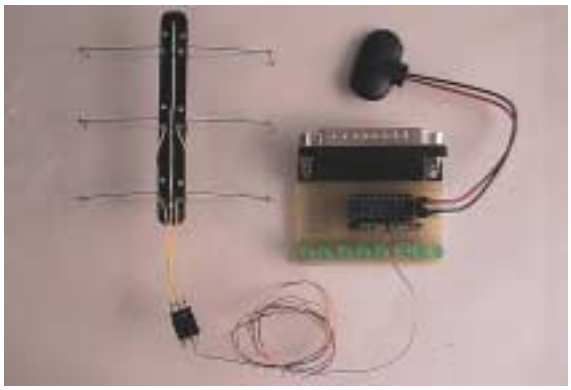
Special Topics: Simple Robots and Microprocessors

ECE 292
Lecture Notes 4



Reading: Chapter 7,Supplemental

NC STATE UNIVERSITY

Quiz 4 - Identify the C errors below (10 of them!)

```
/* A PWM code fragment for one LED (missing */)
For(I==0;i<5;i++){    /* loop for about 200 ms */
   led_on(LED_D8_M);
   sleep(20);
   led_off(LED_D8_M);
   sleep(80);
   }

For<i==0;i<8;i++){    /* loop for about 800 ms */
   led_on(LED_D8_M);
   Sleep(20);
   led_off(LED_D8_M);
   Sleep(80);
   }
```

NC STATE UNIVERSITY

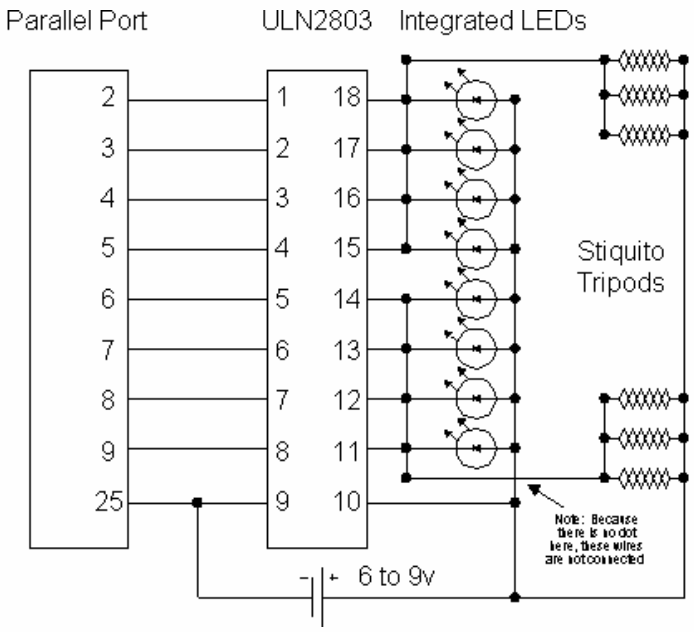
Today's Topics

- Hardware solutions for a two-degrees-of-freedom Stiquito
- Generating a gait for a two-degrees-of freedom Stiquito
- State diagrams
- Sample code for state diagram

NC STATE UNIVERSITY

The new board you made . . . .

- Data register bits 0 through 7, address 0x378
- Do you use a tripod? Something else?

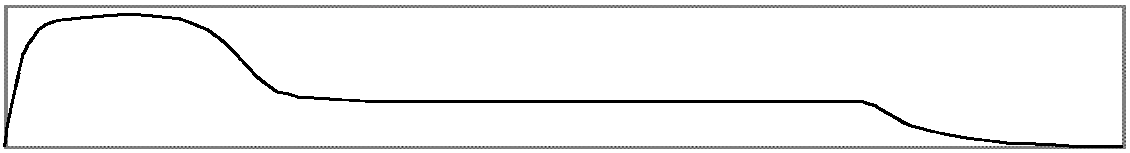


NC STATE UNIVERSITY

Motivation for Pulse Width Modulation

•We have a need to limit the amount of current that Stiquito uses (save battery life, run “cooler”)

percent of length that actuator contracts



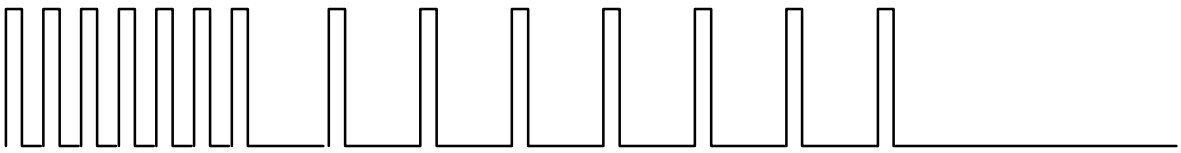
apparent current

NC STATE UNIVERSITY

Implementing Pulse Width Modulation

•All this means is that you should not keep the LEDs (or nitinol wires) “ON” for the entire time. Turn them off every so often.

•The exact amount of time depends on how you built Stiquito (every robot is different).



current pulses

OUT or WRITE statements that generate current pulses (note variable delay)

NC STATE UNIVERSITY

A code snippet for PWM - BASIC

```
REM High frequency pulses initially contract actuators
FOR a = 1 TO 20
   OUT &H378, &HF0              : REM &HF0 is binary 11110000
   FOR x = 1 TO 100 : NEXT x
   OUT &H378, 0
   FOR x = 1 TO 100 : NEXT x
NEXT a

REM Low frequency pulses maintain actuator contraction
FOR a = 1 TO 80
   OUT &H378, &HF0              : REM &HF0 is binary 11110000
   FOR x = 1 TO 100 : NEXT x
   OUT &H378, 0
   FOR x = 1 TO 800 : NEXT x
NEXT a
```

NC STATE UNIVERSITY

A code snippet for PWM - C

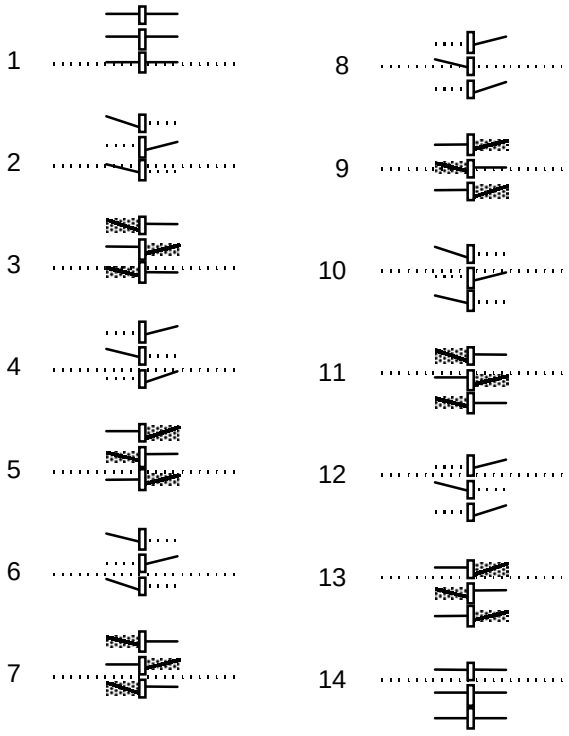
```
/* A PWM code fragment for two LED's - share transistor */
for(i=0;i<5;i++){    /* loop for about 200 ms */
   led_on(LED_D8_M);
   Sleep(10);
   led_off(LED_D8_M);
   led_on(LED_D7_M);
   Sleep(10);
   led_off(LED_D7_M);
   Sleep(20);
   }
for(i=0;i<8;i++){    /* loop for about 800 ms */
   led_on(LED_D8_M);
   Sleep(10);
   led_off(LED_D8_M);
   led_on(LED_D7_M);
   Sleep(10);
   led_off(LED_D7_M);
   Sleep(80);
   }
```

NC STATE UNIVERSITY

A sample gait for Stiquito

leg on ground
leg in air
leg on ground, flexed
leg in air, flexed

This tripod gait shown relies on a leg that has two degrees of freedom. You should strongly consider this for your robot.



NC STATE UNIVERSITY

State Diagram

Easy way to visualize how a system works is to identify the different outputs required.

From the gait on the previous slide, we can identify lifting the legs and flexing it back:

T B T
B T B the tripod gait

NC STATE UNIVERSITY

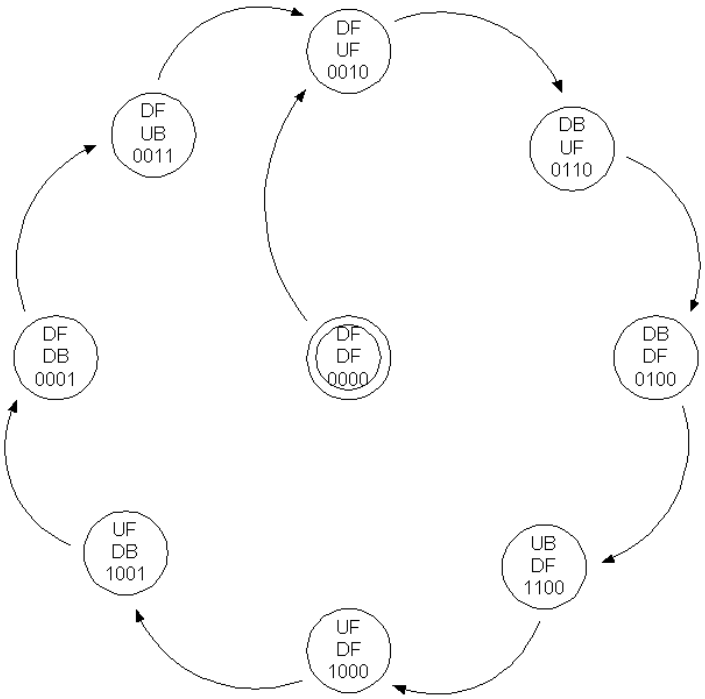
The state for each tripod will be:

DF	-	Down, Forward	-	00
DB	-	Down, Back	-	01
UF	-	Up, Forward	-	10
UB	-	Up, Back	-	11

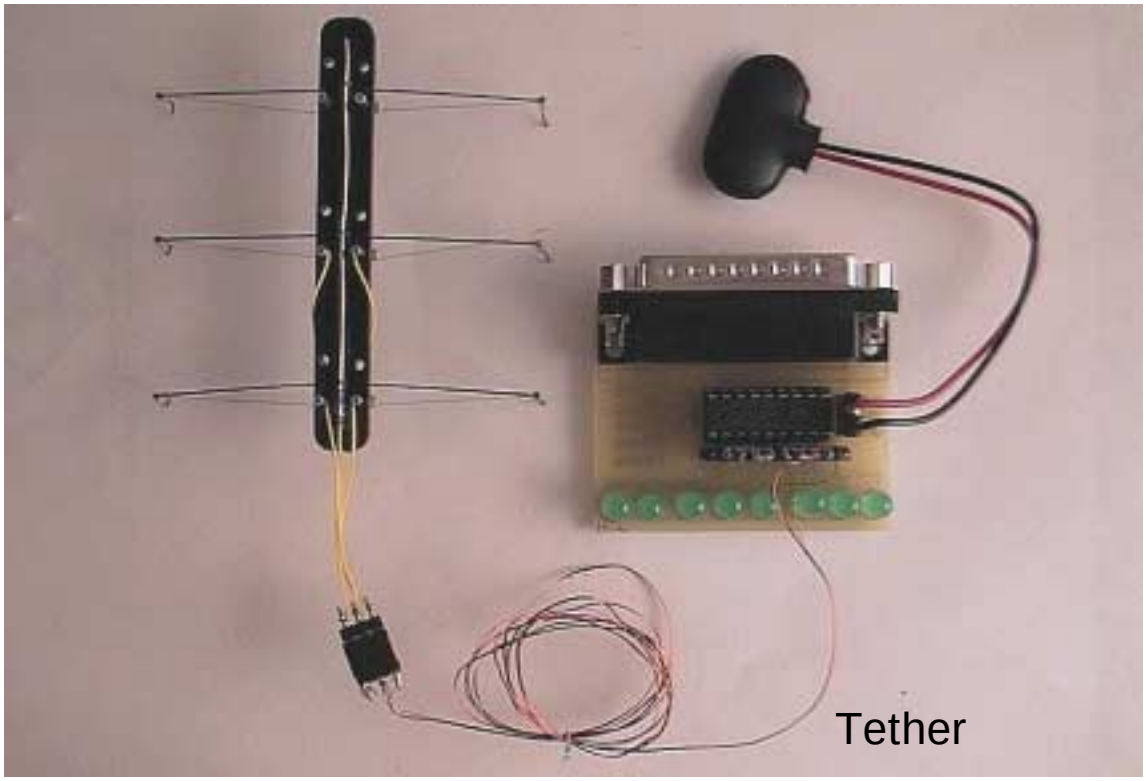
A “1” means activated. A sample state can be:

Meaning, the top tripod is Up, forward. The bottom tripod is down, forward

State Diagram



The Final Product



NC STATE UNIVERSITY

What's next?

•Next week we will start to examine some more embedded systems topics like:

- polling versus interrupts
- micro-controllers and memory architectures
- I/O dependencies

•I will pass out copies of papers and notes.

•Visit the Parallax site (http://www.parallaxinc.com) and read about the Basic Stamp 2

NC STATE UNIVERSITY

Lab 4 . . . .

•Build your Stiquito tether (to connect to the Parallel Port Controller). See Chapter 7 for assembly instructions

•Controlling the Stiquito robot by creating the “best gait” - You will use the code you created for lab 3 to help make Stiquito walk efficiently

•To check out: Show Stiquito walking 5 cm in less than 2 minutes

NC STATE UNIVERSITY