UV RADIATION INTENSITY DETECTOR

A MINI PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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Submitted for the project viva-voce examination held on ____________________

INTERNAL EXAMINER	**EXTERNAL EXAMINER**

MINI PROJECT APPROVAL SHEET

The Mini project sheet **" UV RADIATION DETECTOR '** submitted by **'YUVASRI S (212222060311) , UDAYA BHARATHI M(212222060281), VIJAYALAKSHMI B (212222060294)'** is approved for submission, as partial requirement for the award of the **Degree of Bachelor of Engineering in Electronics and Communication**, Anna University during the academic year 2023- 2024.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ABSTRACT

The excessive exposure to ultraviolet radiation, natural or artificial, is a public health concern. For this reason, it is important that, from an early age, children and teenagers gain awareness of this problem. By not being visible to the human eye, ultraviolet radiation is an abstract concept and difficult to understand, although its short-term effects may be visible. In this project, we proposed the use of the Arduino platform to measure and verify the effect of various sun blocks, making it possible to materialize the concept of UV radiation. Thus, it was the aim of this project to study the influence of the Arduino platform use, associated with an ultraviolet radiation sensor, in the understanding of this type of radiation and in the awareness to the artificial sources of UV radiation used in the daily life of many people. In this project, we are **interfacing UV Sensor HW-837 with Arduino** nano for measuring **Ultra Violet Light Intensity** in **mW/cm^2**.

We will interface UV Sensor HW-837 with Arduino & LCD Display. UV Radiation or Ultraviolet light radiation occurs from **10nm to 400nm** wavelength in the electromagnetic spectrum. The **HW -837 UV sensor** detects **240nm – 370nm** light in a better way. It outputs an analog voltage that is linearly related to the measured UV intensity **(mW/cm2).**

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INTRODUCTION

1.1.1 UV radiation

Ultraviolet (UV) is a form of electromagnetic radiation with wavelength shorter than that of visible light, but longer than X-rays. UV radiation is present in sunlight, and constitutes about 10% of the total electromagnetic radiation output from the Sun. It is also produced by electric arcs; Cherenkov radiation; and specialized lights; such as mercury-vapor lamps, tanning lamps, and black lights.

Although long-wavelength ultraviolet light is not considered an ionizing radiation because its photons lack the energy to ionize atoms, it can cause chemical reactions and causes many substances to glow or fluoresce. Many practical applications, including chemical and biological effects, derive from the way that UV radiation can interact with organic molecules. These interactions can involve absorption or adjusting energy states in molecules, but do not necessarily involve heating.

Short-wave ultraviolet light damages DNA and sterilizes surfaces with which it comes into contact. For humans, suntan and sunburn are familiar effects of exposure of the skin to UV light, along with an increased risk of skin cancer. The amount of UV light produced by the Sun means that the Earth would not be able to sustain life on dry land if most of that light were not filtered out by the atmosphere.More energetic, shorter wavelength "extreme" UV below 121 nm ionizes air so strongly that it is absorbed before it reaches the ground.However, ultraviolet light (specifically, UVB) is also responsible for the formation of vitamin D in most land vertebrates, including humans. The UV spectrum, thus, has effects both beneficial and harmful to life.

The lower wavelength limit of the visible spectrum is conventionally taken as 400 nm, so ultraviolet rays are not visible to humans, although people can sometimes perceive light at shorter wavelengths than this. Insects, birds, and some mammals can see near-UV (NUV), i.e., slightly shorter wavelengths than what humans can see.

Fig 1.1.1 UV rays from sun

1.1.2 Visibility

Ultraviolet rays are usually invisible to most humans. The lens of the human eye blocks most radiation in the wavelength range of 300–400 nm; shorter wavelengths are blocked by the cornea.Humans also lack color receptor adaptations for ultraviolet rays. Nevertheless, the photoreceptors of the retina are sensitive to near-UV, and people lacking a lens (a condition known as aphakia) perceive near-UV as whitish-blue or whitish-violet.Under some conditions, children and young adults can see ultraviolet down to wavelengths around 310 nm.Near-UV radiation is visible to insects, some mammals, and some birds. Birds have a fourth color receptor for ultraviolet rays; this, coupled with eye structures that transmit more UV gives smaller birds "true" UV vision.

1.1.3. Types of UV radiation

The three types of UV radiation are classified according to their wavelength. They differ in their biological activity and the extent to which they can penetrate the skin. The shorter the wavelength, the more harmful the UV radiation. However, shorter wavelength UV radiation is less able to penetrate the skin.

The UV region covers the wavelength range 100-400 nm and is divided into three bands:

- UVA (315-400 nm)
- UVB (280-315 nm)
- UVC (100-280 nm).

Wave Type	UVA	UVB	UVC
Wave length	315-399nm	280-314nm	100-279
Absorption level	Not absorbed by the ozone layer.	Mostly absorbed by the ozone layer, but some does reach the earth surface.	Completely absorbed by ozone layer and atmosphere.

1.1.3.1 UVA

- They have higher wavelengths, but lower energy levels than other UV rays.
- They're more penetrating than UVB rays, which means they can affect cells deeper in the skin.
- They cause indirect damage to DNA.
- They cause skin to age prematurely, leading to visible effects such as wrinkles. They're also associated with some skin cancers.
- Unlike UVB rays, they're not absorbed by the ozone layer. About 95 percentTrusted Source of the UV rays that reach the ground are UVA rays.
- They cause an immediate tanning effect, and sometimes a sunburn. The effects of UVA rays tend to appear right away.
- UVA rays are the main type of light used in tanning beds.
- They can penetrate windows and cloud.

1.1.3.2 UVB

- Relative to UVA rays, UVB rays have shorter wavelengths and higher energy levels.
- UVB rays damage the outermost layers of the skin.
- They directly damage DNA.
- UVB rays cause most skin cancers, but they can also contribute to skin aging prematurely.
- They're partially absorbed by the ozone layer, but some rays still get through. About 5 percentTrusted Source of the UV rays that reach the ground are UVB rays.
- Overexposure to UVB rays leads to sunburns. Usually, the effects of UVB rays are delayed, or appear a few hours after sun exposure.

Most tanning beds use a combination of UVA and UVB rays. Special UVB-only tanning beds may be touted as safe, but they still cause skin damage. No tanning beds are safe to use or recommended. They don't penetrate windows, and are more likely to be filtered by clouds.

1.1.3.3 UVC

Ultraviolet C (UVC) rays have the shortest wavelengths and highest energy levels of the three types of UV rays. As a result, they can cause serious damage to all life forms. Fortunately, UVC radiation is completely filtered out by the ozone layer. As a result, these rays from the sun never reach the ground. Man-made sources of UVC include welding torches, special bacteria-killing light bulbs, and mercury lamps.

Although not considered a risk for skin cancer, UVC rays can cause severe damage to human eyes and skin, including burns, lesions, and ulcers on the skin.

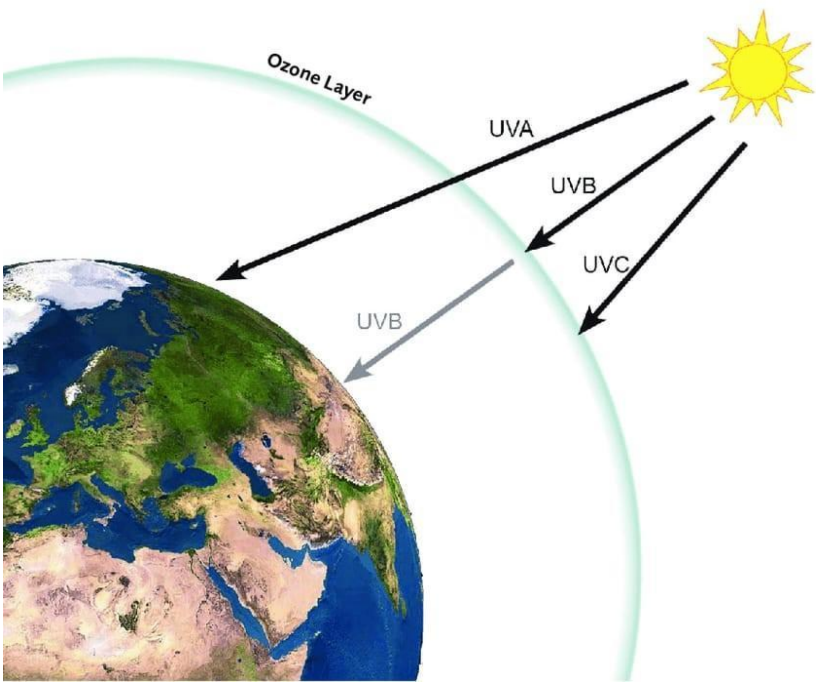

Fig 1.1.3 Types of UV rays

1.1.4 **Benefits of UV radiation.**

Vitamin D production:

UV rays help your body produce vitamin D, which is essential for bone health and immune function. Mood booster: Exposure to UV rays can increase the production of serotonin, a hormone that helps regulate mood and promote feelings of happiness.

Skin conditions: UV rays can be used to treat certain skin conditions like psoriasis, eczema, and vitiligo.

Increased alertness: Sunlight and UV rays can help increase alertness and improve cognitive function. Improved sleep: Exposure to natural light, including UV rays, can help regulate your body's internal clock and improve your sleep patterns.

1.1.5 Harmful Effects

- Sunscreen and sunglasses can be used to protect you from UV radiation.

- Sunburn is a sign of short-term overexposure, while premature aging and skin cancer are
- side effects of prolonged UV exposure.

- UV exposure increases the risk of potentially blinding eye diseases if eye protection is not
- used
.

- Overexposure to UV radiation can lead to serious health issues, including cancer.
- Spend a lot of time in the sun or have been sunburned.
- Have light-color skin, hair, and eyes.
- Take some types of oral and topical medicines, such as antibiotics, birth control pills, and benzoyl peroxide products, as well as some cosmetics, may increase skin and eye sensitivity to UV in all skin types.
- Have a family member with skin cancer.
- Are over age 50.

1.1.6 UV index and Standard Erythemal Dose

UV index	Number of SED/hour	Power of the sun	Duration of exposure equivalent to 1 SED
1	1	Weak	2h20m
2	2	Weak	1h10
3	2.5	medium	45mn
4	3.5	Medium	35mn
5	4.15	Strong	30mn
6	5	Strong	25mn
7	6	Very strong	20mn
8	7	Very strong	18mn
9	8.5	Extreme	16mn
10	9.5	Extreme	14mn
	10.5	Extreme	12mn

1.1.7 Sources of UV rays

- Our natural source includes:

  The sun

- Some artificial sources include:

  Tanning Beds

  Mercury vapor lighting (often found in stadiums and school gyms)

  Some halogen, fluorescent, and incandescent lights

  Some types of lasers.

CHAPTER 2

LITERATURE REVIEW

In this chapter, the development of UV radiation intensity detector is discussed. The radiation level within which it is safe to use is also included in this chapter.Ultraviolet radiation, that portion of the electromagnetic spectrum extending from the violet, or short-wavelength, end of the visible light range to the X-Ray region. Ultraviolet (UV) radiation is undetectable by the human eye, although, when it falls on certain materials, it may cause them to fluoresce—i.e., emit electromagnetic radiation of lower energy, such as visible light. Many insects, however, are able to see ultraviolet radiation.

The research involved a literature review or research presenting data in a consistent theoretical basis for the analysis, design, research results and comparisons. To obtain a summary of each report. Therefore the acquisition of new knowledge to new research, it may be relevant to the further development oriented research for them.

This paper presents an Arduino based UV radiation intensity detector. The authors discuss the hardware setup using arduino.1

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CHAPTER 3
PROPOSED METHOD

3.1 Arduino

Arduino is an Italian open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The microcontrollers can be programmed using the C and C++ programming languages (Embedded C), using a standard API which is also known as the Arduino Programming Language, inspired by the Processing language and used with a modified version of the Processing IDE.

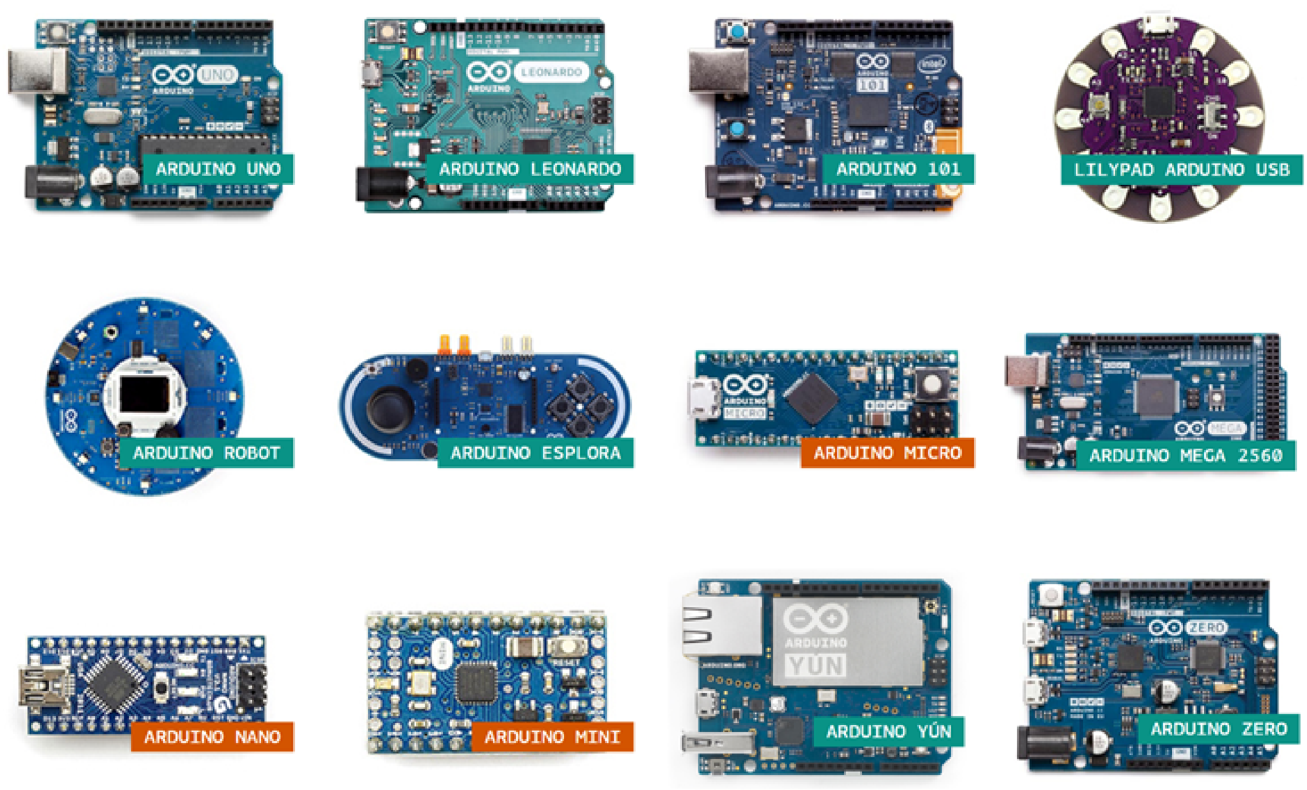
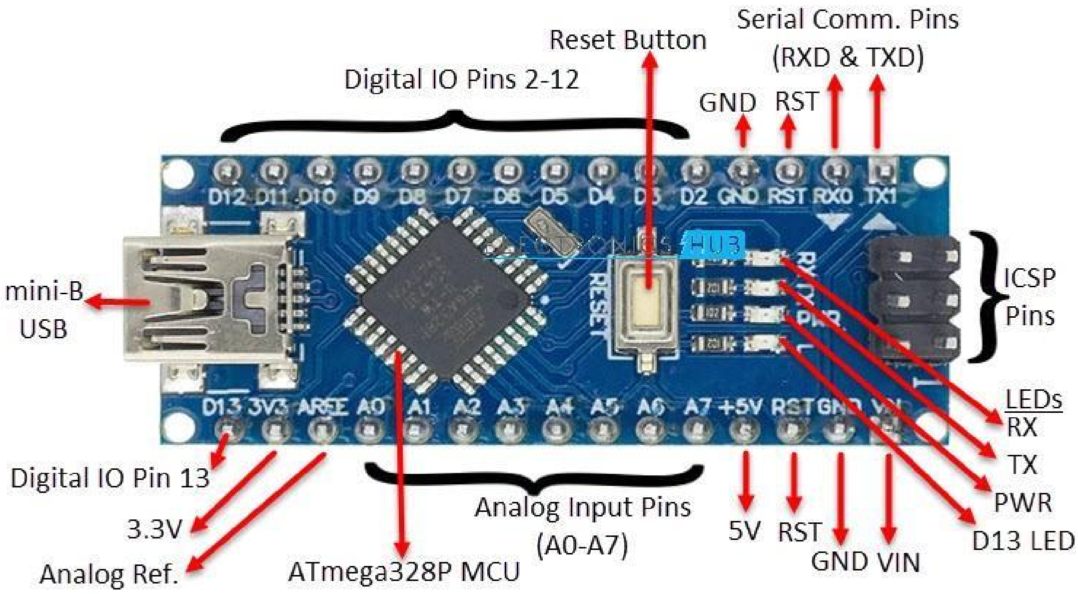


Fig 1.2 Arduino

3.1.1 Arduino Nano

The Arduino Nano is an open-source breadboard-friendly microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.



The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery.

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

3.1.2 Technical specification

Operating voltage: 5 volts

Input voltage: 5 to 20 volts

Digital I/O pins: 14 (6 optional PWM outputs)

Analog input pins: 8

DC per I/O pin: 40 mA

DC for 3.3 V pin: 50 mA

Flash memory: 32 KB, of which 2 KB is used by bootloader

SRAM: 2 KB

EEPROM: 1 KB

Clock speed: 16 MHz

Length: 45 mm

Width: 18 mm

Mass: 7 g

USB: Mini-USB Type-B

ICSP Header: Yes

DC Power Jack: No

3.2 Sensor

The GUVA-S12SD UV Sensor chip is suitable for detecting UV radiation in sunlight. It can be used in any application where you want t0 monitor for the amount of UV light and is simple to connect to any microcontroller. Output of the sensor is Analog voltage. I recently noticed that some sellers had little modules for this sensor at a reasonable price so decided to purchase one Application:

UV tester, UV watches, outdoor sports equipment, mobile phone, etc

3.2.1 Features:

Low power consumption

Power supply voltage of 2.5 V ~ 5 V

working current is microamps.

High sensitivity

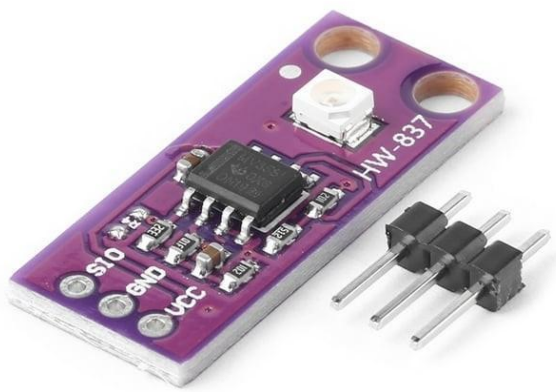
High stability

Wide detection range: 240 nm to 370 nm

Wide Angle: 130 degrees

Schottky type photosensitive diode

Size: 11 mm x 27 mm



3.3 Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

3.3.1 Feature

The operating voltage of this LCD is 4.7V-5.3V

It includes two rows where each row can produce 16-characters.

The utilization of current is 1mA with no backlight

Every character can be built with a 5×8 pixel box

The alphanumeric LCDs alphabets & numbers

Is display can work on two modes like 4-bit & 8-bit

These are obtainable in Blue & Green Backlight

It displays a few custom generated characters

A 16×2 LCD has two registers like data register and command register. The RS (register select) is mainly used to change from one register to another. When the register set is '0', then it is known as command register. Similarly, when the register set is '1', then it is known as data register.

3.4 Arduino IDE

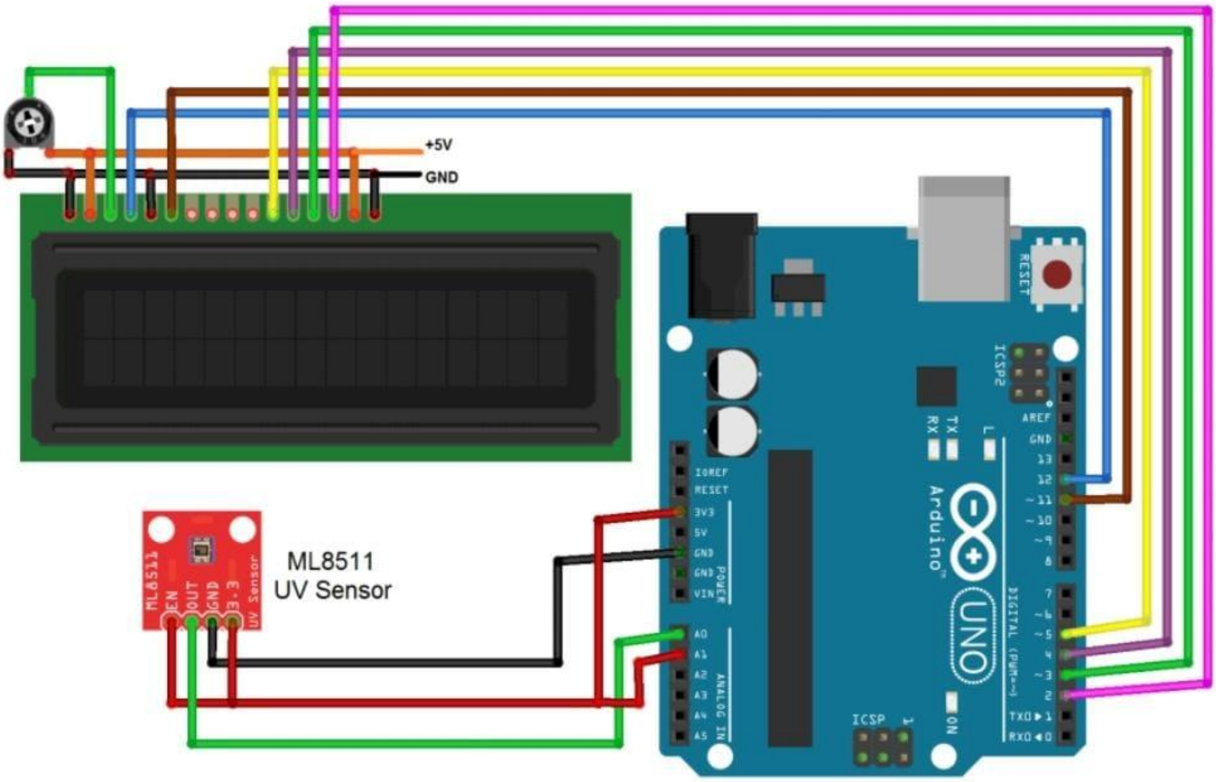
The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

The Arduino Software (IDE) makes it easy to write code and upload it to the board offline.

3.5 Circuit Diagram:

Interfacing UV Sensor ML8511 with Arduino. The circuit diagram for interfacing UV sensor ML8511 with Arduino and LCD

Display is given below. The 16×2 LCD RS, EN, D4, D5, D6, D7 is connected to Arduino 12, 11, 5, 4, 3, 2 pins. LCD is supplied with 5V. It has 10K POT attached to LCD pin 3 to adjust the contrast.



The UV Sensor has 5 pins Vin, 3V3, GND, OUT, EN. Some of the modules don't have Vin pin which is not used too. The EN pin and 3V3 pin are connected to the 3.3V pin of Arduino. The same 3V3 Pin is connected to Analog pin A1 which is used as a reference voltage. The out pin is connected to A0 of Arduino and GND to GND.

This connection for ML8511 is somewhat tricky. Analog to digital conversions rely completely on VCC. We assume this is 5.0V, but if the board is powered from USB this may be as high as 5.25V or as low as 4.75V. Because of this unknown window, it makes the ADC on the Arduino fairly inaccurate. To fix this, we use the very accurate onboard 3.3V reference (accurate within 1%). So by doing an analog to digital conversion on the 3.3V pin (by connecting it to A1) and then comparing this reading against the reading from the sensor, we can extrapolate a true-to-life reading, no matter what VIN is (as long as it's above 3.4V).

3.6 The source code:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(2, 3, 4, 5, 6, 7);

//Hardware pin definitions
int UVOUT = A0; //Output from the sensor
int REF_3V3 = A1; //3.3V power on the Arduino board
```

```
void setup()
{
Serial.begin(9600);
lcd.begin(16, 2);
pinMode(UVOUT, INPUT);
pinMode(REF_3V3, INPUT);
Serial.println("ML8511 example");
}
void loop()
{
int uvLevel = averageAnalogRead(UVOUT);
int refLevel = averageAnalogRead(REF_3V3);
//Use the 3.3V power pin as a reference to get a very accurate output value from sensor
float outputVoltage = 3.3 / refLevel * uvLevel;
float uvIntensity = mapfloat(outputVoltage, 0.99, 2.8, 0.0, 15.0);
//Convert the voltage to a UV intensity level
Serial.print("output: ");
Serial.print(refLevel);
Serial.print("ML8511 output: ");
Serial.print(uvLevel);
Serial.print(" / ML8511 voltage: ");
Serial.print(outputVoltage);
Serial.print(" / UV Intensity (mW/cm^2): ");
Serial.print(uvIntensity);
lcd.clear();
lcd.print("UV Ray Intensity");
lcd.setCursor(0, 1);
lcd.print(uvIntensity);
lcd.print(" mW/cm^2");
Serial.println();
delay(200);
}


//Takes an average of readings on a given pin
//Returns the average
int averageAnalogRead(int pinToRead)
{
byte numberOfReadings = 8;
unsigned int runningValue = 0;
for(int x = 0 ; x < numberOfReadings ; x++)
runningValue += analogRead(pinToRead);
runningValue /= numberOfReadings;
return(runningValue);
}

float mapfloat(float x, float in_min, float in_max, float out_min, float out_max)
{
return (x - in_min) * (out_max - out_min) / (in_max - in_min) + out_min;
}
```

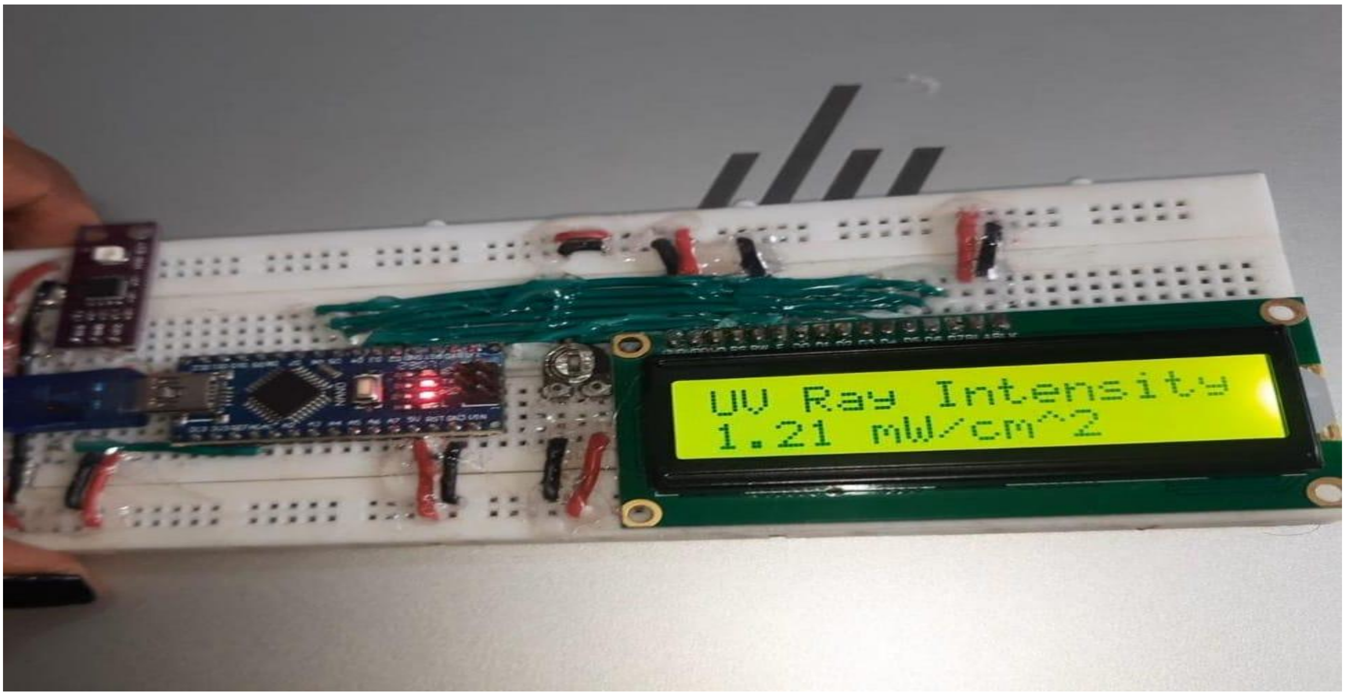
CHAPTER 4
EXPERIMENTAL RESULT

4.1 Experimental set-up

A step-by-step process for implementing the UV RADIATION INTENSITY DETECTOR and obtaining experimental results:

1. Connect the UV RADIATION INTENSITY DETECTOR to the Arduino board.
2. Connect the LCD display to the Arduino circuit to note the readings.
3. Write the Arduino code. You will need to program the Arduino to read the analog input from the UV sensor and calculate the intensity. The code will also handle displaying the UV intensity rate on the LCD display.
4. Upload the code to the Arduino board using the Arduino IDE.
5. Power on the Arduino board by connecting it using the USB cable and start showing the UV rays source towards the sensor.
6. Monitor and record the readings of the intensity from the display specific duration of time or during a specific distance.
7. Analyze the collected data to draw conclusions or observations. You can calculate the intensity exerted by each device for a specific duration and from a specific distance.

4.2 Experimental - Output



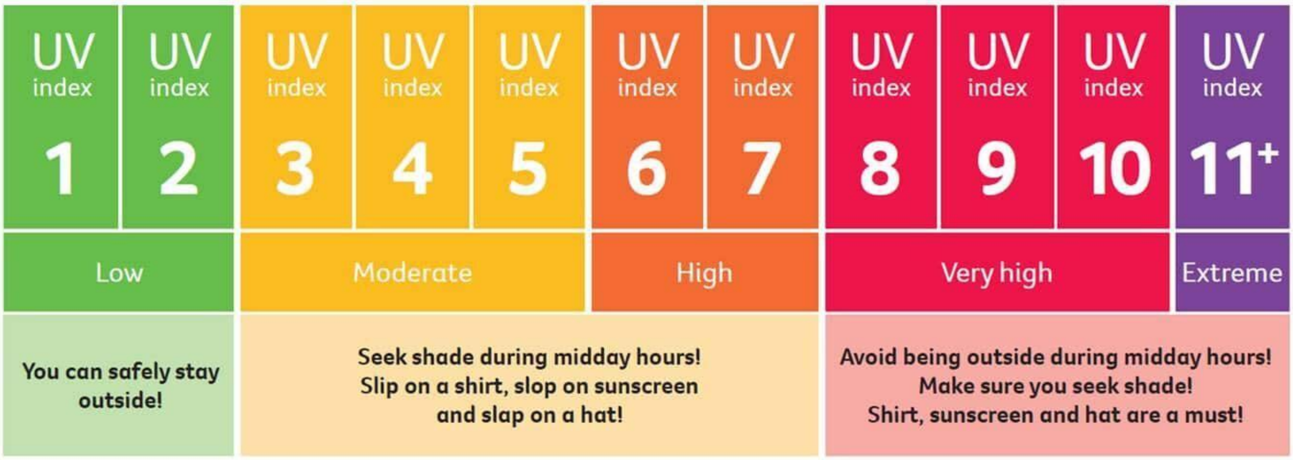
CHAPTER 5 CONCLUSION AND FUTURE SCOPE

5.1 Future Scope

The future scope of the UV detector is using Arduino, with several potential areas of development and improvement, we can continue to improve the device.

By developing the algorithms and incorporating more calculation and information, we could display the UV Index range that the device falls into, and display whether it is safe to use the device or to change the device.

We could also display whether the intensity exerted from the device is safe or not not using the UV index chart.



5.2 Conclusion

By combining Arduino Microcontroller boards with the UV intensity detector circuit, it is possible to create a reliable and low-cost detector for real time monitoring. Arduino- based UV intensity detector system is feasible and relatively easy to implement as Arduino is a flexible platform for integrating sensors and processing data. The accuracy of the output is also taken care by the code using functions.

This Arduino based device is cost-effective compared to the professional devices. It is easy to operate and affordable also.

The purpose of making this device is to be aware the radiations around us and have healthy life. As we could generally see this that every person around us has issues with eye sight and even kids of age sound 10 -15 are also affected by UV rays due to the usage of gadgets. So using this device we could analyse and try to avoid our scree time accordingly.

CHAPTER 6
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