UV radiation Measurement via Smart Devices

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***Abstract*— Sun is an important factor for our health, too much exposure to sun light may cause health problems ranging from sunburns to skin cancer. Even though people are aware of these risks, sunlight related skin damages have increased over the past decades. Nowadays, the public basically gets information about UV radiance through weather forecasts. However, they provide rough and average predication for a certain large region. This paper introduces a concept that can measure UV radiance by using UV sensors which will detect the radiation and operate with an wavelength of 300nm to minimize the effects of natural background radiation. In addition, by utilizing Raspberry Pi and LCD display we can control and display the precautionary steps to be taken.**

***Index Terms*— UV measurement, UV radiance, UV sensors, Raspberry Pi, LCD display.**

I. Introduction

Ultraviolet (UV) radiation is harmful to human health. Many studies have shown that UV is contained in sunlight and is a carcinogen, which can cause skin cancer. Currently, the most effective way to block UV radiation is applying sunscreen. However, many people ignore protecting their skin simply because they do not know the intensity of UV radiation outside. It will be very important and helpful to provide a way to let people measure UV rays conveniently and accurately.

There are two major types of equipment, which can measure UV radiation. The first type is spectroradiometers, which are basically used in laboratories. Although spectroradiometers can provide extremely accurate results, they are quite expensive and complex to operate. The second type is portable digital UV meters. There are several variations in this type. Some are small and easy to carry, but are not capable to provide accurate readings. Some have a little larger size and provide relatively accurate readings, but are still expensive for consumers. Thus, the obvious disadvantages are the popularization of traditional UV measurement equipment: neither accurate nor affordable enough.

In recent years, the idea of using smart phones to detect UV radiation has emerged. Since there are no smart phones equipped with UV sensors on the market, the methods generally seek other UV related sources. We can implement by using UV to compute the UV radiation results instead.

II. Related Works

Recent studies have shown that Ultraviolet (UV) detectors work by detecting the UV radiation emitted at the instant of ignition. UV detectors typically operate with wavelengths shorter than 300 nm to minimize the effects of natural background radiation. The solar blind UV wavelength band is also easily blinded by oily contaminants.

More recently the survey shown that smart watches market was growing rapidly. Some models just provide limited functionality and accelerometers only, while some other models are very sophisticated and multiple sensors such as gyroscopes, GPS, and heart rate sensors. Few models have built-in UV sensors. For example, Apple Watch is a very high-end smart watch and even provides an ambient light sensor, but it is still absent from a UV sensor.

a. Wearable Sensing Unit

The wearable sensing unit consists of a Raspberry Pi 0 which consist of a built-in printed circuit board, Input/output slots to connect to hardware and 512MB of RAM. The UV sensor and the LCD display is used to sense and display.

FIGURE.1: RASPBERRY PI 0

b. UV Sensor

The Variable Wavelength UV Detector uses a monochromatic (slits and a grating) to select one wavelength of light to pass through the sample cell. The Photodiode Array Detector passes all wavelengths of light through the sample cell, and then focuses each wavelength on a single sensor element.

Features

- High stability
- Good sensitivity
- Low power consumption
- Wide response range

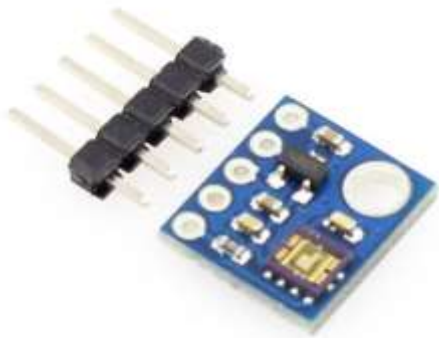

FIGURE.2: UV RAYS SENSOR

UV Sensor is used for detecting the intensity of incident ultraviolet radiation. This form of electromagnetic radiation has shorter wavelengths than visible radiation.

c. Determination of UV radiation

In the area of solar radiation, many things are focused on collecting data about solar radiation in different places in the world and in different time throughout the year. These studies explicitly indicated that UV radiation occupies approximately 3% of all solar radiation.

d. Survey

As mentioned in the introduction, the number of skin cancer cases has constantly increased over the past years and most of the non-melanoma skin cancers are associated with exposure to ultraviolet radiation. [1]

A study of New Zealand showed that 17.8% of the skin cancer cases can differently be attributed to sun burn.

During the surveying of different papers 60 % of humans have undergone risk due to sunburns and 95% know that sunburns increases the risks of skin cancer. Roughly two thirds of the respondents experience sunburn at least once a year, and almost everybody (96%) has already been sunburned.[2]

Sl. No.	Category of answer	Percentage
1.	Misjudgment the solar radiation	23%
2.	No sunscreen at hand	19%
3.	Staying in the sun for too long	18%
4.	Incorrect/insufficient application of Sunscreen	13%
5.	Forgot to apply sunscreen	13%
6.	. Did not pay attention	10%
7.	Sport activities	10%
8.	The skin was not yet accustomed to the sun (mostly in spring)	8%
9.	Did not apply sunscreen (reason unknown)	8%
10.	Sleeping in the sun	6%

Table 1. Most popular reasons for sunburn according to our survey.
A single answer could have been assigned to more than one category.

FIGURE.3: SURVEY READINGS

e. Ultraviolet Rays

1. **Ultraviolet C** (UVC, 100-290 nm) are the shortest and most energetic portion of the UV spectrum. These highly energetic wavelengths. The important wavelengths in the UVC are removed within the atmosphere, mainly by absorption in the ozone layer and not reach the earth's surface in any quantity[5].

2. **Ultraviolet B** (UVB, 290-320nm) is the most damaging part of UVR that we encounter. UVB are wavelengths mostly blocked by dense clouds, closely woven clothing and glass window panes. Significant amounts are transmitted from blue sky in the middle of the day in summer. It is less dangerous when the sun is low in the sky, at high latitude in winter, and in early mornings and late evenings in summer[5].

3. **Ultraviolet A** (UVA, 320-400nm) is about 1000 times less damaging to the skin than UVB as measured by sunburn (Erythema) or damage to cell DNA. On the other hand, 20 times more UVA than UVB reaches the earth in the middle of a summer's day. It is not greatly affected by absorption and scattering in the atmosphere when the sun is low in the sky, and is now known to contribute significantly to the total exposure at moderate levels throughout the whole day and year. UVA penetrates deeper into the skin and leads to deeper damage than UVB does. It penetrates cloud cover, light clothing and untinted glass relatively easily, and may induce a degree of continuing skin damage over long periods, even when UVR exposure is not obvious[5].

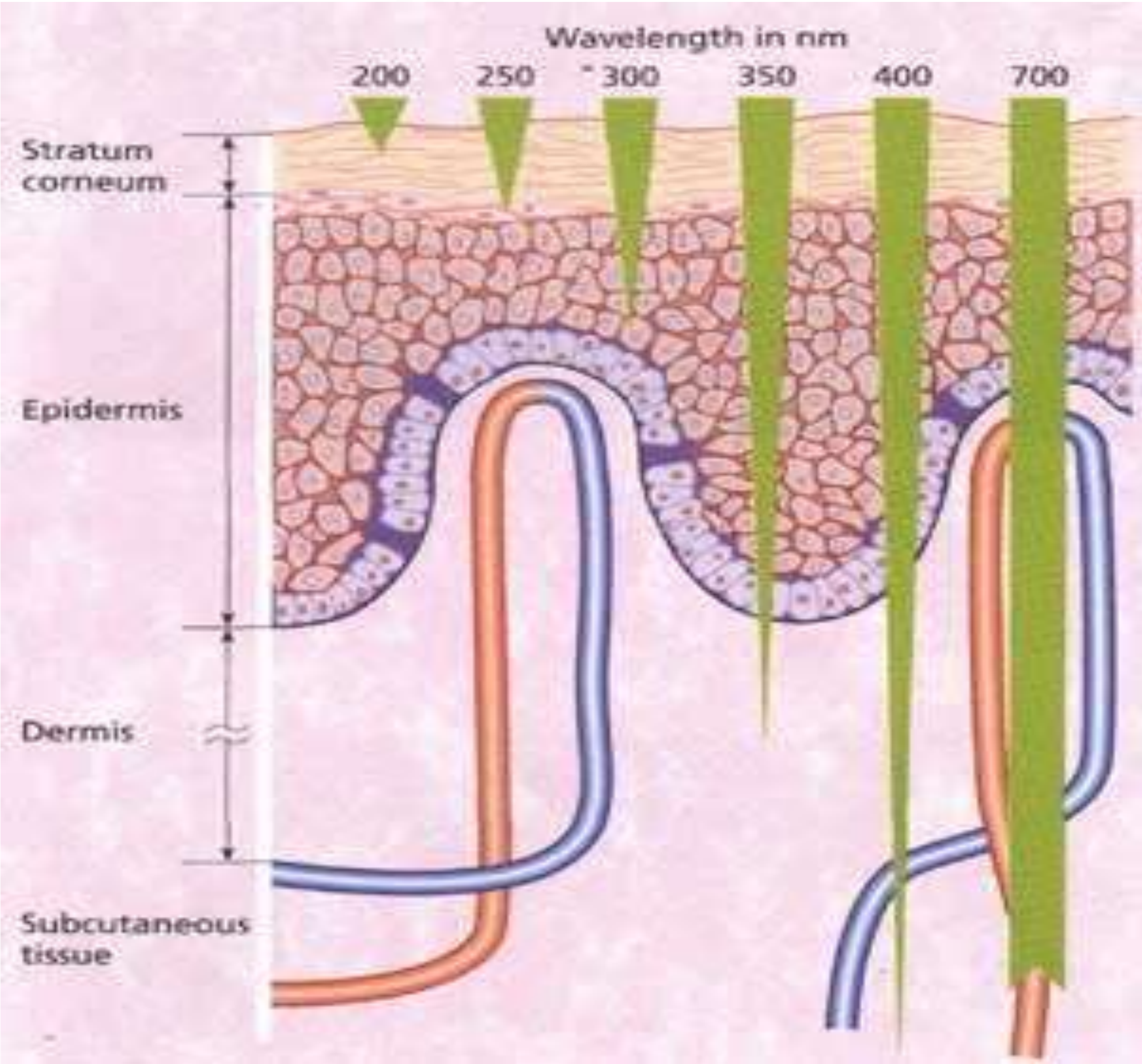

FIGURE.4 ENERGY ABSORBED AT A DEPTH BETWEEN 0.20 TO 0.22 MM

f. OLED display

These displays are small, only about 1 diagonal, but very readable due to the high contrast of an OLED display. This screen is made of 128x32 individual white OLED pixels and because the display makes its own light, no backlight is required.

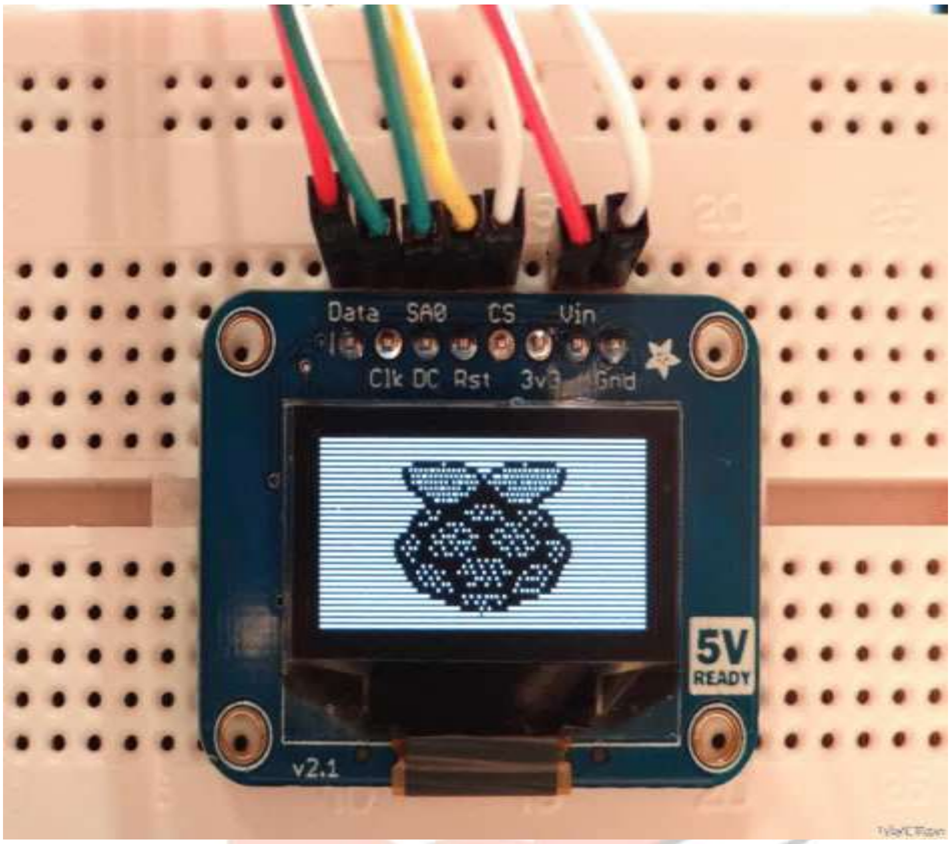

FIGURE.5 OLED FOR RASPBERRY PI

This reduces the power required to run the OLED and is why the display has such high contrast. The OLED uses only the I2C pins so you have plenty of GPIO connections available for buttons, LEDs, sensors, etc. It's also nice and compact so it will fit into any case.

III. CONCLUSION

In this paper, we proposed a procedure which could validly measure UV radiation at a specific location by using UV sensors. The procedure directly utilized readings from sensors for real-time computation, meaning that it can be used on almost all the smart devices on the market. In addition, we introduced how to take advantage of Raspberry Pi 0 to improve the result accuracy in real time. Furthermore, the developed UV meter app was light-weight, fast and effective. Overall, results from rigorous experiments showed that the proposed procedure could achieve an average of 95% accuracy of a typical professional digital UV meter and far better accuracy than using the emerging UV sensors equipped on smart watches.

It is important to mention that this paper has some limitations. First, this paper just utilized the general percentage of UV radiation versus total solar radiation. Since the percentages are slightly different for different locations on earth, different seasons and different times throughout the day, future studies can focus on how to utilize the history of UV levels to generate a specific percentage for a location at the different time of a day and a year. Second, this paper showed that the brightness of the scene has a strong impact on the accuracy. We will conduct more experiments to learn the relations between the brightness and the calculated results. Third, more experiments need to be done in multiple areas, such as on beaches, in the mountains, and at riverbanks, in order to get more convincing results.

IV. AUTHORS AND AFFILIATION

Sl.No.	Author Name	Advantages	Disadvantage
1	M. Watson, D. M. Holman, and M. Maguire-Eisen	Effective disinfectant No residual toxicity	Energy intensive
2	A. R. Young, J. Claveau, and A. B. Rossi,	More effective than chlorine in inactivating most viruses, spores cysts	Hydraulic design of UV system is critical
3	T. Fahrni, M. Kuhn, P. Sommer, R. Wattenhofer, and S. Welten,	No formation od DBPs at treated effluent	Low pressure low intensity lamps required acid wasting to remove scales
4	K. Dunstone and L. Wakely	Requires less space than chlorine distinction	Less effective in inactivating some viruses spores cysts at low dosages

TABLE.2. COMPARISION

V. ACKNOWLEDGEMENT

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