DATA ACQUISITION OF SOLAR RADIATION AND ULTRA-VIOLET (UV) INTENSITY

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Abstract

The intensity of solar radiation and UV radiation are measured using BH1750 by BH1750 sensor and light sensor and ML 8511 UV sensor respectively. The process is implemented by using microcontroller. As BH 1750 light sensor is inter- integrated circuit (I2C) device, it is connected to microcontroller with I2C mode. The data from each sensor are sent to Arduino microcontroller and then, data are displayed on LCD. Simultaneously, the intensity of light and UV radiation are logged in excel spreadsheet directly using the parallex data acquisition (PLX-DAQ) software. These data are uploaded directly to Microsoft(MS) excel spreadsheet directly with the accompanying the current date and time.

Keywords: UV radiation, I2C, data acquisition, MS excel

Introduction

The Sun also emits light across a broad spectrum. At the low end is the Infrared light (which is perceived as heat), followed by the visible light that are all familiar with living and non-living things. And then there is Ultraviolet light at the high end. Ultraviolet or UV light is filtered to a large degree by the Earth's Ozone layer, a protective layer of gas in the upper atmosphere that absorbs UV radiation. But the ozone layer is not a perfect filter and as a consequence some of the UV makes it through. The visible light is detected by BH1750 light sensor and UV radiation is detected by ML8511 sensor. Since BH1750 is inter-integrated circuit (I2C) device, "wire" library is included in Arduino integrated development and Environment (IDE) software. Arduino microcontroller can detected the output voltage of two sensors and these are converted to the intensity value by using respective equation. These data are directly transferred to the Microsoft(MS) excel spreadsheet using the parallex data acquisition (PLX_DAQ) software.

Materials and Methods

In this research, Arduino microcontroller, BH 1750 light sensor, ML8511 UV sensor and LCD are required as the hardware. BH1750 library is downloaded from website. "wire" and" Liquid Crystal" library is built- in library in Arduino IDE. The circuit diagram is illustrated in figure 1.BH1750 is I2C device which has serial data and serial clock line. Analog pin A4 and A5 are serial data and serial clock pin for Arduino uno, SDA and SCL are connected to A4 and A5 of Arduino, respectively.

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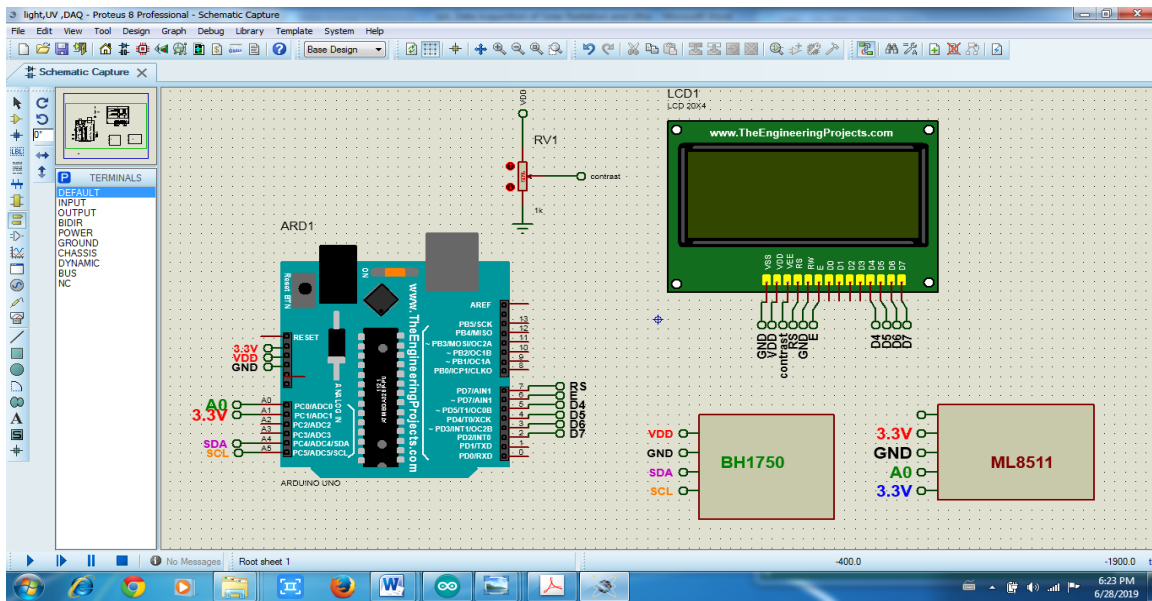
Figure 1   Schematic circuit diagram of light meter

BH1750 light sensor

BH1750 light intensity sensor breakout board(figure.2) consists of a 16 bit AD converter built-in which can directly output a digital signal; there is no need for complicated calculations. With the BH1750 Light Sensor intensity can be directly measured by the lux meter, without needing to make calculations. The data which is output by this sensor is directly output in Lux (Lx). By connecting the BH1750 with I2C bus interface it can determine the light intensity with illuminant to digital converter. It is possible to detect with wide range and high resolution 1 up to 65535 lx with low current power down function.
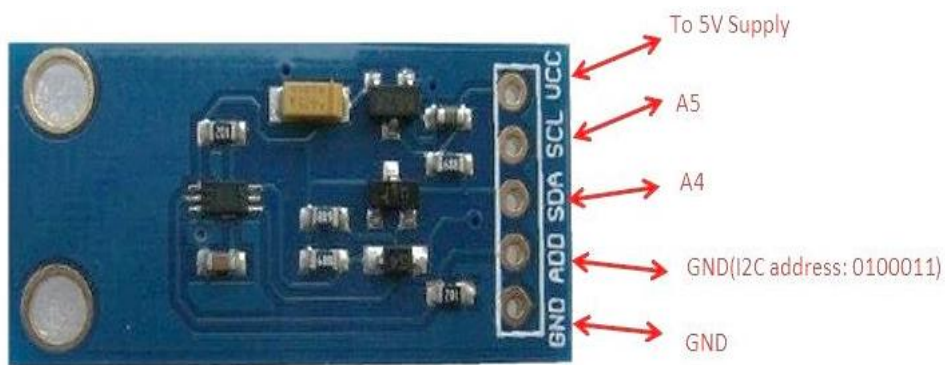

Figure 2   BH1750 light sensor

ML 8511 UV Sensor

The MP8511 UV (ultraviolet) Sensor works by outputting an analog signal in relation to the amount of UV light that's detected. This sensor detects 280-390nm light most effectively. This is categorized as part of the UVB (315nm- 280nm) spectrum and most of the UVA (400nm-

315nm) spectrum. It outputs a analog voltage that is linearly related to the measured UV intensity (mW/cm2). The sensor ML8511 has a UV photodiode and Internal Amplifier which will converts photo current to voltage output depending on the UV light intensity. Through the voltage output it is easy to interface with external micro controllers and ADC.
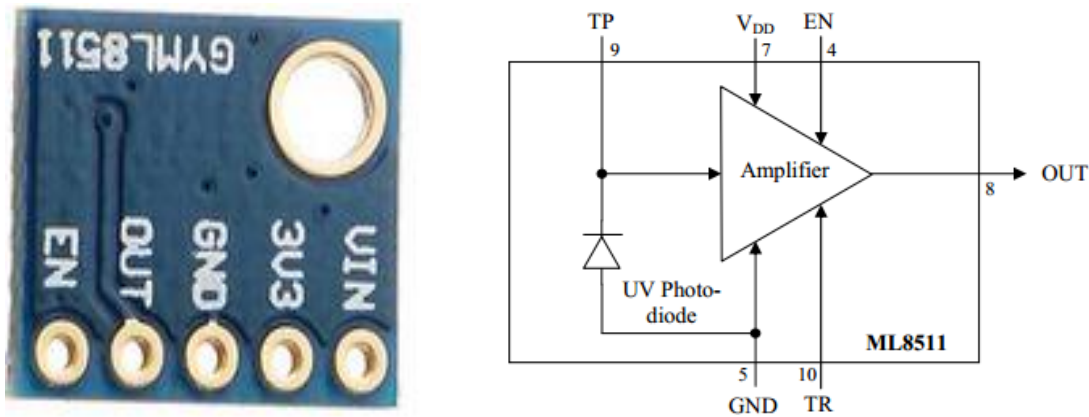
Figure 3 UV sensor and its block diagram

      The UV Index scale was developed by Canadian scientists in 1992, then adopted and standardized by the WHO in 1994. In most areas of the world the UV Index ranges from 0 to 10, but it can get a lot higher than that. Locations in the tropics often have UV levels exceeding 12 and high altitudes like mountaintops routinely register a UV Index of 20.UV index is illustrated in figure 4. UV intensity is directly proportional to the output voltage of ML 8511 sensor as shown in figure.
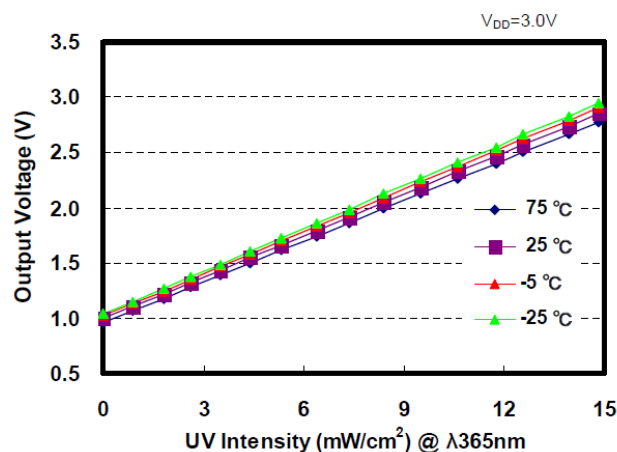
Figure 4 UV index level

Figure 5 Output voltage dependency on UV radiation

Program Explanation

- Address and Library file for BH 1750 are included in Arduino IDE.

#include <LiquidCrystal.h>

#include <Wire.h>

#include <BH1750.h>

LiquidCrystallcd(7, 6, 5, 4, 3, 2);

To obtain the light intensity

Wire.beginTransmission(BH1750address);

Wire.write(0);

Wire.endTransmission();

Wire.requestFrom(BH1750address, 1);

while(Wire.available() == 0);

 uint16_t lux = lightMeter.readLightLevel();

To get UV intensity, floatmap() function is used . From figure 5, output voltage is extended from 0.99V to 2.9 V while the UV intensity is varied from 0 to 15mW/m^2. Since the reference level is 3.3V, firstly output voltage is determined and then, transform to UV intensity by mapping.

float outputVoltage = 3.3 / refLevel * uvLevel;

float uvIntensity = mapfloat(outputVoltage, 0.99, 2.9, 0.0, 15)

Light intensity and UV intensity are displayed on LCD and are sent to excel sheet simultaneously.

For data logging in excel, firstly , data are clear and make the heading line of table as follows;

Serial.println("CLEARDATA");

Serial.println("LABEL,Date,Time,Intesity(lux),Intesity(FtCd),Intesity(W/m^2),UVIntensity(mW/cm^2)");

And then, data sent from microcontroller are filledin the excel table.

Serial.print("DATA,DATE,TIME,");

Serial.print(lux);

Serial.print(",");

Serial.print(lux/10.764);

Serial.print(",");

Serial.print(lux/683.0);

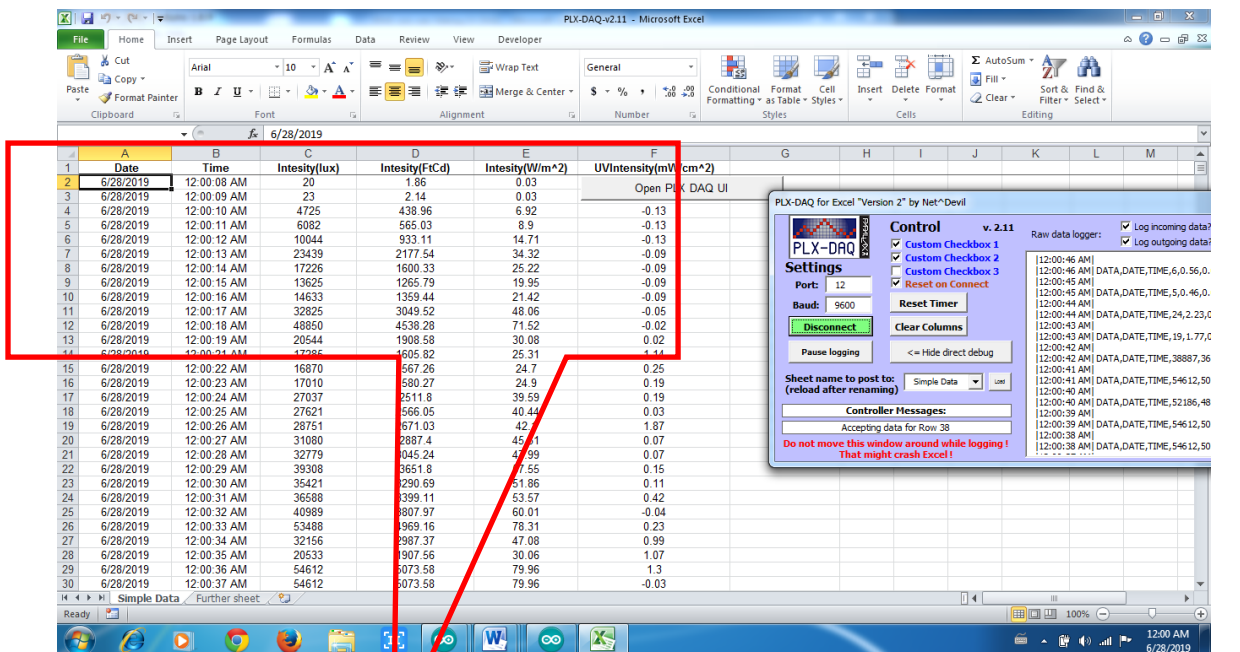Serial.print(",");

Serial.println(uvIntensity);

Results

Light intensity is measured in "lux", "foot candle"(ft-cd) and W/m^2. UV intensity is measured in mW/cm^2.Figure 7 shows the Light intensity and UV intensity of phone flash light on LCD at the distance 2cm to 10 cm variation. Light intensity is varied with distance but UV intensity is small and almost same. So, phone flash light emits the low level UV radiation. Data are sent to excel via PLX_DAQ software in figure 8. When UV light falls on sensor, UV level are changed with distance between source and sensor as shown in figure 9.

Figure 6 Experimental setup

Figure 7 Light intensity of Phone Flash light

Figure 8 Data on excel

Figure 9 Testing UV index and light intensity

Conclusion

In UV data measured in the room light, it takes negative. The output voltage of 0.99 V is referred to 0 mW/cm^2. When voltage is less than 0.99V in room light,UV intensity takes the negative value. There are some advantages and disadvantages of effects of UV radiation. The purpose of the UV Index is to help people effectively protect themselves from UV radiation, which has health benefits in moderation but in excess causes sunburn, skin aging,DNA damage, skin cancer, immunosuppression,[1] and eye damage such as cataracts.

Acknowledgements

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