Display

CSE 132

Upcoming Logistics

• Full hardware kits needed today – LCD display
  – One per group OK for studio
  – Purchase in department office
• Quiz 2 – available this afternoon, due Wed.
  – Change: two dropped quizzes during the semester
• Midterm exam – Thur., March 3, 6:30-8:30pm
  – Lab Sciences 300, NOT HERE!!!!!!!!!!!
  – We will start right at 6:30, NOT 6:40!
  – Let me know about conflicts in quiz
  – Review in lecture and studio next week, help session next Tue evening (Lopata 101, 8-10pm)

Two Assignment 4 Issues

• Typo in cover-page.txt
  – 0x21 0x35 0x94 0x30 0x10 0x11

• Sending 4-byte floats isn’t easy, use this:

  float f = 23.5;
  unsigned long rawBits;
  rawBits = *(unsigned long *) &f;

Today’s Outline

• LCD display – initialization and use
• I2C peripheral devices – including LCD display
• Information representation – images

LCD Display on Arduino

• 2x16 character LCD display (class ST7036)
  – print() method is available
  • Accepts multiple data types: string, int, etc.
• Initialization and use
  – Constructor: ST7036 lcd = ST7036(2,16,0x7c);
  – in setup():
    lcd.init();
    lcd.setContrast(0);
  – in loop():
    lcd.setCursor(line, column);
    lcd.print("Hi!");

Serial Communications

• UART – universal asynchronous receiver/transmitter
Synchronous Interface

- SPI – serial peripheral interface

Supporting Multiple Masters

- I²C – inter-integrated circuit bus

Physical Hardware

- Protocol
  - Address bits first – msb to lsb (7 bits)
  - R/W indicator – (1 bit)
  - Ack / Nack – (1 bit)
  - Data bits last – msb to lsb (8 bits)

Bit-level Communication

Images

- Consider the following bits:
  0x002400081881423c
  0000 0000 0010 0100 0000 0000 0000 1000
  0001 1000 1000 0001 0100 0010 0011 1100
- Make 1 dark and 0 light:

Images

- Arrange in rows, one byte per row:

- Each bit is a “pixel” in the image
**Controlling pixels**

- Common approach is row, column multiplexing
  - Extend with intensity control for each pixel
    - 8 bits → 0 is “off”, 255 (or 0xff) is “on”

**Row-based Multiplexed Control**

```plaintext
for r = 1 to 7
  wait until next row time
  set row_r LOW
  set all other rows HIGH
  for c = 1 to 5
    set column_c to value for row_r
    (HIGH for on, LOW for off)
  end for
end for

This needs series resistors on each column
```

**Column-based Multiplexed Control**

```plaintext
for c = 1 to 5
  wait until next column time
  set column_c HIGH
  set all other columns LOW
  for r = 1 to 7
    set row_r to value for column_c
    (LOW for on, HIGH for off)
  end for
end for

This needs series resistors on each row
```

**Add color and more pixels**

**Color**

- Additive color – primaries Red, Green, Blue
  - Position close together and put diffuser above
    - This builds one pixel