Take our Daughters and Sons to Work Day

https://github.com/Mark-MDO47/TODAS_DaughtersAndSons.git

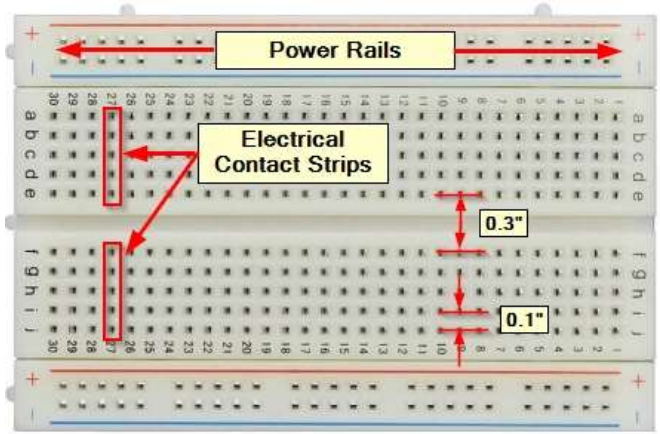
June 2024

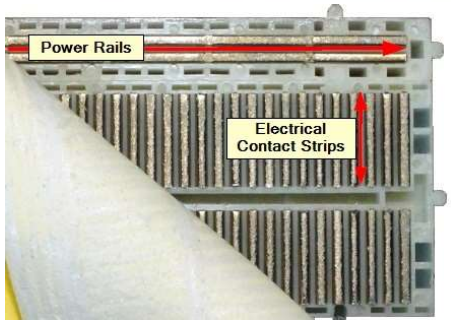
TODAS – Electricity, Arduinos, Fun

1. Water Flow - a way to think about Electricity
2. Arduino (computer on a chip), buttons, and LEDs
3. Sonar Control and big LED ring
4. Bananas and Sounds

- Resources

01 – Breadboards – how do they work?

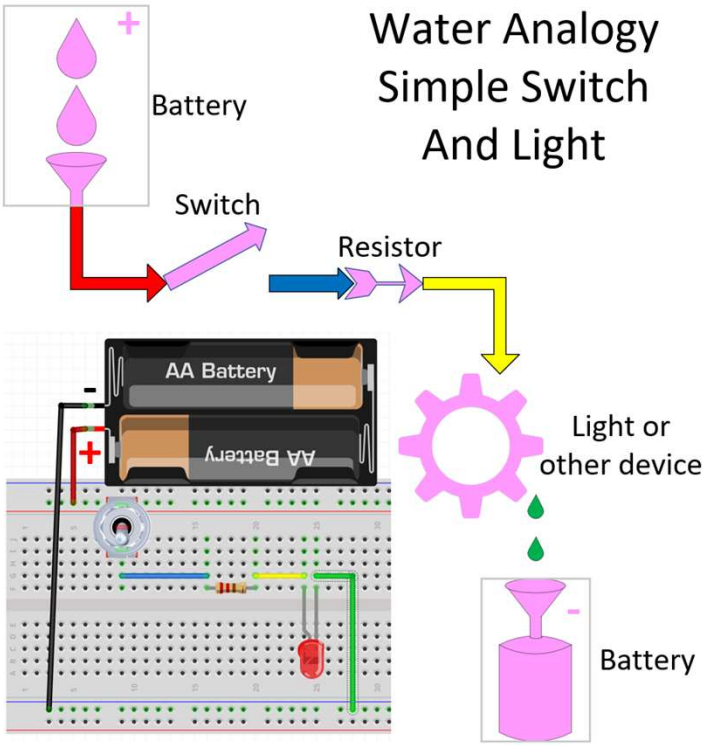




- Sides have power rails – length
- Center has contact strips – width

- Images from protosupplies.com

01 – Water Analogy – Simple Circuit



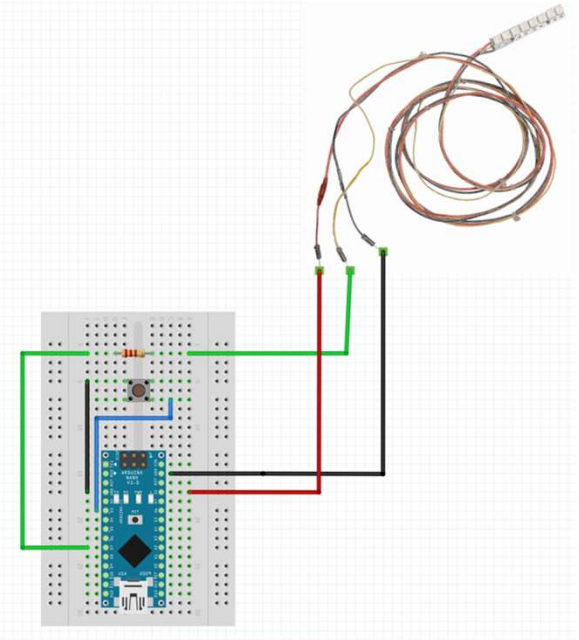
- Electrons in wires actually flow from negative to positive, but many electrical symbols are drawn as if the current flow is from positive to negative so let's get used to it!

- "Pictorial" circuit is "Fritzing Diagram"
  - https://fritzing.org/ - 8 Euros

01 Simple Circuit Schematic

- TBS

02 – Arduino Moving Color Lights



- "Fritzing diagram" of color lights in motion!
  - LED is Light Emitting Diode
- Press button to stop, release to continue
- How does it work? SOFTWARE!
  - Pins can be input or output – you tell it which
  - Read the button
  - If not pressed – display next light
  - Short delay
- TLDR – WS2812B individually addressable color LEDs using FastLED library

02 Arduino Moving Color Lights Schematic

- TBS

02 – Arduino Inputs

- For now we will talk about how to USE inputs
  - We will talk more about how it works when we GO BANANAS!
- We want to do LED motion when button is NOT pushed
  - Assign name to the pin we use
  - Make the pin an input
  - If the state is HIGH (button not pushed) do the motion
  - Delay a little bit

02 – Arduino Button Input Software

- The first line defines a name for pin D3 for the button
- “pinMode” sets that pin to be an input
- The “if(HIGH” block does the motion if button NOT pushed
- “delay(500) delays for ½ second

```
#define DPIN_BTN_IN  3  // this pin is used to sense the external button

  pinMode(DPIN_BTN_IN, INPUT_PULLUP); // digital INPUT_PULLUP means voltage HIGH unless grounded

if (HIGH == digitalRead(DPIN_BTN_IN) {     // push button to STOP
  do_motion(); // do motion if button NOT pushed
} // end if button NOT pushed

  delay(500);                    // wait half a second
```

02 – Arduino Software Structure

```
1  #define DPIN_BTN_IN  3 // pin D3 is used to sense the external button
2
3  // the setup function runs once when you press reset or power the board on
4  void setup() {
5    pinMode(DPIN_BTN_IN, INPUT_PULLUP); // digital INPUT_PULLUP means voltage HIGH unless grounded
6  } // end setup()
7
8  // the loop function runs over and over again forever
9  void loop() {
10   if (HIGH == digitalRead(DPIN_BTN_IN){ // push button to STOP
11     do_motion();                        // do motion if button is NOT pushed
12   } // end if button NOT pushed
13   delay(500);                           // wait half a second
14 } // end loop()
```

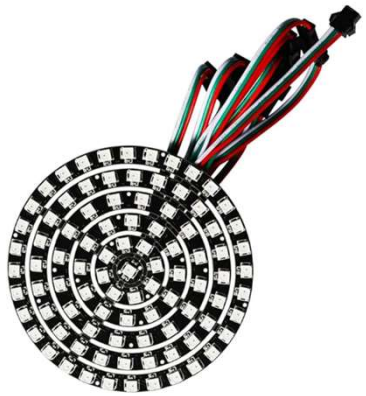
Start with stuff used everywhere

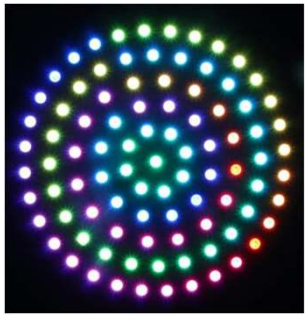
setup() for things done once at start

loop() for things done repeatedly after setup()

The “if” statement is magical!
Only do inside {} if it is TRUE

03 – Go Big with Sonar Control

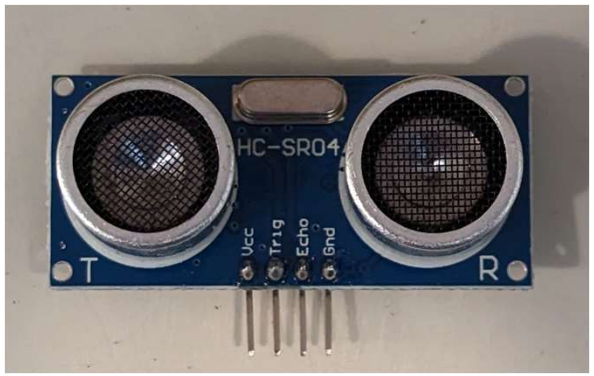


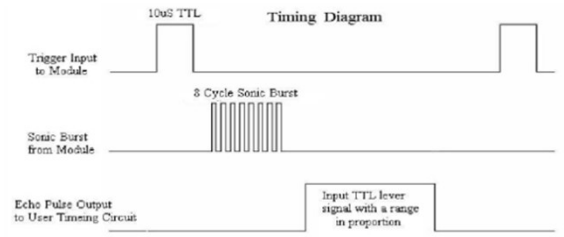


- 8 LEDs is fun – but 241 LEDs is MORE fun!
  - TLDR – WS2812B individually addressable color LEDs using FastLED Library
- Displays moving patterns we choose
- Disk is mostly wired; less soldering needed
- Needs more power than Arduino can give

- Pictures from amazon.com
  - TLDR - https://www.amazon.com/WESIRI-WS2812B-Individually-Addressable-Controller/dp/B083W44B8N

03 – Ultrasonic Sonar Control





- Sonar sensor detects distance
- Bounces ultrasonic sound off objects

- Set “Trig” HIGH then LOW to start sonic burst
- Measure time until “Echo” is HIGH
- Divide time by speed of sound to get distance

- TLDR diagram from the sparkfun.com HC-SR04 spec.

03 – Ultrasonic Sonar Detector Software

Include library, define names for pins

"my_ultra" is how I use the HC-SR04

Define distances and limits for patterns

"handle_ultra" returns a pattern number

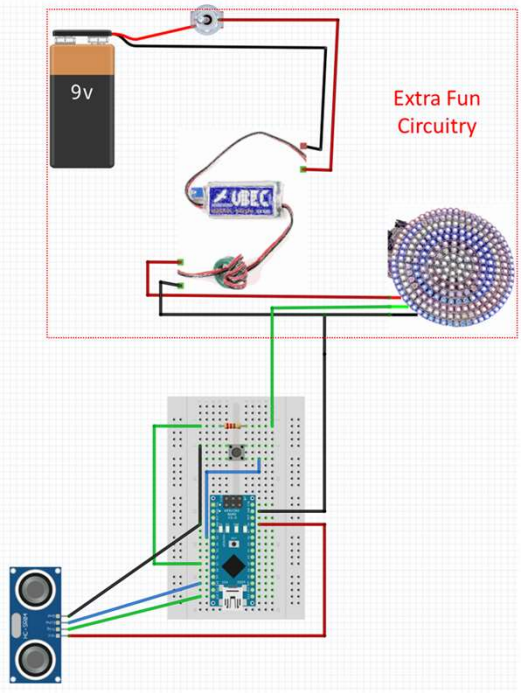
"my_ultra.read(CM)" gives distance in CM stored in "ultra_dist"

Use math to turn "ultra_dist" into "pattern"

Return "pattern" (number) to caller

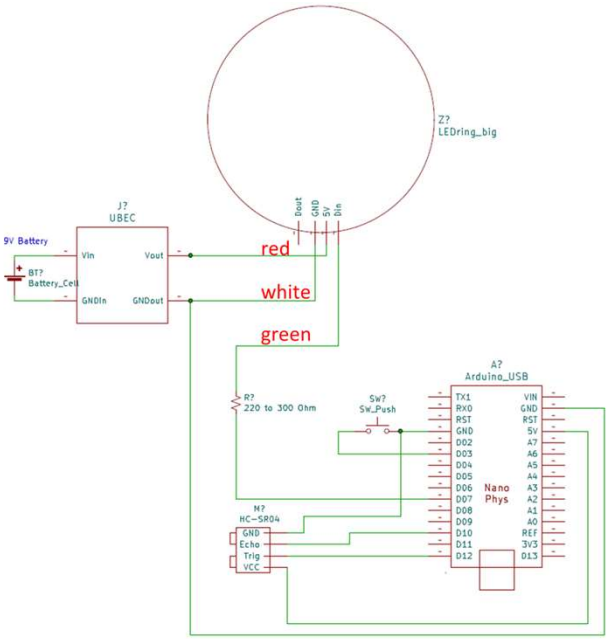
```
#include "Ultrasonic.h"

#define ULTRA_TRIG_PIN 12 // HC-SR04 Trigger digital pin
#define ULTRA_ECHO_PIN 10 // HC-SR04 Trigger echo pin

// instantiate my HC-SR04 data object
Ultrasonic my_ultra = Ultrasonic(ULTRA_TRIG_PIN, ULTRA_ECHO_PIN); // default timeout is 20 milliseconds

#define ULTRA_CM_PER_REGION 9 // HC-SR04 every this many CM is a different pattern
#define ULTRA_IGNORE_INITIAL_CM 3 // HC-SR04 ignore the first 3 CM since valid range starts at 2 CM
#define PATTERN_MAX_NUM 5 // maximum pattern number we have

////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
// handle_ultra() - process HC-SR04 data.
//    returns: pattern number 0 <= num <= PATTERN_MAX_NUM
//

int handle_ultra() {
  int pattern; // integer pattern number from 0 thru 5 inclusive
  // get the range reading from the Ultrasonic sensor in centimeters
  int ultra_dist=(my_ultra.read(CM));

  ultra_dist -= ULTRA_IGNORE_INITIAL_CM;
  if (ultra_dist < 0) ultra_dist = 0;
  pattern = ultra_dist / ULTRA_CM_PER_REGION;
  if (pattern > PATTERN_MAX_NUM) pattern = PATTERN_MAX_NUM;

  return(pattern);
} // end handle_ultra()
```

03 – Fritzing Diagram



- Replace 8-LED stick with 93-LED Disk
  - Separate power for 93-LED Disk
- Add new HC-SR04 Ultrasonic Sensor
- Button unused – can leave it

03 – Schematic Diagram

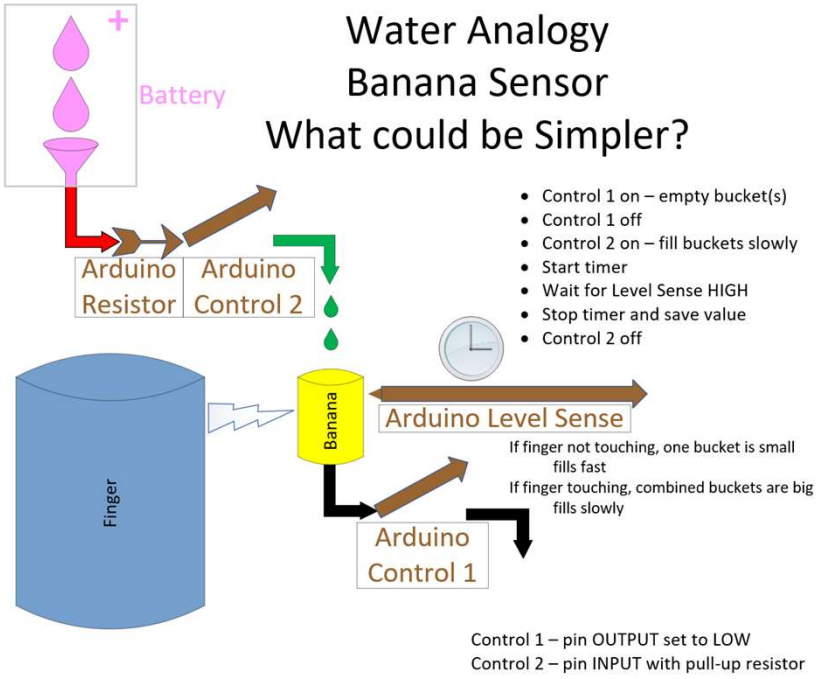


04 – Go Bananas!

- A Banana Piano! Several “key” fruit types…
  - Uses “capacitive sensing” – depends on how fast Arduino can charge it up
    - Touching banana makes it take longer to charge
- Digitized sounds are played when the “key” is pressed
- Only one sound at a time can be played

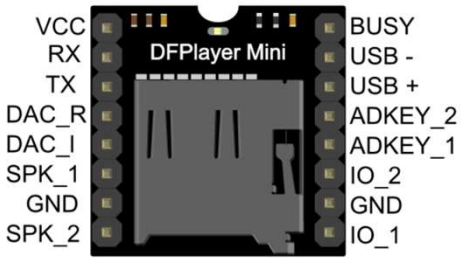
- TLDR - Image by krakenimages.com on Freepik

04 – Banana Input



- Note that this is an analogy of how it works
- We use a library to do this
- Easier than coding it

04 – Digitized Sound Output



- DFPlayer (YX5200) accepts SD card with digitized audio
  - Plays SD card audio files by number
  - UART interface to Arduino
  - Direct mono speaker output
  - Line-out stereo output, usable for BlueTooth
- Many tricks to using YX5200
  - Check out my github page on it (below)

https://github.com/Mark-MDO47/AudioPlayer-YX5200

04 Bananas Software – customization

```
// "pin index" state:
//   -1 means nothing selected
//   0-3 (3 = NUM_MEASURE_PINS-1) represent pins MEASURE_PIN_01 to MEASURE_PIN_03,
//   any other value is invalid
int8_t gCurrentPinIndex = -1; // Index number of which PinIndex is current - nothing selected
int8_t gPrevPinIndex = -1; // previous PinIndex - nothing selected

// "pin index" to sound mapping
//    pin index goes from -1 to 3 (3 = NUM_MEASURE_PINS-1)
//    we add one to that number to go from 0 to 4
//       0 = Silence sound
//       1 through 4 = MEASURE_PIN_01 through MEASURE_PIN_04
uint16_t gPinIndex2SoundNum[1+NUM_MEASURE_PINS] = { SOUNDNUM_SILENCE, SOUNDNUM_C, SOUNDNUM_D,
```

```
////////////////////////////////////////////////////////////////////
// pin2soundnum(pinIndex) - convert pin index to sound number
//
// pinIndex to sound mapping
//    pinIndex goes from -1 to 3 (3 = NUM_MEASURE_PINS-1)
//    we add one to that number to go from 0 to 4
//       0 = Silence sound
//       1 through 4 = MEASURE_PIN_01 through MEASURE_PIN_04

uint16_t pin2soundnum(int8_t pinIndex) {
  uint16_t soundNum = SOUNDNUM_INVALID;
  if ((pinIndex >= -1) and (pinIndex < NUM_MEASURE_PINS)) {
    soundNum = gPinIndex2SoundNum[pinIndex+1];
  } else {
    Serial.print("ERROR pin2soundnum() - pinIndex="); Serial.pri
    soundNum = SOUNDNUM_INVALID; // not really needed
  }
  return(soundNum);
} // end pin2soundnum()
```

- Place sound numbers into array gPinIndex2SoundNum[]
- Calls to pin2soundnum() will convert PinIndex to sound number
- Most of routine is error checking (this is normal)

Only one line is needed to actually do translation

could just use gPinIndex2SoundNum[pinIndex+1] if wanted to skip error checking

04 Bananas Software – setup() - one time

- Initialize serial debug interface
- Do capacitive sensing setup
- Initialize sound card interface
- Initialize complete
- Play intro sound then start

```
////////////////////////////////////////////////////////////////////////////////////////////////////
// setup()
void setup() {
  Serial.begin(115200);         // this serial communication is for general debug; set the USB serial port
  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }
  Serial.println(""); // print a blank line in case there is some junk from power-on

  CapacitiveSetup();

  pinMode(DPIN_AUDIO_BUSY,  INPUT_PULLUP); // HIGH when audio stops
  mySoftwareSerial.begin(9600); // this is control to DFPlayer audio player
  // initialize the YX5200 DFPlayer audio player
  DFsetup();

  Serial.println("TODAS init complete...");

  // play the INTRO sound to completion, then allow normal loop() processing
  DFstartSound(SOUNDNUM_INTRO, SOUND_DEFAULT_VOL);
  while (!DFcheckSoundDone()) {
    delay(10); // wait for the INTRO sound to finish
  } // end while

} // end setup()
```

04 Bananas Software – loop() - repeats

- Executes block every 50 milliseconds
- Gets active PinIndex
- If this is change in PinIndex: start sound
  - Could be "silence" sound
- Not a change, still holding: repeat sound
- No key pressed: repeat silence
- Extra credit: can you simplify the last if/else/endif ?

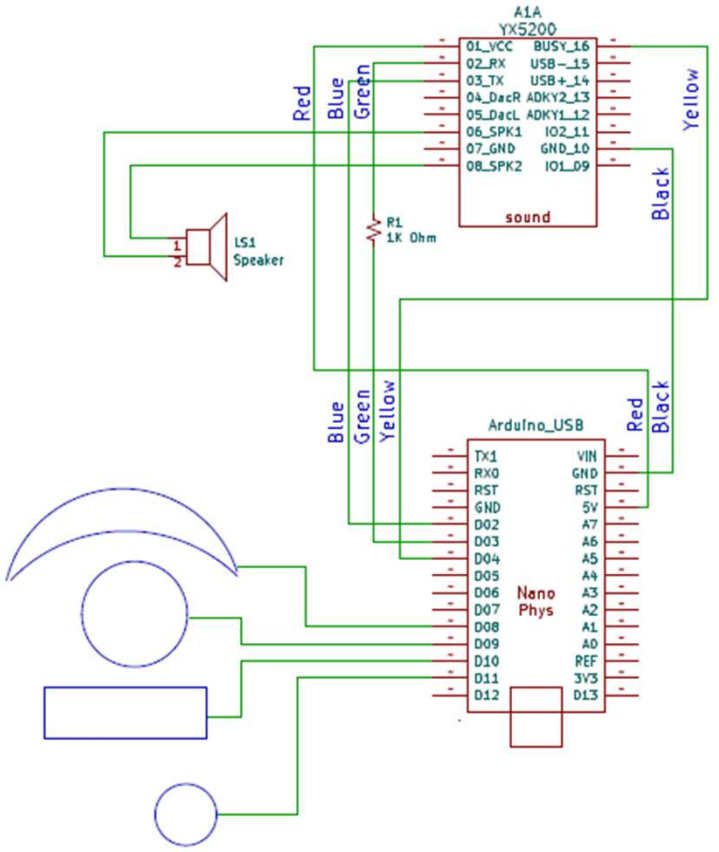
```
////////////////////////////////////////////////////////////////////////////////////////////////////
// loop()
void loop() {
  EVERY_N_MILLISECONDS( 50 ) {
    gCurrentPinIndex = handle_capacitive(); }
    if (gPrevPinIndex != gCurrentPinIndex) {
      // "key" (PinIndex) is different than before so start a new sound
      //    -1 will start the silent sound, otherwise the chosen key sound will start
      gPrevPinIndex = gCurrentPinIndex;
      DFstartSound(pin2soundnum(gCurrentPinIndex), SOUND_DEFAULT_VOL);
    } else if (DFcheckSoundDone()) {
      if (gCurrentPinIndex >= 0) {
        // PinIndex is not -1 so we are still holding a key down - restart sound
        gPrevPinIndex = gCurrentPinIndex;
        DFstartSound(pin2soundnum(gCurrentPinIndex), SOUND_DEFAULT_VOL);
      } else {
        // PinIndex is -1 so no key is held down - start silence sound
        gPrevPinIndex = -1;
        DFstartSound(pin2soundnum(gCurrentPinIndex), SOUND_DEFAULT_VOL);
    } // end if
  } // end EVERY_N_MILLISECONDS
} // end loop()
```

04 Bananas Fritzing Diagram

- TBS

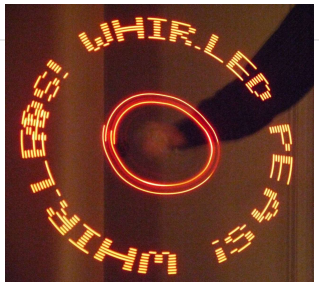
04 Bananas Schematic

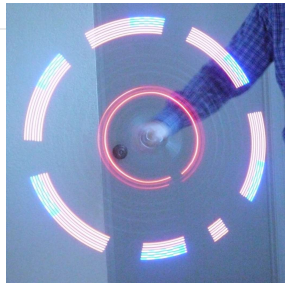
- Bottom half has Arduino and fruits
  - Capacitive sensing of fruits
- Top half has sound module and speaker
  - UART serial interface
  - Universal Asynchronous Receiver / Transmitter

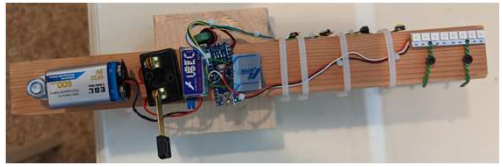


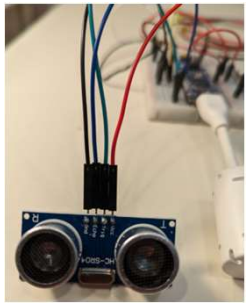
Resources – Arduino

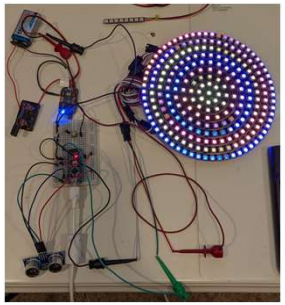
https://github.com/Mark-MDO47/ArduinoClass

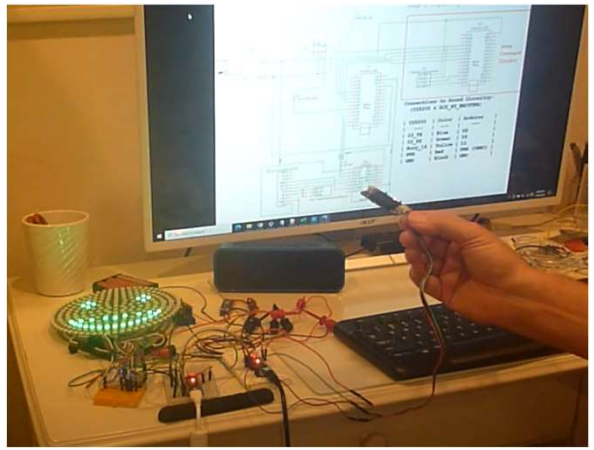


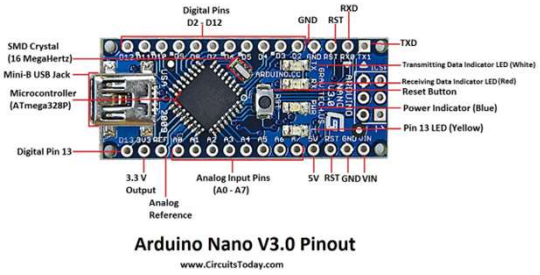






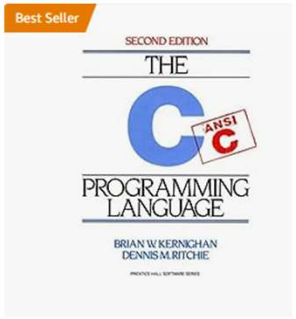


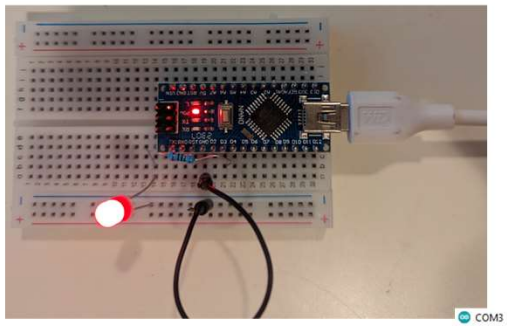




If you know a bit of programming…

Resources – C for Arduino





If you can use a programming refresher…

https://github.com/Mark-MDO47/CforArduinoClass