임베디드컴퓨팅
Embedded Computing
(0009488)
Sensor applications

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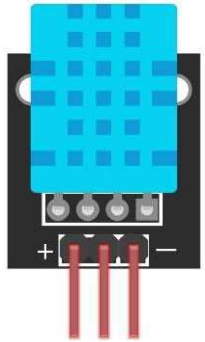
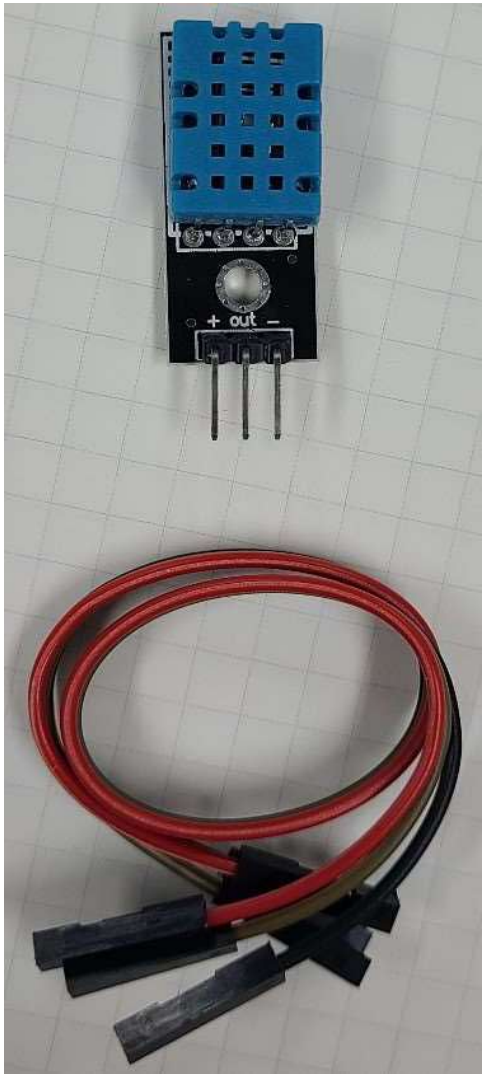
Temperature and humidity sensor

- A sensor that measures temperature and humidity
  - used in integrated HVAC systems (HVAC: Heating, Ventilation, Air Conditioning), dehumidifiers, and weather stations
- Pins (+, -, out)
  - + : a pin for power (+)
    - opr. voltage = 3.0 ~ 5.5V
  - - : a grounding pin
    - connected to the GND
  - out : Data signal pin
    - connected to the digital pin



DHT11



Feature of DHT11

- Ultra low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm

ref. - https://learn.adafruit.com/dht/overview

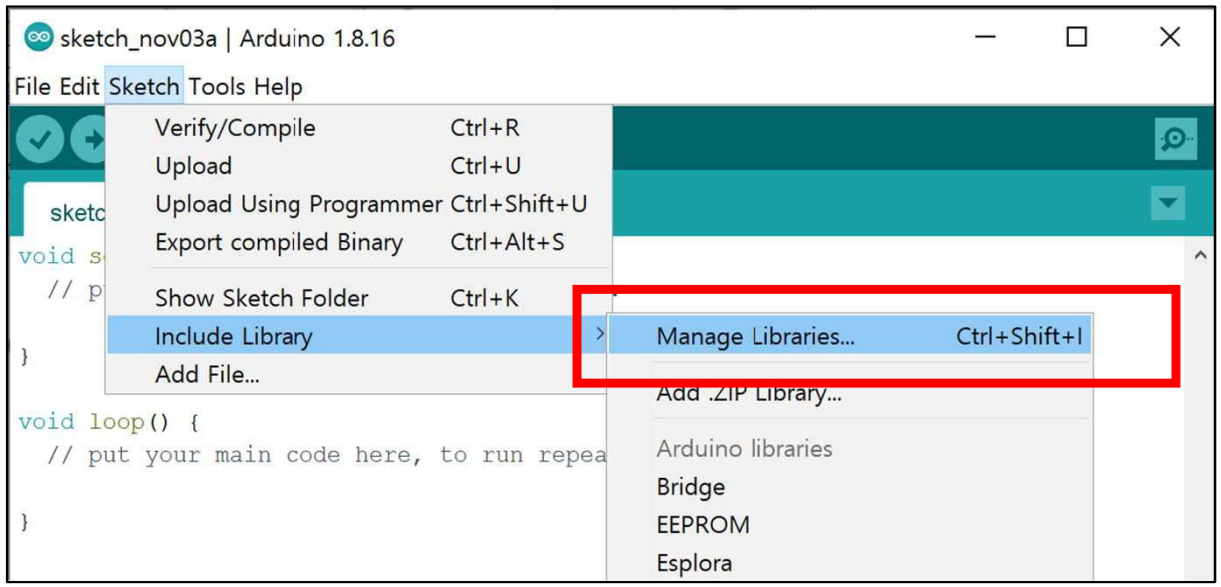
Library for DHT11 sensor

- To use DHT11 sensor, we need to install additional library via Arduino IDE
  - Adafruit_Unified_Sensor
  - DHT_sensor_library

- **Library?**
  - The Arduino environment can be extended through the use of libraries, just like most programming platforms.
  - Libraries provide extra functionality for use in sketches
    - e.g. working with hardware or manipulating data.

Library in Arduino

- To use a library in a sketch, select it from [Sketch] > [Import Library].



- You can download or create your own library.
  - To write your own libraries, see the tutorial and API Style Guide for making a good Arduino-style API for your library.
    - https://www.arduino.cc/en/Hacking/LibraryTutorial
    - https://www.arduino.cc/en/Reference/APIStyleGuide

Library manager: Search & install libs.

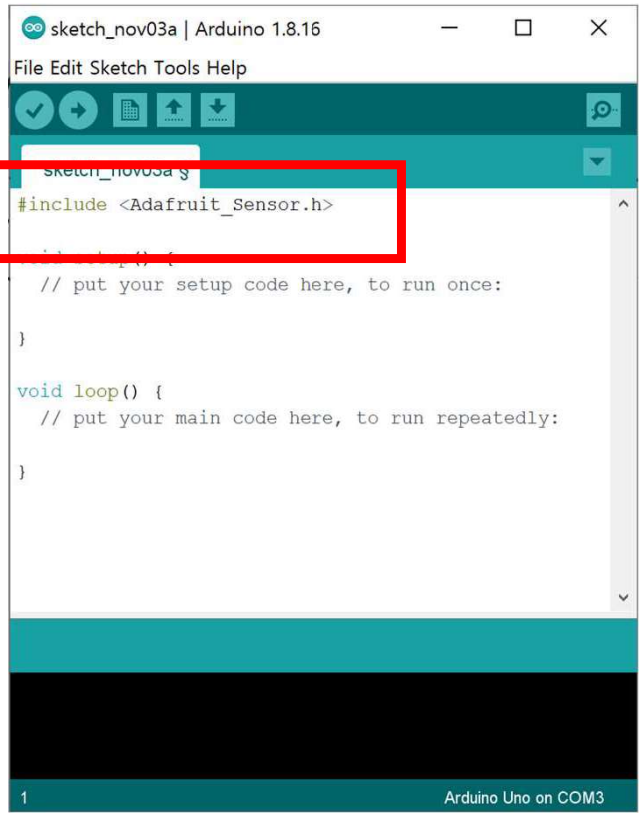
Update if you have older version

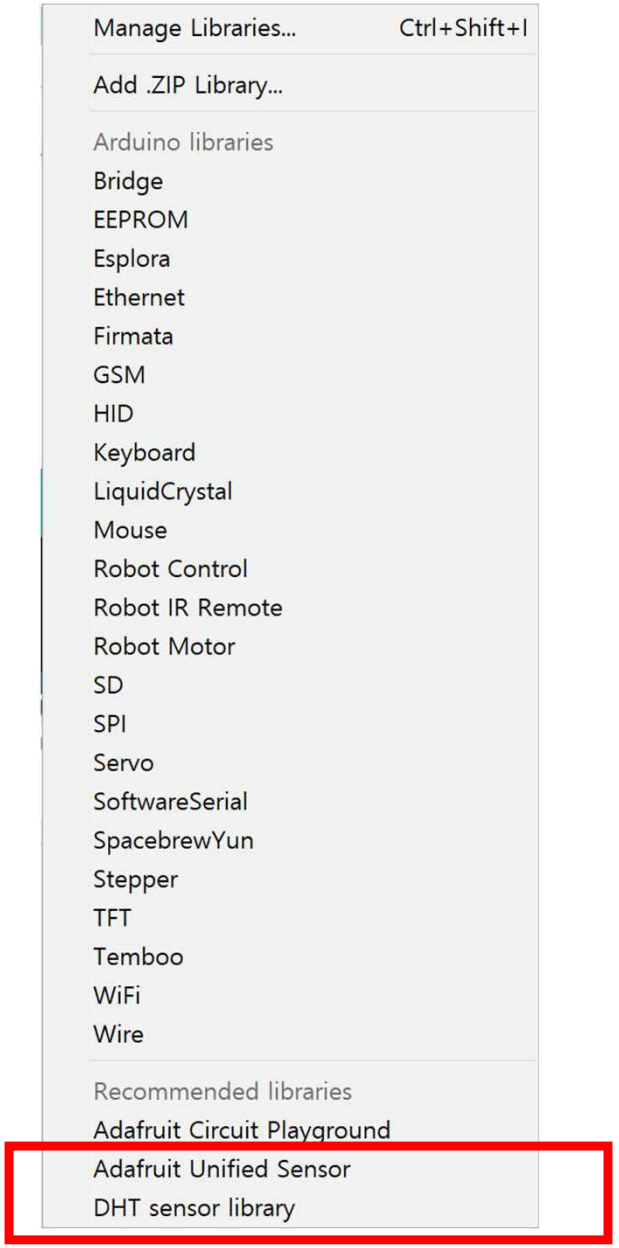
- Adafruit_Unified_Sensor
  - The unified sensor abstraction layer is also useful for data-logging and data-transmission
  - https://github.com/adafruit/Adafruit_Sensor

- DHT_sensor_library
  - An Arduino library for the DHT series of low-cost temperature/humidity sensors.
  - https://github.com/adafruit/DHT-sensor-library

Check the installed libraries

- After installation libraries, restart your Arduino IDE.
- Check the [Sketch] -> [Include library]
- Click the library, **what happens?**

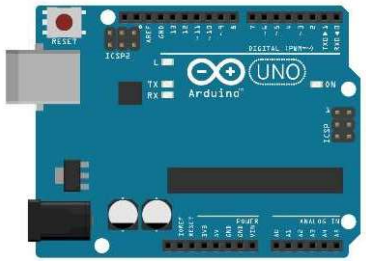
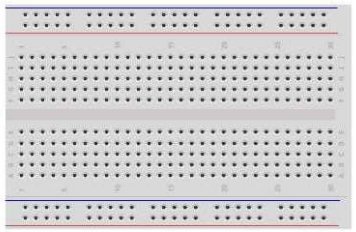
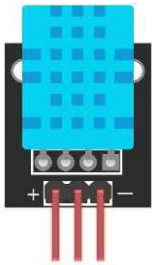
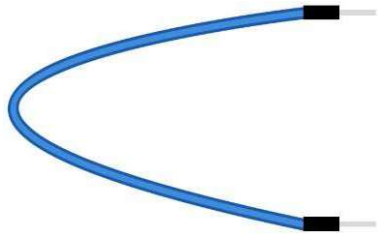




Digital output with DHT11 sensor

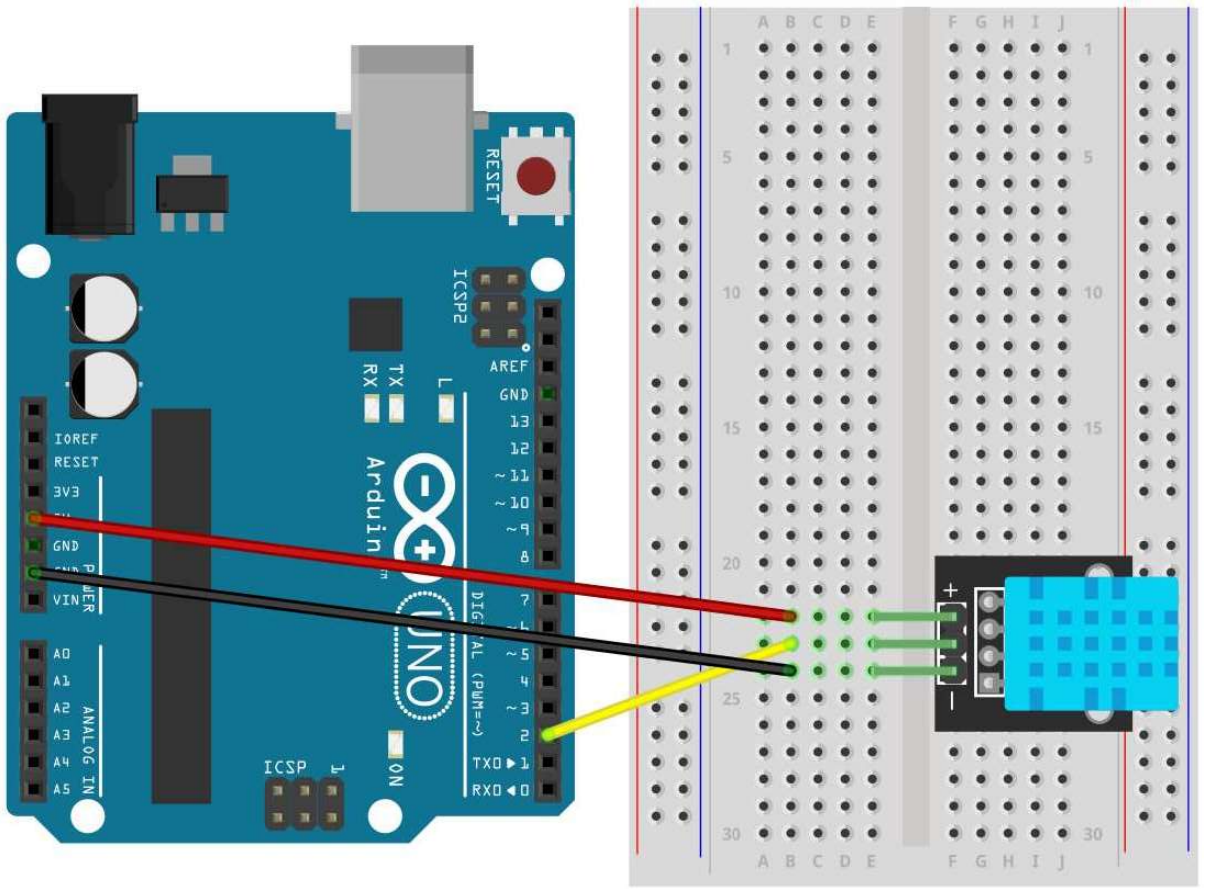
- Let's check the temperature and humidity data measured by the temperature/humidity sensor using serial communication.

- Required H/W components

Arduino Uno board	Breadboard	Sensor (DHT11)	Jumper cable (Male-Male)
			
x 1	x 1	x 1	x 3

Circuit wiring setup

DHT sensor	Arduino board
+	5V
-	GND
out	digital 2



Basic setup for DHT sensor

```
#include <DHT.h>
#include <DHT_U.h>

#define DHTPIN  2
#define DHTTYPE DHT11

DHT dht(DHTPIN, DHTTYPE);

void setup() {
  Serial.begin(9600);
  dht.begin();
}
```

Use library ➔ Include library header files

Macro for functionality extension

DHT object declaration.

You need another declarations whevever adding new DHT sensors

DHT dht2 = DHT(*pin*, *type*);

DHT object initialization

Read sensor values

```
void loop() {
  float hum, temp;
  delay(2000);
  hum =
  temp =
  if
    return;
  }
  Serial.print("Humidity: ");
  Serial.print(hum,1);
  Serial.print("%  Temperature: ");
  Serial.print(temp,1);
  Serial.println("C");
}
```

dht.readHumidity();
dht.readTemperature();

(isnan(hum) || isnan(temp))

are required for measuring humidity and temperature.

Every two seconds, read sensor values. Not allowed > 1 Hz.

Use in-library functions for reading sensor values:

see <dht.h>

Serial.print(float, decimal places);

NaN execption means error

Lab: Display Discomfort index

- Discomfort Index (DI)
  - a factor that greatly affects daily life according to the degree of feeling the heat
  - has a relation with temperature (T) and relative humidity (RH)
- DI equation (by E. C. Thom (1957))

$$DI = \frac{9}{5}T - 0.55(1 - RH)(\frac{9}{5}T\text{-}26)\text{+}32$$

- DI Table (Right)

Ref-
https://web.kma.go.kr/weather/lifenindustry/li_asset/HELP/basic/help_01_05.jsp

Level	Index range	Description
Extreme	>= 80	Very strong discomfort
High	75 ~ 80	50% of population feel discomfort
Normal	68 ~ 75	Slight discomfort sensation
Low	< 68	No discomfort

Calculate DI index

```
void loop() {
  float hum, temp, di;
// ....
    di = (float)9 / 5 * temp -
    0.55*((float)1-hum/100)*
    ((float)9/5*temp-26)+32
// ....
  Serial.print("C   DI: ");
  Serial.print(di,1);
  Serial.println(" pt");
}
```

declare new variable for DI

write a calculation equation

display!

Assignment: Discomfort index analyzer

- Requirements
  - Based on the example of discomfort index, write a sketch program as follows.
    - Every 2 seconds, collect sensing data of temperatures, humidity, and DI.
    - Calculate simple moving average of 10 data.
    - Display data, moving average with counter via Serial communication
      - Float type: two decimal places
  - Write block-type comments in the top of your source code, which includes "your student no., your name, writing date, what you feel about this assignment, etc."
- Results
  - (a source code file) sketch source code (***"sketchfilename.ino"***)
  - (a Arduino board capture file) a photo capture showing how you setup your circuit (max. 1GB file).