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Low-cost disinfection device with ultraviolet light

Cleaning surfaces and disinfecting is a task that we should do quite often and specially in places as hospitals and laboratories. For doing that, we must use different products that according to Markkanen et al. (2009) are often a mixture of many chemical ingredients, but the cleaning products are designed to remove surface contaminants and the disinfecting products, are meant to destroy microorganisms.

In this context, "the use of UV-C is a chemical free and low-cost procedure, which represents a green alternative method for disinfection" (Bentancor & Vidal, 2018) and that is why they develop a programmable device that uses UV-C "in order to eliminate and prevent biological contaminants" (Bentancor & Vidal, 2018). This type of light, "represents the most lethal wavelength for a wide spectrum of microorganisms" (Bentancor & Vidal, 2018) and according to Bentancor & Vidal (2018) that is why it disinfects, because it causes DNA damage, meaning it alters DNA structure thus interfering with DNA replication.

Care must be taken when you use this kind of light, because "…the excess UV-C energy applied to surfaces … can prematurely damage the surface, shortening the useful life of the asset" (Teska, 2020).

For making this device, Bentancor & Vidal (2018) detailed the list of materials, were to find them, the cost of each material and their metrics (if needed) they used to build the device. In this case I will details the main materials of the device and they respective aim.

First, we have the Arduino UNO board and the Bluetooth module HC06 that with other parts is used for program this device and used and control it remotely. Then we have the wheels, one wooden base that are used to transport it without carrying it. Also, we have the UV-C lamps with holders and the holders, that is the principal material of the device, and we already explained their use. For last, we have the PIR sensor, that detects when a human is present and shut down the device if someone come in, because UV light is dangerous for the human being.

The total cost is USD 176.40 and is good to know that USD 100 is because they used four UV-C lamps and each cost USD 20, and each lamp holder cost USD 5, so for example, if you want to use less lamps is cheaper. If important to distinguish that their total cost turns their devise "… in a very competitive device because it represents a more than 80% save compared with proprietary commercial devices with similar functions…" (Bentancor & Vidal, 2018).

Once you have all the materials, this paper detailed step by step how to assemble the device. They even attached some files for each main part of the design, which are the mobile base and structure and the control unit. Following this, they detail some operation instructions for explain how to make the device work and in the appendix, they put a code for Arduino board with comments in each line explaining what does. Bentancor & Vidal also attached a video, showing how the final device look like and works.

Of course, the main objective of the devise is disinfection, so to prove that it accomplishes the main objective they validate this device by putting *Escherichia coli* in petri dishes. After applying the light, all the bacteria in the cultures, according to Bentancor &

Vidal (2018), were gone. Also, they put the same thing once again but with the half of the petri covered by aluminum, after incubating overnight at 37º, Bentancor & Vidal (2018) discovered that the bacteria only grown in the non-exposed side of the plate. Finally, they measure the efficiency of the light a different distances and times of exposure. In the first case, they put different plates at one and two meters of distance of the light, when the time passed, Bentancor & Vidal (2018) concluded in both cases they device works. In the second case, they put the plates in the area with the different timing, then they compared the different plates and Bentancor & Vidal (2018) concluded that fifteen minutes were enough time to disinfection for a one meter of distance.

Now, you can proceed to build this devise because this paper is under a Creative Commons license with an attribution 4.0 International, that allows to share and adapt this material for any purpose under the terms of attribution of an appropriate credit and indication of any changes that were made. Is also with Open access and statistically it has been shared, liked, commented and tweeted about.

As I said in the beginning, there are many cleaning and disinfecting products, and this is one of those products that are not chemical. An example of other disinfecting products are Disinfecting Wipes, Disinfecting Spray, but they are chemical products. There are many cleaning products that also could complement the disinfecting products, and a way to "… measure the efficiency of cleaning procedures also in environments with very low microbial counts" (Sanna et al., 2018), is the ATP-bioluminescence-assay. This can help "…to increase the awareness of operators and allows immediate action to be taken in critical situations" (Sanna et al., 2018), by providing rapid feedback in for example health facilities.

In conclusion, UV-C is a good way to disinfect areas if you used it with caution and without overusing it. This devise was published in 2018, so Bentancor & Vidal said that their devised could potentially be used in culture room disinfestation, material curing and lowering the microbial load in food supplies, but in that year COVID-19 wasn't a virus that caused a pandemic, so I can say that a potential application is to disinfect areas and, in that way, prevent the spread of COVID-19.

According to a paper publish in Nature, there was found a "… highly controlled experimental model that allowed us to identify the UV-C radiation dose sufficient to inactivate SARS-CoV-2" (Biasin et al., 2021). In that way, Biasin et al. (2021) said that it all depended on UV-C dose and the virus concentration, so for example in a low-level contaminated closed environment with COVID-19 infected patients, small dose of less than 4 mJ/cm2 was enough and even in the highest viral concentration, the viral replication inactivated with a dose of at least 16,9 mJ/cm2.

Following these results, they concluded that "…the SARS-CoV-2 is extremely sensitive to UV-C light, and they are important to allow the proper design and development of efficient UV based disinfection methods to contain SARS-CoV-2 infection" (Biasin et al., 2021), and for that reason we can say that devices like the one presented are very useful in this pandemic circumstances.

References:

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