System for Monitoring and Warning of the Ultraviolet Radiation Index: A Study Case in Ecuador Elementary Schools

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Abstract. Solar ultraviolet (UV) radiation has increased in recent years due to ozone layer depletion and in Ecuador in particular, due to its geographical position and the height of its cities. Prolonged sun exposures in childhood increase the risk of causing malignant effects on the skin and eyes, such as squamous cell carcinoma, melanoma and cataracts. For this reason, this document describes the design of a device based on UV optical sensors that allows determining the existing radiation index. As a processing unit there is the Raspberry Pi 3B+ embedded board and to display the data physically there are LED panels. The storage of information is done through a database managed by MySQL and also implemented on the board. The levels of the ultraviolet radiation index (UVI) are presented through a graphical user interface (GUI) in real time, which also allows generating a report in a .csv file. Functional tests were carried out in the central courtyard of two educational units, to raise awareness among parents and authorities on the adoption of preventive measures that avoid possible damage to the skin of children when carrying out outdoor activities.

Keywords: Web monitoring · Elementary schools · Skin cancer prevention · UV index · UV optical sensor

1 First Section

Ultraviolet radiation or UV radiation is part of the electromagnetic spectrum, its wavelength is between 100 and 400 nanometers (nm) and is invisible to the human eye as it is above the visible spectrum [1, 2]. It can be of natural (solar) or artificial origin, but in this investigation only the first one is evaluated, since it cannot be controlled by living organisms exposed to it. This radiation is an integral part of solar rays and causes

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various health effects as it is a radiation between ionizing and non-ionizing [3, 4]. The World Health Organization (WHO) mentions and warns about the possible effects of this radiation on human health, both due to insufficient exposure (at high latitudes during winter), and excessive exposure (during summer, especially at low latitudes) [5]. The risks of insufficient exposure include a higher incidence of certain bone diseases and perhaps some autoimmune diseases such as multiple sclerosis. On the other hand, exposure to sunlight in small doses, has a beneficial effect for a person, since it allows the synthesis of vitamin D and improves mood [6]. Increasing the doses also makes it dangerous, since they cause short-term effects such as sunburn (erythema), pigmentary diseases such as spots, melasma (pregnancy cloth) or vitiligo [7]. Other dermatological problems can appear such as photoimmunosuppression (cold sores), photodermatitis (benign solar flares), as well as other stranger types such as lupus, light urticaria or developing photosensitivity [8].

According to information of The Skin Cancer Foundation[1], one in three cancers that are diagnosed is skin; establishing more than 13 million cases of skin cancer annually and more than 65,000 people die each year from this disease. In Latin America the reliability of the measurement of solar irradiation is questionable, since it cannot be compared with those of neighboring countries, since they do not handle international measurement standards [9]. In some countries such as Mexico and Uruguay, according to the American Cancer Association, approximately 3 million non-melanoma skin cancers are diagnosed each year and 90% of these are associated with ultraviolet radiation [10]. At higher altitudes, there is less atmosphere and, therefore, less ozone that protects living beings from these rays. According to WHO1, for every 1000 m of altitude increase, there are 10% to 12% more UV rays and that is why, the geographical location of Ecuador is the factor that determines the high solar radiation it receives in summer. Being close to the equinoctial line, the rays fall perpendicularly and therefore the radiation is greater, as explained by the National Institute of Meteorology and Hydrology (INAMHI). The cities with the highest altitude (located in the Ecuadorian highlands) such as Quito (2,850 m), Ambato (2,550 m) and Cuenca (2,350) exceed 13 points of UVI, according to data recorded in recent years.

Variations in environmental conditions can cause serious health problems for people. That is why in [11] is presented a device that incorporates a portable network of sensors intended to monitor environmental conditions (CO2, humidity, pressure and temperature) wirelessly (IoT). By means of a sensor node called WE-Safe, data is captured in real time and transmitted to a remote cloud server. Data can be displayed to users through a web-based application located on the cloud server. In particular, to determine the effects of UV radiation on the planet and its inhabitants, prototype non-scientific instruments are available on the market that measure different exposure parameters as presented in [12]. This study explores the ways in which UV radiation sensors can provide information about high sun exposure in playgrounds, tourist attractions, workplaces, and swimming pools. However, the risk of using personal meters that have not been validated as public health tools is specified. Another important study is described in [13], a comprehensive review of the use of smartphones

[1] https://cancerdepiel.org/quienes-somos/lider-en-la-Lucha-contra-el-cancer-de-piel.

in monitoring and predicting UV radiation. The practical aspects, limitations and general challenges are reviewed, specifically in relation to public education and its impact in geographical and social areas with low socioeconomic resources. Overall, the review shows that smartphones offer multiple opportunities in different ways to educate users about personal health regarding UV radiation.

Remote monitoring can be applied in various fields of science, obtaining exponential development thanks to continuous advances in computing and connectivity [14–19]. Semlali et al. [20] describes the development of a software that collects, processes, and displays environmental and pollution data. These data are used to build an environmental map and can be viewed from any location. Similarly in [21] is presented an independent system that allows you to store data on the climatic parameters of a city using IoT. This proposal allows access to information in real time, which can be viewed from a smartphone, PC or Tablet.

It is evident that performing remote monitoring tasks has contributed to improving human living conditions, as shown in the presented literature. By focusing these studies on skin care, you can prevent medium and extremely dangerous diseases [22]. In this context, it is proposed to implement a monitoring and alert system for the ultraviolet radiation index (UVI) inside two primary education units. This in order to support parents, teachers and school officials in taking protective measures for students from direct exposure to the sun, when performing outdoor school and entertainment activities. Schools are an essential means of getting the message across to young people. Teachers and the associations representing them should be encouraged to champion the cause and include UV radiation awareness and protection projects in the education system. This initiative seeks to demonstrate the risk that children suffer and to change people's thinking, attitudes and behavior regarding sun exposure from an early age and to prevent skin cancer in the future.

This work is made up of six sections: the introduction to the subject in Sect. 1 and the case study in Sect. 2. Section 3 shows the distribution of the hardware elements of the system and Sect. 4 respective software development. Analysis of results and conclusions are described in Sect. 5 and Sect. 6 respectively.

2 Study Case

In general, excessive exposure to the sun can cause damage to people's health, depending on the intensity and concentration. The majority of the inhabitants of the populations of the Ecuadorian highlands located over 2000 m are unaware that UV radiation is higher than in cities that are at sea level, despite being in the same country and having a reduced territorial extension[2]. It is important to consider that these quantities are much more sensitive to the state of the atmosphere and depend on multiple factors such as: clouds, aerosols, soil reflectivity (albedo), height of the place, thickness of the ozone layer, etc., making the study much more complex. These radiations have enough energy to produce damages in biological systems. Under

[2] https://twitter.com/inamhi/status/1032832578854764544/photo/1.

normal conditions, radiation with wavelengths shorter than 290 nm does not reach the Earth's surface. That is why, each species of living being, including different individuals of the same species, have a different response to solar radiation.

This research was carried out in the metropolitan district of Quito, the capital of Ecuador and better known as the half of the world, since it crosses the equator, which precisely gave its name to this nation and receives the sun's rays from perpendicular shape. In addition, tests have been carried out in the city of Ambato, given its geographical position and altitude similar to the first case. A prospective study was carried out on patients attending the consultation at the Society for the Fight Against Cancer of Ecuador (SOLCA), their cases and the type of skin cancer they had in the period 2017–2019 were analyzed, and thus was able to determine the incidence of skin cancer by city. According to the statistical data provided by SOLCA and the Ecuadorian Social Security Institute (IESS), the city of Ambato has the highest incidence of skin cancer in the country and then there is the city of Quito. Skin cancer or melanoma includes basal cell carcinoma and squamous cell carcinoma; they are the most common diseases in these cities. Risk factors include exposure to ultraviolet rays, having light hair and eyes, European descent, and living in tropical areas. The main factor has been identified as direct excessive exposure to sunlight without any protection.

3 Hardware

This proposal is based on the general scheme described in Fig. 1, where the services presented to the user can be seen. Regarding the prototype that is physically implemented, this section establishes the hardware components that are used to graphically display a numerical value that symbolizes the level of UV radiation available in that given time and space. Next, the parts that make up this system is explained.

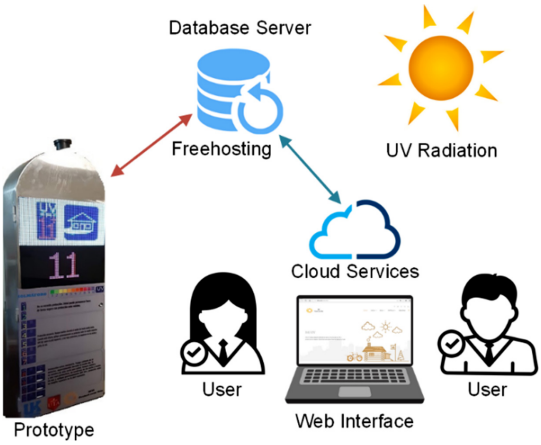

Fig. 1. General outline of the proposal presented.

3.1 Data Acquisition

Data acquisition is done using the Si1145 sensor, which has a calibrated light detection algorithm that can calculate UVI and is designed to operate directly with low-cost embedded boards such as Arduino or Raspberry Pi. This device is widely available in the market and has greater sensitivity, since it has a true ultraviolet radiation reader, at a reduced cost. Through the I2C protocol, this data is transferred to Raspberry Pi, using the 3.3 V, GND, SDA and SCL pins.

3.2 Information Processing

Its main component is the Raspberry Pi 3 model B + board, an integrated board with support for various peripherals of a common computer and that works with the Linux operating system (O.S.). It has GPIO (general purpose input/output) pins that can be used as digital inputs or digital outputs and different communication buses such as SPI and I2C. A micro SD card is incorporated to install the O.S. respective and for the storage of data from the previous stage. With this information, the conversion of bits to hexadecimal values is carried out and then to decimal numbers and other additional calculations.

3.3 Data Visualization

It is carried out in two ways: on a personal computer through a web application, which will be explained in more detail later and on the two prototypes physically implemented in the educational units. For the second case, a 64 × 32-pixel tricolor LED matrix screen 4 mm apart is used, where each pixel consists of a red and green LED (commonly called "1R1G"); For the dimensions, standards and budget were considered. In total there are 2,048 pixels and 4,096 individually directional LED elements, including shift register circuits, so all elements can be controlled with just 11 I/O lines from the controller.

3.4 Physic Structure

The structure was built using stainless steel, to protect the electrical and electronic devices that are part of the prototype, by making permanent measurements outdoors and supporting the different climatic environments that may arise. During the design, it was determined that the structure must allow the UVI sensor to protrude so that it captures the irradiation of the day and does not cover itself with any object. It should also be considered that the led panels have a significant height with respect to the ground, for better viewing and that a front door is incorporated to facilitate access to the devices in the event of a modification or failure. In addition, the protection measures that the user must have are visually incorporated, depending on the degree of exposure they are experiencing at that time.

4 Software

4.1 Initial Settings

The Raspbian OS is installed on the Raspberry Pi board, downloaded from the official website, whose image was saved on a 32 Gb micro SD memory card (recommended to be class 10). The Lite version of Raspbian (the "GUI"), is a "complete" version, which has resources that allow you to regulate the use of the Raspberry module for compiling the graphics part, preventing board overheating. In addition, it supports the configuration of the Wi-Fi connection, without having to connect to Ethernet first. The micro SD card is inserted into a PC, in order to access the directory: cd/Volumes/boot and there a file called wpa_supplicant.conf is created, where the necessary configurations are made. With this file in the directory, when the system starts, Raspbian will move it to:/etc./wpa_supplicant/. On the SD card to connect via SSH, you need to create an empty file called SSH to enable it. If this file exists, SSH will be enabled when the Raspberry Pi is started and with it you can enter the raspberry module remotely, without the need for a screen, keyboard or other peripherals. The wpa_supplicant.conf file automatically disappears from the micro SD boot directory, when Raspbian Lite first starts.

Once the card is switched on and connected to the network, the default username and password are set and the Matrix LED Adafruit software is downloaded from its official page. When installing and running it for the first time, you must choose the type of adapter used which is RGB Matrix HAT with RTC. Additionally, the drivers for the real-time clock must be installed and the image quality improvement of the LED matrix is managed. Please note that these settings could cause occasional flickering of the array and to correct this these plugins should be reinstalled or the image quality of the array slightly reduced.

4.2 Data Acquisition

Python is used as the programming language, whose scripts are simpler than C++, but can cause delays in animations if many pixel variations are required. On a Raspberry Pi you get a refresh rate of about 400 fps (85 fps for 5 strings) with a program developed in Python, while with C++ you can do the same with 3500 fps (700 fps for 5). In this project the SetPixel() function was used to incorporate static images without animation; SetImage() for animations; CreateFrameCanvas() to fill full off-screen boxes and SwapOnVSync() to make swaps. In addition, RGBMatrix for the management of led panels and for their use root privileges are required, therefore, all scripts are run as sudo.

To read the data from the Si1145 sensor, the I2C standard is enabled on the embedded board through the raspi-config interface, installing i2c support for the ARM kernel and for the Linux kernel. When checking the connected devices, it can be seen that two I2C addresses are in use: 0×40 and 0×70 by the Si1145 and Adafruit Matrix Hat. These values will be different depending on the modules that are connected to the Raspberry Pi I2C pins. As a last step, the complementary drivers of both devices are installed and the operation of the system is verified by running a preloaded

example. The script allows converting the hexadecimal values of the transducer and taking the values of infrared proximity, UVI and ambient light, which allows the data to be accurate and for this purpose. This code must be saved in/home/intiuv.py.

4.3 Web Services

It allows the user to access IIS (Internet Information Services) through a website, it provides information about the radiation that is available in real time and the precautions that must be taken before going outside. It has a portal for the administrators of the measurement units, which consists of a presentation layer, which is responsible for interacting with the client or the end user, i.e., the interface in which all the display options are presented. This layer communicates with the productive or intermediate layer, responsible for implementing all the visual rules and dictating the application administration rules. It will also maintain a dialogue with the data layer, which will handle the switching of data to the engine and provide the response information to the presentation layer. This interface is easy to use and intuitive and allows the presentation of data and reports to the user. The architecture used is shown in Fig. 2.

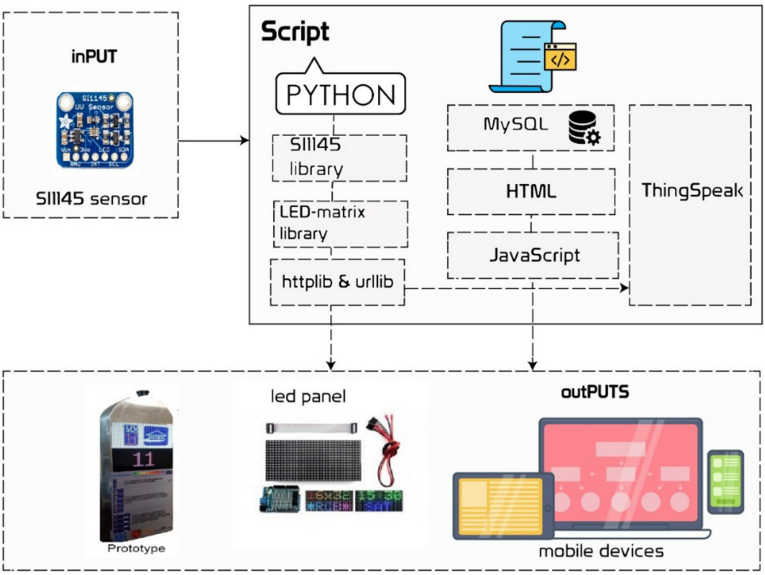

Fig. 2. Architecture used for online coordinates, storage and visualization of routes in real time.

For the development of the architecture the interactive web technique Ajax (Asinchrous JavaScript and Xml) is used, this application is executed in the client, which can be any web browser such as Chrome, Explorer, etc. In parallel, an asynchronous communication with the server is executed in the background through

ThingSpeak (IoT), which allows to collect and store data from the sensors in the cloud and update them when necessary, thus improving the speed of execution.

It is a publish-subscribe architecture developed primarily to connect bandwidth-restricted and power-restricted devices over wireless networks. MQTT is a simple and lightweight protocol that runs on TCP/IP, WebSocket's, and SSL (Secure Socket Layer) sockets and has two components: agent and MQTT client. The first is a central point of communication; the broker is responsible for sending all messages between clients. While the second is any device (for example, a computer or a mobile phone) that connects to the corridor; a client who sends messages is a publisher and if he receives them, he is a subscriber. To receive a message, the customer must subscribe to the subject of that message. You can post and subscribe to MQTT messages using MQTT Publish and MQTT Subscribe blocks. These blocks support MQTT only through TCP/IP sockets. Algorithm 1 presents the connection between Python and ThinkSpeak.

Algorithm 1. connection between Python and ThinkSpeak

```
#!/usr/bin/python
import sys
import RPi.GPIO as GPIO
from time import sleep
import urllib2
import SI1145.SI1145 as SI1145
sensor = SI1145.SI1145()
baseURL= 'https://api.thingspeak.com/update?api_key=QO610ENLQWTUT3ES&field1=0'
uvIndex = 0
vis = 0
while( uvIndex < 1000):
    vis = sensor.readVisible()
      IR = sensor.readIR()
      UV = sensor.readUV()
      uvIndex = UV / 100.0
      print uvIndex
    f = urllib2.urlopen(baseURL +  "&field1=%s&field2=%s" % (uvIndex, vis))
    f.read()
    f.close()
      print vis
      sleep(60)
print "Program has ended"
```

4.4 Data Storage and Visualization

The storage of the information is done through a database managed by MySQL, for its later presentation through the free software Grafana. MySQL is one of the most notorious relational database methods worldwide, it is a frequent inclusion in most LAMP stacks (Linux, Apache, MYSQL and PHP) and for PHP to access the database they must be installed mysql libraries. When connecting to the database, user and

password are specified and when requested they must be modified for security. Default access to the MySQL server is through the primary IP address, which is disabled in the initial configuration. So, you must configure the local connection using commands or the internal socket connection. To grant access to a remote connection, a new user must be created to avoid using root and then set permissions for access from a fixed IP address.

To copy information from the database to/from a remote server, there are several methods, but being a low budget proposal, we worked with a method without cost, but which guarantees the quality of the data in a safe way. The command -ssl with mysqldump enables the connection through SSL, for domains without certificate configuration, so this option is only good if you have an SSL that is available. The database model used is ORM, the models.py file found in the respective folder is edited and the same is done with intibase.py. A file called intiuvser.py is created that allows data to be sent to the remote database.

Depending on the UVI variation that the sensors have captured throughout the day, week or month, this statistical information is expressed in a dynamic and user-friendly interface. This stage is made up of a server that, through Grafana (Apache, MySQL and PHP), provides web services that manage the database. The goal is to have real-time monitoring with access to history from anywhere with internet access. Figure 3 the historical ones presented.

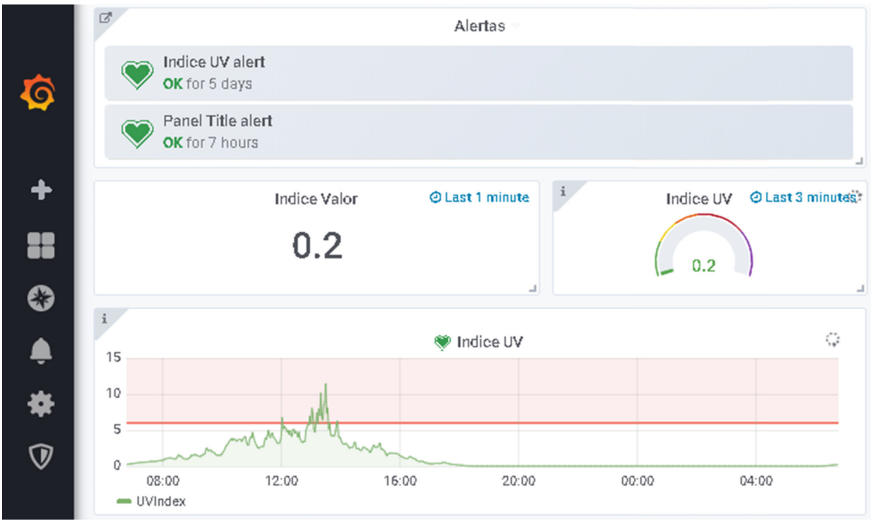

Fig. 3. Main board of the Grafana software presented to the user.

5 Tests and Experimental Results

Once the different elements of the UV measurement system were installed, the relevant tests were carried out to certify the validity of the system. On-site data acquisition is executed and sent to the central station, for further processing, storage, sending to the server and backup.

5.1 UV Sensor Validation

To validate the linearity of the Si1145 sensor, its configuration, working modes and tests were carried out under normal conditions based on its datasheet; electrical data assumes ambient light levels <1 klx (1000 lx). The sensor already integrated into the prototype measures the spectral and total intensity of UV radiation, in the range from 290 nm to 330 nm (includes UV-A and UV-B), with intervals of 0.4 nm. In addition, determine the total ozone column by examining the absorption of solar radiation at certain UV wavelengths. Based on all these parameters, the UVI is calculated. It should be considered that the proximity detection performance can be degraded, especially when there is high optical crosstalk, such as undesirable signals or adverse atmospheric conditions. This also produces variations in the power supply for the LED panels and for the controller, causing their saturation and the values to appear out of range, due to the fact that the sensor is optical and very sensitive to mishandling. As a reference, 32 klx are captured from sunlight on an average day at least and 100 klx at most, which has been proven to work properly to be used in subsequent tests.

5.2 Comparison with a Commercial Device

On August 12, 2019 (summer time) a period of quality control tests began, for which the operation of the prototype located in the city of Ambato was compared with a commercial device owned by the municipality. The procedure consisted of recording the level of UVI that these two instruments presented between 7:00 and 17:00 (- GTM 5) when exposed to UV-B radiation. Both were placed at a certain distance from each other relatively closely, with the intention of subjecting them to similar climatic conditions. For comparison, 4 samples were taken every 60 min for 3 weeks and the data obtained is described in Table 1. In Fig. 4 and Fig. 5, the daily and monthly results, respectively, are delivered to the user through the Web application.

The results of this comparison must have a discrepancy of less than 5%, to be considered a valid prototype according to local regulations established by the Ecuadorian Standardization Service (INEN). According to the information obtained, the comparison between the implemented prototype and the commercial device establishes an error margin that ranges between 5% and 1%, with an average error value of 2,28%, which is within the established range. The analysis is carried out in the Origin Lab software, which is in charge of regularizing the data and thus checking whether it is correct. Based on this, it can be indicated that the measuring device has a high fidelity, since the values are similar to those issued by a certified scientific team.

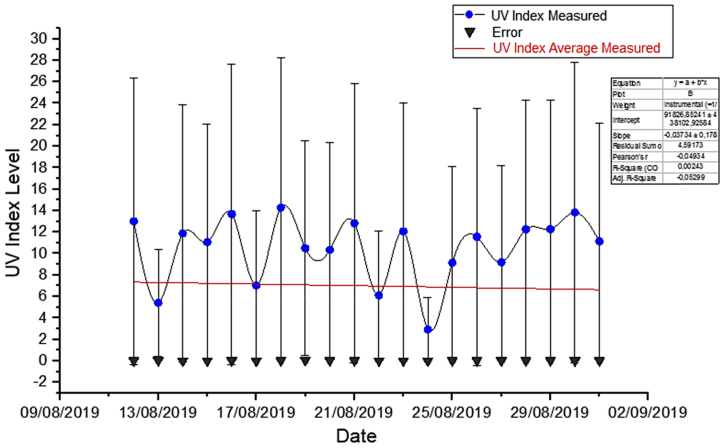

Fig. 4. Data measured with the prototype during August 2019 in Ambato.

Table 1. Data obtained when using the implemented device vs. a commercial nature device.

Date	UV Index Average	Commercial device - Ambato Municipality	Error	Error (%)
12/08/2019	13,33	13,00	0,33	2,54%
13/08/2019	5,41	5,00	0,41	8,20%
14/08/2019	11,87	12,00	0,13	1,08%
15/08/2019	11,06	11,00	0,06	0,55%
16/08/2019	13,68	14,00	0,32	2,29%
17/08/2019	7,03	7,00	0,03	0,43%
18/08/2019	14,27	14,00	0,27	1,93%
19/08/2019	10,50	10,00	0,5	5,00%
20/08/2019	10,34	10,00	0,34	3,40%
21/08/2019	12,81	13,00	0,19	1,46%
22/08/2019	6,10	6,00	0,1	1,67%
23/08/2019	12,06	12,00	0,06	0,50%
24/08/2019	2,93	3,00	0,07	2,33%
25/08/2019	9,15	9,00	0,15	1,67%
26/08/2019	11,57	12,00	0,43	3,58%
27/08/2019	9,18	9,00	0,18	2,00%
28/08/2019	12,26	12,00	0,26	2,17%
29/08/2019	12,28	12,00	0,28	2,33%
30/08/2019	13,83	14,00	0,17	1,21%
31/08/2019	11,14	11,00	0,14	1,27%
Average	**10,54**	**10,45**	**0,22**	**2,28%**

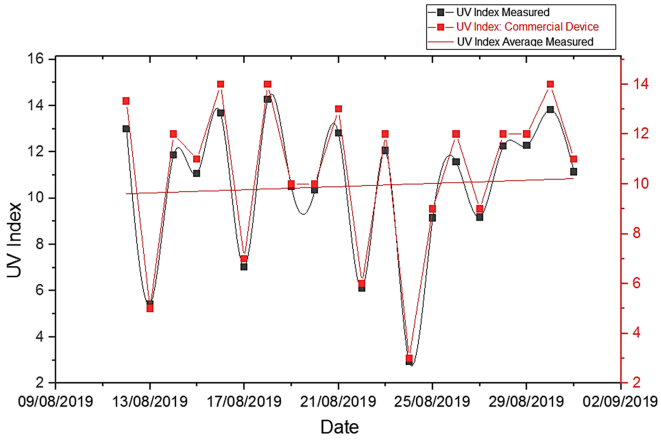

Fig. 5. Comparison of the data measured with the prototype and with a commercial device during August 2019 in Ambato city.

5.3 Comparison Between Cities

For the development of these tests, the prototypes have been located inside two state schools of primary education, in the cities of Quito and Ambato. Taking into account that environmental factors vary according to geographic position, a comparison has been made between these two populations to determine the level of UVI to which students are exposed during the month of August. Among the main atmospheric conditions to take into account is the time, height, climate and altitude. Table 2 shows the data obtained and Fig. 6 and Fig. 7 show the information collected graphically. Data for February (winter) have also been obtained and are being processed, but could not be included in this version of the blind peer review.

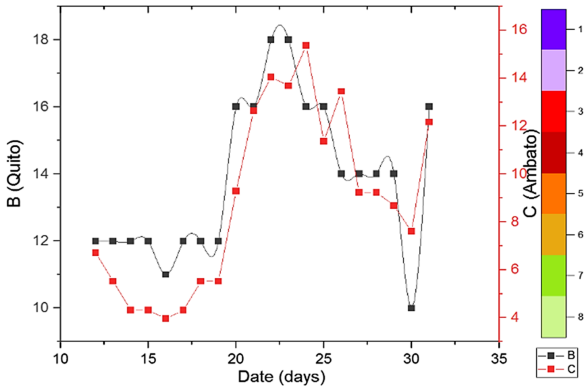

Fig. 6. Comparison of the data measured with the prototype in two educational units in Quito and Ambato respectively.

Table 2. Definition of parameters for tests.

Date	UVI - Quito	UVI - Ambato	Date	UVI - Quito	UVI - Ambato
12/08/2019	12,1	6,8	22/08/2019	17,9	14
13/08/2019	12,2	5,6	23/08/2019	18,2	13,8
14/08/2019	12,3	4,4	24/08/2019	15,9	15,3
15/08/2019	12,1	4,4	25/08/2019	16,1	11,4
16/08/2019	11,3	4,1	26/08/2019	13,1	12,6
17/08/2019	11,9	4,3	27/08/2019	13,2	8,7
18/08/2019	11,92	5,5	28/08/2019	14,3	9,4
19/08/2019	12,3	5,7	29/08/2019	14,1	8,7
20/08/2019	15,9	9,2	30/08/2019	10,1	7,7
21/08/2019	16,2	12,8	31/08/2019	15,7	11,9
…	…	…	Average	13,84	8,82

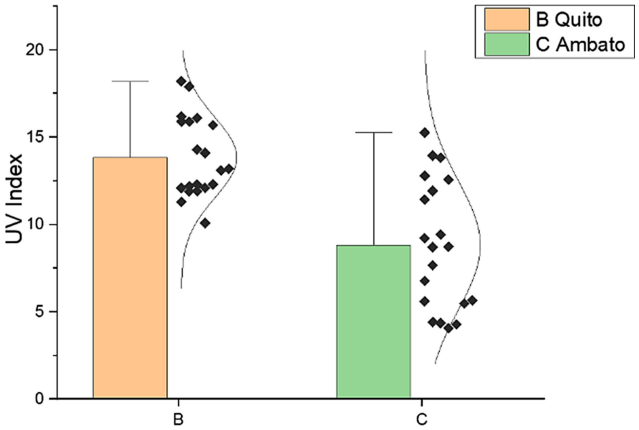

Fig. 7. Level of incidence of UVI in Quito and Ambato cities during August 2019.

In the month of August, the average level of the UVI for the city of Ambato during the test period was 23% lower compared to that of Quito. Comparable days are also analyzed, i.e. days totally clear in both places and the projection increases to a 53% difference. This shows that the Ecuadorian capital has higher levels of radiation and during longer intervals of time. The values obtained are explained by the existing altitude difference, since Ambato is 350 m below its torque. In addition, there is an attenuation coefficient due to the greater presence of suspended clouds in this area. These elements act as filters in the atmosphere and can scatter radiation. An-other important factor for which the project measurements may have a margin of error is related to the optics of the instrument. The neutral density filter does not have the same

absorption for all wavelengths, as it happens in the optical fiber and the spectrometer, if there is any particle that prevents light from passing, it is scattered.

The UVI scale is endorsed by organizations such as the World Health Organization, the World Meteorological Organization, the UN Environment Program and the International Commission against Radiation. Thanks to it, the calculation methods of the index have been standardized, providing a color code and graphics to offer the information in a simple and practical way to the population about the care that must be taken. According to the data obtained on average, the level of UVI in the city of Quito is approximately 14 and that of Ambato is between 10 and 11, on a scale that goes up to 15 (but that could take even higher values). Considering that from number 11 it is considered that ultraviolet radiation is extremely high, residents should be made aware of the high potential for damage to the skin and eyes to which they are exposed. As suggested protection measures, a very high index (8, 9 and 10) is used: a hat or a cap, sunscreen with a high filter, sunglasses, care for children and an exposure of 11 to 34 min. maximum. For an extreme level it is recommended to avoid leaving the house, especially in the midday hours and in exceptional cases an exposure of 8 to 23 min maximum depending on skin tone.

6 Conclusions

The implementation of commercial devices that allow the ultraviolet radiation index to be measured has increased in large cities, given the increasing number of cases of people with skin cancer. Through wireless devices operating in the 2.4 GHz band, with hardware and free software platforms, a system was developed to collect data on solar radiation individually in two primary schools located in different cities. The prototypes have been designed with technologies and equipment that allow web development for multiplatform, the use of embedded systems reduces implementation costs, as well as the use of a host that is tailored to the needs. In this way a robust device can be presented to the general public that, using colored LED panels, expresses the appearance of a traffic light. Following the WHO recommendations, the display of information should use five colors (green, yellow, orange, red and violet) to denote the low, medium, high, very high or extreme degree of radiation. This device also shows informatively the minimum prevention measures that must be followed to protect yourself when you are in environments without a cover. When comparing this proposal with a commercial device, there was an uncertainty of less than 3%, demonstrating its validity as a detection tool for the level of UVI.

As a case study, two of the highest altitude cities in Ecuador have been chosen which, due to their geographical position, have the highest levels of radiation, which has been verified when using this system. The objective of this research has been to be able to provide primary education schools with a tool, since students can be exposed to high levels of radiation without knowing this reality. In the same way it happens with teachers and parents who do not provide the necessary protective equipment, since they are unaware of the subject. In Ecuador, in coordination with public health, the Department of the Environment and the municipalities, events are held that promote the development of a better culture of prevention in terms of prolonged exposure to

sunlight. Part of their job is to manage a monitoring and alert network, which includes air quality, noise level reports, ultraviolet radiation, among others. Constituting an integral system that allows improving the quality of life of citizens and providing them with the necessary information channels.

The authors of this document have planned their implementation in parks and schools, where children and adults share moments of recreation without having knowledge of the latent danger. It is also planted to patent this proposal and through the support of private companies to obtain financial sustainability and be able to reach communities and villages with low economic resources that cannot invest in a commercial technological solution.

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