Internet of Things Weather Station

IEEE Northern Virginia Section

Hands-On Professional Development Series

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Sketch 03 – Standalone Weather Station

Activities This Session

- Our platform can measure anything with the appropriate sensors.
- We are going to measure a few signals associated with weather:
  - Temperature, Humidity, Atmospheric Pressure, Light Intensity
- We have some wiring to do.
- We are going to download and install some software libraries needed by the sensors.

Weather Sensors

- Our weather station measures
  - Temperature
  - Humidity
  - Barometric Pressure
  - Ambient Light Intensity
- Other weather related measurements are possible
  - Wind speed and direction
  - Precipitation gauge (rain, snow)
  - Ultraviolet (UV) Index
  - Lightning

Non-Weather Sensors

- Magnetic compass
- Vibration
- Accelerometers
- Gyros
- Strain and pressure
- Myoelectric
- Pulse/heart rate
- RFID
- Soil moisture
- Distance/proximity
- Motion
- Current, Voltage
- pH
- Radiation
- Vibration
- H, CO, Methane

Sensor Technology

- How sensors work is fascinating!
  - The field combines multiple disciplines like nanotechnology, device physics, and signal processing
- They are the focus of the IEEE Sensors Council
  - Sponsored by 24 IEEE technical societies
  - Publish the IEEE Sensors Journal and the IEEE Internet of Things Journal
  - Sponsors the annual IEEE SENSORS Conference and more
  - Membership is free to members of IEEE or sponsoring societies
- We don't have time to discuss how they work in this course

Atmospheric Pressure

- Also known as barometric pressure.
- High pressure generally indicates good weather. Low pressure indicates stormy weather.
- Pressure at point of measurement is the **Station Pressure**.
- Station Pressure is strongly dependent on elevation, less dependent on temperature and humidity.
- Atmospheric Pressure decreases with altitude.
- **Standard Atmosphere** (at sea level, mid latitude):

  1,013.3 hPa ≡ 760 mmHg ≡ 29.92 inHg ≡ 14.7 psi

- Calculated pressure at sea level is called **Relative Pressure** or **Sea Level Pressure**.

Light Intensity

Illuminance	Example
50 µlx	Starlight
100 µlx	Moonless overcast night
1 mlx	Moonless clear night
10 mlx	Quarter Moon
250 mlx	Full Moon clear night
1 lx	Moon high alt. in tropics
10 lx	Candle at 1 foot
50 lx	Family living room
80 lx	Hallway
400 lx	Brightly lit office
1 klx	TV studio
32 klx	Sunlight avg. day (min)
64 klx	Sunlight avg. day
100 klx	Sunlight avg. day (max)

Sensors

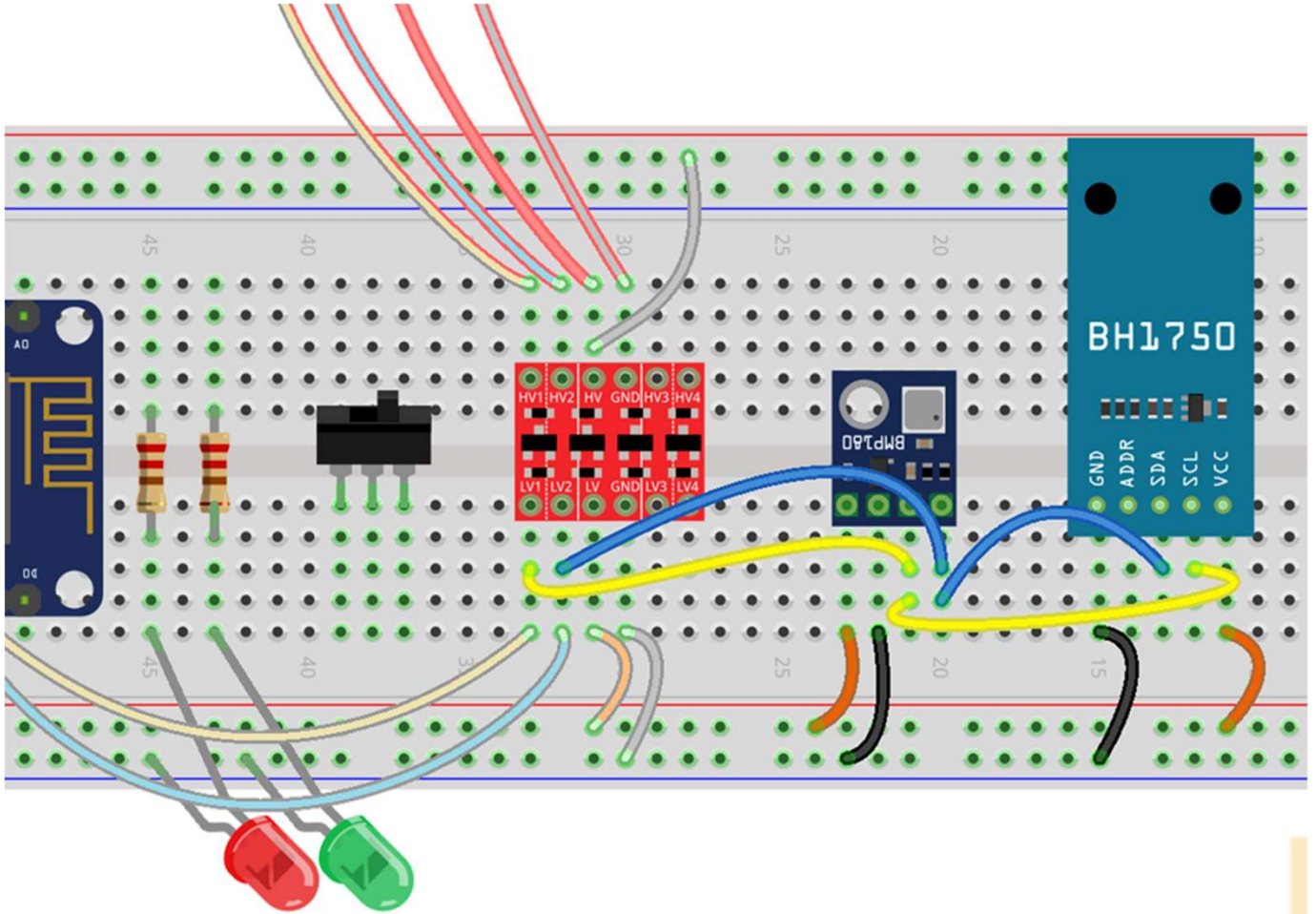
- BME280 – Barometric Pressure / Altitude / Humidity / Temperature Sensor
  - Range: 300 to 1100 hPa ±1.0 hPa (8.9 to 32.5 inHg ±0.03 inHg)
  - 9000m to -500m ±1m (29,500 to – 1,600 ft ±3ft)
  - -40ºC to 85ºC ± 2ºC (-40ºF to 185ºF ±3.6ºF)
  - 0 to 100% relative humidity ±3%
- BH1750 Light Intensity Sensor: 1 – 65535 lux

Sensor Connections

- Turn off the regulator.
- Remove the MicroUSB connector.
- Use 120mm jumpers to connect sensors:

Signal	Color	Level Shifter	BME280	BH1750
SCL (D1)	Yellow	LV1	SCL	SCL
SDA (D2)	Blue	LV2	SDA	SDA
+3.3V	Orange	LV	VIN	VCC
GND	Black	GND	GND	GND

Level Shifter to BME280 & BH1750



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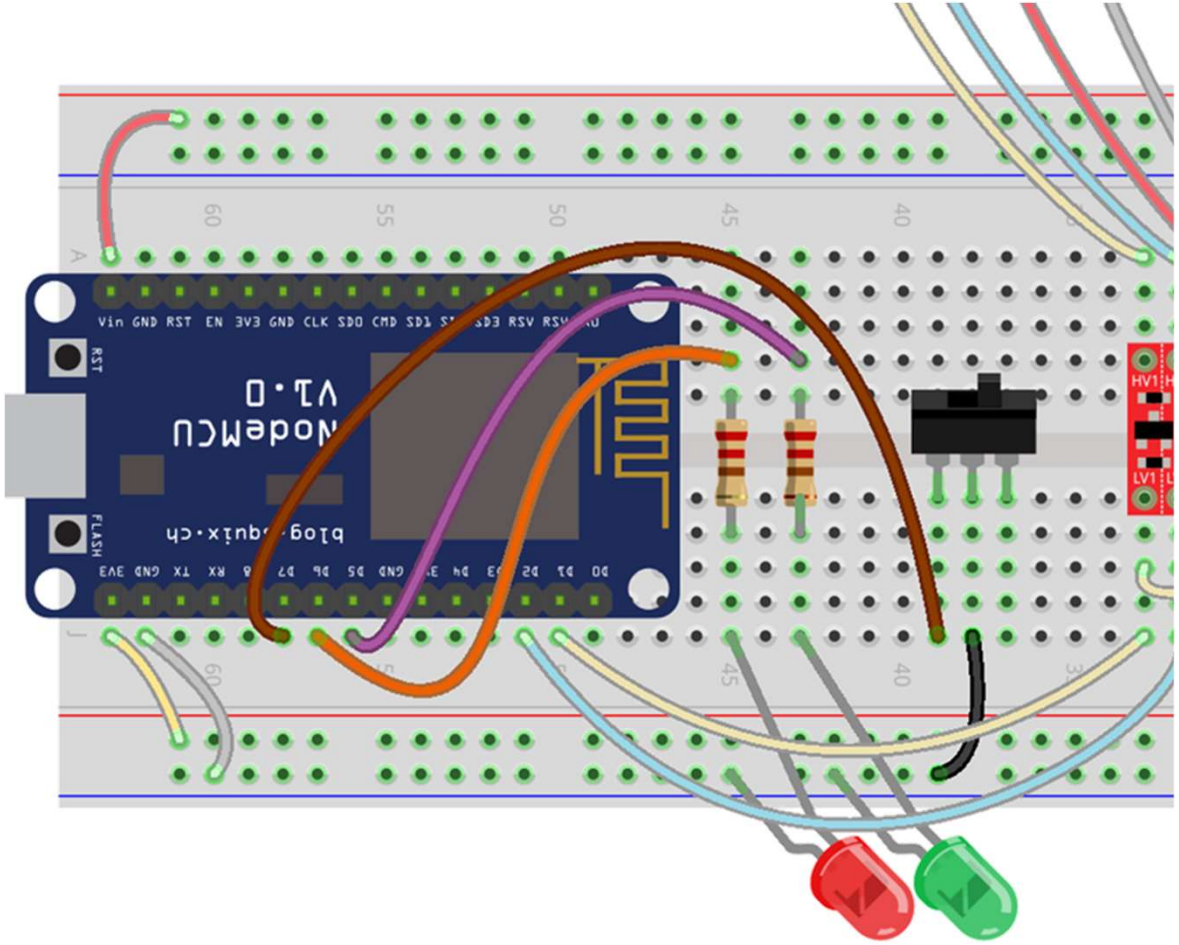
Switch & LED Connections



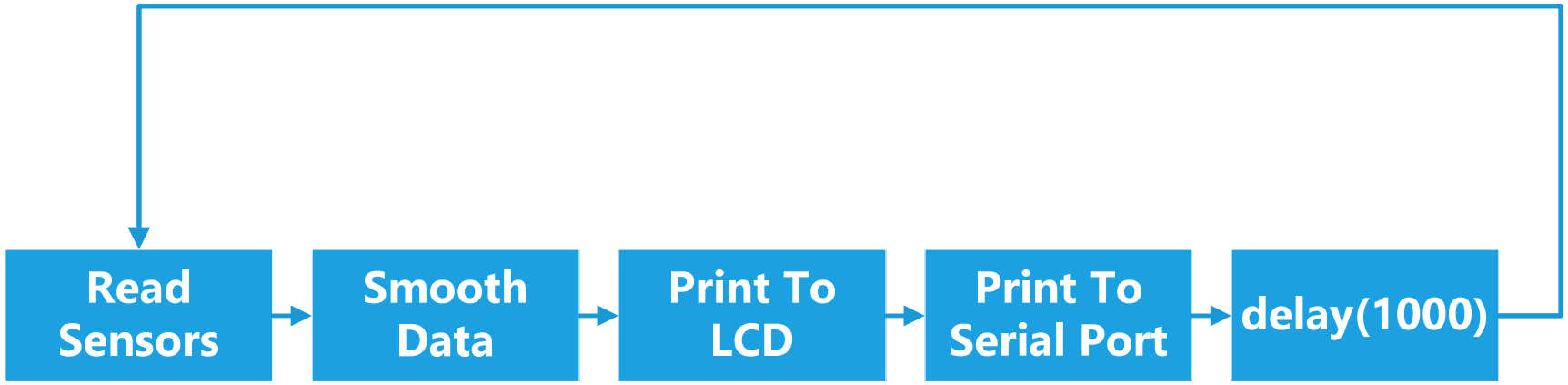
Install Libraries

1. In web browser, open
   w4krl.com/projects/ieee-iot/2016october
2. Download Arduino Library Files: 1) bh1750, 2) runningaverage
3. Open Arduino IDE
4. Open menu item **Sketch | Include Library | Add .ZIP Library**
5. Navigate to your download directory and add the two new libraries
6. Open menu item **Sketch | Include Library | Manage Libraries**.
7. Search for and install **BME280** by Tyler Glenn

Sketch03 – StandAlone

1. Open menu item **File | Sketchbook | IEEE_IoT_Sketch03_Standalone**
2. Verify and Upload.
3. Open Serial Monitor. (little magnifying glass in upper right)
4. Set Baud rate to **115,200**.
5. Observe flow of data on serial monitor and LCD.

Sketch 03 Program Flow



Sketch 03 StandAlone

```
void setup() {
  Serial.begin(115200);      // initialize the serial port
  lcd.begin();               // initialize the lcd
  splashScreen();            // show the splash screen
  myBME280.begin();          // initialize BME280 pressure/temperature/humidity
  myBH1750.begin();          // initialize BH1750 light sensor
  pinMode(UNITS_PIN, INPUT_PULLUP); // configure units selection pin
} // setup()

void loop() {
  rawData = readSensors();  // load all sensor data into rawData struct
  smoothData = averageSensorData(rawData);
  bool units = readUnits(UNITS_PIN);
  printToLCD(smoothData, units);
  printToSerialPort(rawData, smoothData, units);
  delay(UPDATE_INTERVAL_SENSORS);
} // loop()
```

Accomplishments

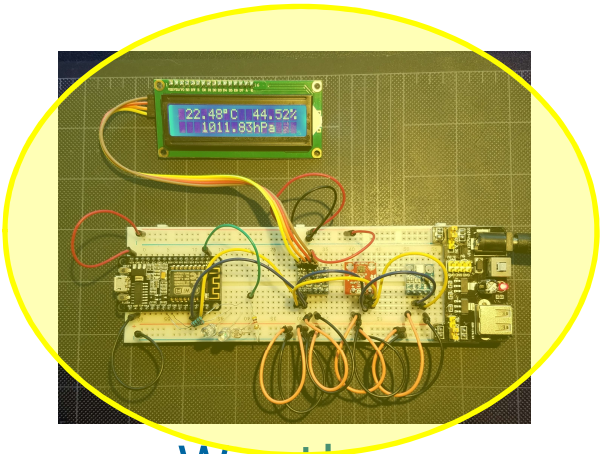
- We now have a standalone weather station.
- It measures temperature, humidity, barometric pressure, light intensity, and power supply voltage.
- It displays smoothed measurements on a local LCD display.
- It streams raw and smoothed data to a serial port.
- It will become an IoT device when connected to the Internet.

Personal Computer

ThingSpeak Server

Cloud

Personal Computer



Weather Station

Local Wi-Fi

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Questions?