Environment Monitoring

Purpose

Using Arduino micro-controllers with "Lab in Your Pocket" app to monitor environment such as temperature, light intensity, UV Index and air pollutant.

Theory

- Our surrounding environment is ever-changing from place to place due to a multitude of natural and artificial driving forces. In general, the environmental data obtained from authorities may only represent environmental conditions in a local scale at a specific timeframe. With the sensors given in this exercise, environmental parameters can be retrieved locally on real-time basis.
- Temperature describes molecular kinetic energy of air, generally conceptualized as "hotness". Higher temperature represents hotter environment. The unit is degree Celsius (°C).
- Light intensity describes the power of light per unit area. The unit is lux (lx). 1 lx = 0.00146 Wm^{-2}
- UV index is a linear scale (from 0 to 11+ as shown in Fig 1) measuring the strength of ultraviolet radiation leading to sunburn. UV with shorter wavelength is more fatal but more absorbed by the atmosphere. The UV index is defined in a complicated mechanism where a weighted irradiance (higher weighting for shorter wavelength) of UV with different wavelengths is divided by a constant irradiance. The higher the UV index, the more dangerous is the light. UV index during summer midday with clear sky is around 10.

UV Index and exposure level

UV Index	Exposure Level
0-2	Low
3-5	Moderate
6-7	High
8-10	Very High
>= 11	Extreme

Fig 1

Credit: Hong Kong Observatory

- Particulate matter (PM) is known as suspended atmospheric aerosols in form of microscopic fluid and solid. PM2.5 and PM10 are the most concerned particulates when it comes to air pollution. The values (2.5 and 10) represent the diameters of particulates in terms of micrometer (μm). Small particulates are deadliest as they may penetrate into lungs and bloodstream to affect body functions. The unit is $\mu g/m^3$, of which the PM2.5 value was directly transformed into Air Quality Index (AQI) in the past. AQI was replaced by Air Quality Health Index (AQHI) since 30 December 2013 which involves 3-hour moving average of 4 air pollutants: ozone, nitrogen dioxide, sulphur dioxide and PM2.5/10.

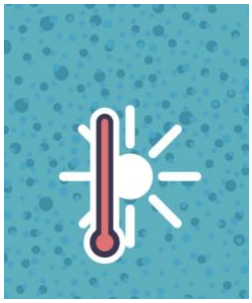
Apparatus

- 3 slots of D.C. electricity supplies with appropriate voltage (i.e. no more than 5V)
- A mobile device with “Lab in Your Pocket” app
- An Arduino PM2.5 sensors (provided by PolyU)
- An Arduino temperature and light sensors (provided by PolyU)
- An Arduino UV and pH sensors (provided by PolyU)

Precautions

1. The sensors give data with a time delay.
2. The light and UV sensors should be laid on flat surface directly under the light source without blockage of filter or obstacle.

Procedure



1. Conduct the measurements in form of groups at different spots.

<u>Indoor Environment (e.g. Classroom/Laboratory/Home)</u>

2. Connect the Arduino sensors to a 5V power supply respectively.
3. Open “Lab in Your Pocket” app in the mobile device and choose “Environmental Monitoring”.
4. Register the Arduino sensors with the addresses printed on the sensors. Press “Connect” to connect the sensors. When the connection finishes, the app will automatically jump into a monitoring interface showing the data retrieved from all connected sensors.
5. Observe the data from all sensors and record them in the data sheet below.
6. Repeat the measurements at different time.
7. Compare the results of different groups and evaluate the errors or discrepancies.

<u>Outdoor Environment (e.g. Playground/Roadside)</u>

8. Repeat Step 2 to 6 at outdoor spots.
9. Compare the real-time district data announced by authorities with your results.
10. Compare the results obtained from different locations with your classmates. Discuss the phenomena and discrepancies observed.

District Temperature
https://www.hko.gov.hk/contente.htm

UV Index
https://www.hko.gov.hk/wxinfo/uvindex/english/euvtoday.htm

Air Quality Index
https://aqicn.org/city/hongkong/

Data

Indoor Environment

Location: _____

Date and Time	Temperature (°C)	Light Intensity (lx)	UV Index	PM2.5 (μg/m^3)

Outdoor Environment

Location: _____

Date and Time	Temperature (°C) (Measured | Official)		Light Intensity (lx)	UV Index (Measured | Official)		PM2.5 (μg/m^3) (Measured | Official)	

Discussion

1. For indoor measurements, how does your result differ from the other groups? What would be the possible reasons for the discrepancies? How would your class minimize the error?
2. For outdoor measurements, is the data obtained close to the announced data from the authorities? If not, what are the possible reasons? In fact, scientists have introduced the concept of **"microclimate"** where climate may vary drastically within small areas due to multiple factors.
3. How does the data vary at different time given that it is recorded at the same location? What factors affect the results?
4. Compare the outdoor measurements with other groups that measure different locations. How does the data vary with location? What are the possible factors that influence the results?
5. Overall, what insights do the indoor and outdoor measurements provide you? Where are the more and less healthy locations for people? What advices would you give to the general public on staying healthy in different environments?