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Ultraviolet Sterilization Chamber

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Abstract

We all are pretty aware of the incidence of Coronavirus Disease (COVID-19). This pandemic has struck many countries severely. The use of sanitizers, face masks and N95 respirators have become a crucial part of everybody's life. Many researchers and reports also claimed that this virus could get stuck on non-living object surfaces and stay there for up to 9 hours. In such an infectious pandemic, maintaining cleanliness and disinfecting each object in the surrounding can be a tedious task in social places like airports, bus stations, railway stations, malls and other places. Sanitizing every object can be a tough task. The authors here want to present an automated disinfection device based on Ultraviolet light that is U.V light technology, which shall ensure the full sanitization of non-living and inanimate things such as bags and luggage carried by travelers at public places with the help of this technology.

Keywords- *disinfection, respirators, tedious, pandemic, Ultraviolet light, inanimate*

I. INTRODUCTION

Many shreds of evidence proved that COVID-19 spreads between people directly, indirectly (through contaminated objects or surfaces). The market has got many preventive methods to avoid the direct spread of the coronavirus, but stopping the indirect spread of this virus through non-living objects is also a thing to be worried about. There are pretty good chances the virus can get stuck on the surface of an object. There, are thousands of people travelling around on globe. There can be a possibility that the traveller, travelling through any public transport gets his luggage infected with the coronavirus molecules. Sanitizing every small and big object with harmful chemicals cannot be the only solution to stop the spread of the virus. We need to have some simple and quick technique that can kill the germs and viruses if it gets stuck on the surfaces of non-living objects, there are many shreds of evidence that have proved that if the virus can get stuck on any surface can last up to 9 hours on it! So, for this thing we have come to a solution to stop this indirect spread, that is through the U.V light technology. It has been medically proved that the U.V light technology is capable enough to kill many kinds of germs, microorganism and even harmful viruses.

So, carrying the same idea, we came up with a solution that is an 'Ultraviolet Sterilization chamber'. This machine can sanitize the objects with help of the U.V light technology. There are thousands of people who travel from one place to another every day and use public transport for the same. One of the major problems the public services can face is the sanitization of the luggage and bags of the public.

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An ultraviolet sterilization chamber is a machine, which will take your luggage through a conveyor belt fitted on it, inside a chamber that is fitted with U.V lights. This chamber will put U.V light on the luggage from all side. Keeping the luggage under lights for at least 40-50 seconds can kill all the disinfectants present on it. Hence completely sanitizing the luggage and bags, and at another end of the conveyor belt, you will receive the sanitized luggage.

II. MOTIVATION BEHIND THIS PROJECT

A. Understanding Market Problem

1. Use of hazardous chemicals to disinfect non-living objects.
2. According to the World Health Organisation (WHO), the use of harmful chemicals every time on the surface of objects is not a good practice.
3. Unavailability of manpower at public places for sanitization work.
4. Thousands of people go to different places every day, to places like airports, there is no automated product for sanitizing luggage.
5. Social distancing is not kept in public places, a high overcrowding in the cleaning service is observed.
6. Lack of cleaning and disinfecting facilities.
7. Refilling of chemicals is needed in the existing sanitizing equipment.

B. Market Opportunity

1. The demand for disinfecting products has increased recently.
2. People are trying to find alternatives for toxic chemicals.
3. Because of the pandemic situation, various establishments are working on effective solutions to disinfect nonliving objects, this product could be one of the solutions.
4. There are few devices only in the market that use U.V technology for sanitation purposes, huge reach on the way to new products.

C. Target Market Description

1. People travelling from one place to another by public transportation, as people would carry their luggage with them which have to be sanitized.
2. Students from schools and colleges would also be our likely target, as students carry bags that should be sanitized.
3. People go to the workplace daily in industries and MNCs. As in these locations, various items are brought indoors by employees.

D. Unique Selling Proposition

1. This product shall save labour charges, sanitizing cost hence making it a cost-effective product.
2. This product shall save the time which was being utilized in sanitizing the objects manually.
3. U.V light technology is a safe technology it shall not affect the objects which would come underneath.
4. No separate infrastructure would be needed to keep this product, it might be adjusted with the existing ones

E. Target Customer Description

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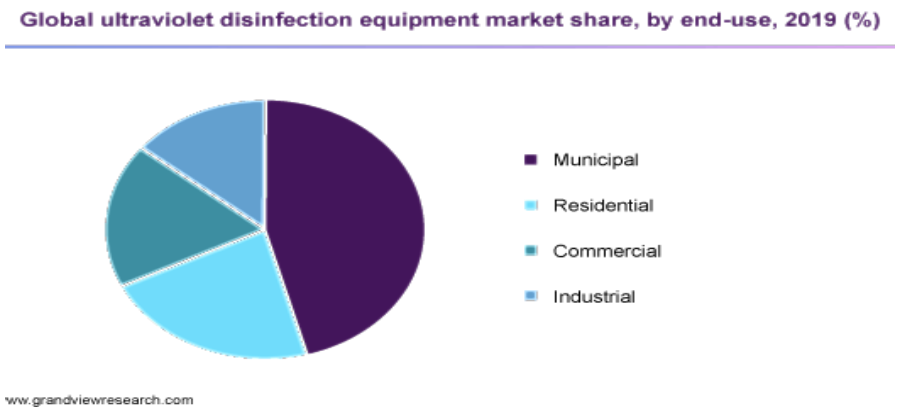

Fig. 1 Sectors using U.V light for sanitization [Reference-5]

From the above graph, we can state that there is a huge market for U.V light technology and our likely customers would be:

1. Authorities at public places like airports, railway stations, bus stations, etc.
2. Schools and Colleges management for whom this device might be useful.
3. Industries and MNC's where people come to work daily.

F. User Needs Analysis and Future Scope:

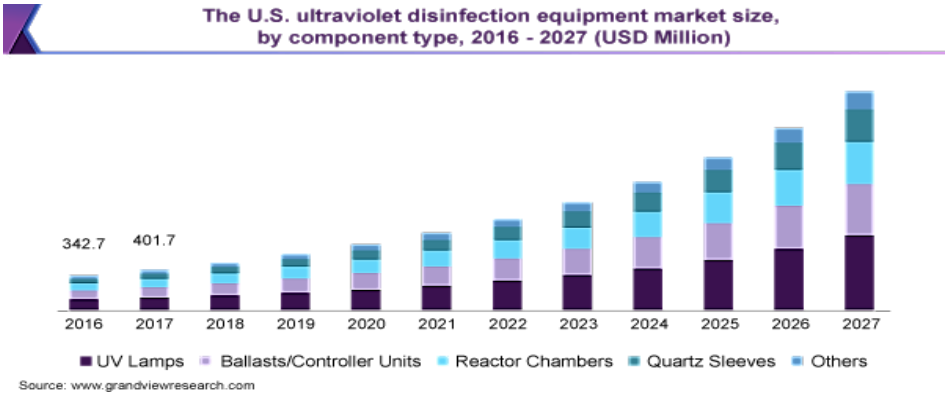

Fig. 2 Future analysis for U.V light growth [Reference-5]

1. With years passing by, the need for U.V disinfection equipment is going to increase and people want an easy and automated device that would effectively do the task of sanitizing.
2. As the unlocking process has already started and people are getting back to normal, travelling on the domestic and international level has increased.
3. Old sanitization practices are not efficient and safe.
4. Reduction in the cost of sanitization work is much needed.

III. EXISTING METHODOLOGY

In market there many options available when it comes to sanitization of non-living objects. Use of alcohol base spray sanitizers have drastically increased and the demand for it always remains high. Various machines and devices have also been introduced which automatically sprays the sanitizer on object with the purpose of sanitization. Like in many public places walkthrough sanitization gates have

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been installed. This walkthrough gate will automatically spray sanitizer whenever someone enters in its premise. There are many electric spray guns available, in which sanitizer is filled and sprayed on objects in order to disinfect it. These machines are mostly operated manually. But the drawback of these machines cannot be overlooked, use of hazardous chemicals every time is not a good practice. Most of these spray machines are operated manually hence increasing the man work and cost. Chemical sprays need to be refilled after their use.

There are also disinfection machines which use Ultraviolet light technology. In market there are U.V sterilization box available in which ultraviolet light is fixed in a closed box. These machines are operated manually, the operator need to place the object to be sanitized inside the box, close the lid of the box and switch on the light and wait for certain time till the object inside the box get sanitized. Here these devices being operated manually are not so efficient and increase the latency time.

IV. PROPOSED METHODOLOGY

We aim to make an automated sanitizing device. Our product to be designed shall disinfect non-living items using the U.V lamp, which would be installed inside a well-recessed box (called the chamber here).

The chamber shall be mounted on a conveyor belt. The objects to be sanitized must be kept on this belt, which would carry the objects inside the chamber for disinfection. There would be some proximity sensors connected to the controller which would detect the presence of the object on the belt. As soon as the object is detected the conveyor belt shall start to rotate and take the object on it inside the chamber. When the object is in the chamber, the conveyor belt ceases to rotate for a certain period of time. During this time, the item should be sanitized under the U.V light.

When the object is sanitized, the belt starts to rotate again and on the receiving side we get a completely sanitized object.

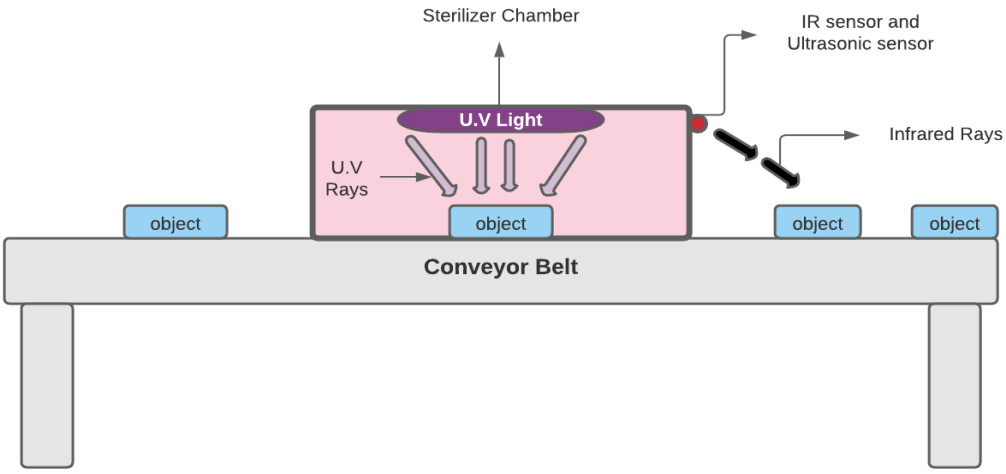

Fig. 3 Hardware design

V. LITERATURE REVIEW

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After going through many research papers, we learned a huge demand for effective sanitization machines in the market. U.V light technology can also be one good source to serve this demand of disinfection device. Below are some papers that tell how U.V light is an effective device in killing various germs and viruses and which tools and devices are compatible with making an automated machine.

[Reference 1] We learned how U.V light could be used to even kill a deadly virus-like a corona, through this paper. Exposure of U.V light on the surface of an object for a certain time is enough to kill many different germs. Most of the U.V lights available in the market, which are used for disinfection purposes, are first tested in biological laboratories. With proper safety and protection, these lights are safe to use. [1]

[Reference 2] In the market, there are different types of U.V light available according to their use. U.V lights have different wavelengths. These wavelengths are defined according to the industrial and market standards and used accordingly for different operations. For our purpose, 'Type-C U.V light' is best as this U.V is used in medical fields and also used for sanitization purposes. The wavelength of type-C may vary from 200-280 nm. [1]

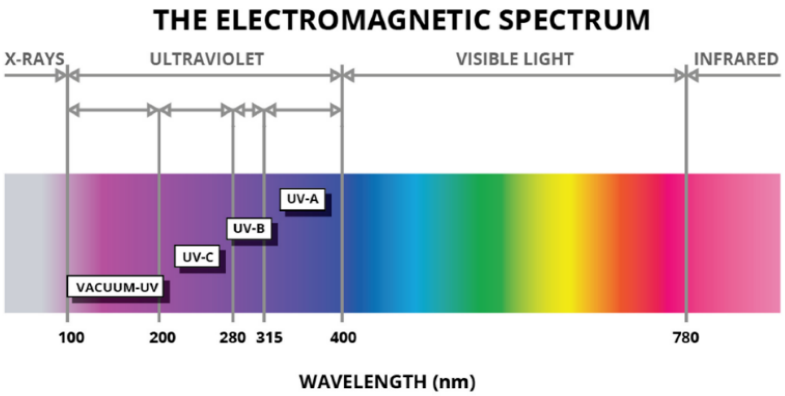

Fig.4 Wavelength of U.V lights [Reference-6]

[Reference 3] A microcontroller is the heart of any electronic device. Choosing the right microcontroller is mandatory. This paper gave us the direction of why the Arduino microcontroller is a good option for this product.

The Arduino microcontroller is an open-source programmable tool that can be used to create various interactive works. It can be used to drive motors, LEDs, sensors and other electronic components. Microcontrollers are small computing systems used for low power and low memory purposes. It is a 32-bit microcontroller. A microcontroller consists of a microchip on a circuit board. Along with microchips, it also consists of read-write capabilities, memory space, inputs and outputs ports provided to carry to various tasks according to the user requirements. [1]

[Reference 4] In any automotive device, the sensor plays a major role. Similarly, we planned to detect the objects that were going to be kept on the conveyor belt by the sensing devices and let those sensors give the raw information to the microcontroller. Further, when the microcontroller receives the information about the object's presence on the conveyor belt, it will take the appropriate action required for further tasks to perform.

So, from this paper, we found ultrasonic sensors and Infrared (IR) sensors are best for object detection and measuring the distance between two objects. Maintaining proper distance between two objects here

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in this project is an important factor. The amplitude response of infrared (IR) sensors depends on the reflectance properties of the target. As the IR sensor emits infrared light of a certain wavelength which is emitted by IR Light Emitting Diode (LED). This light strikes the surface of the object and it reflects back again to the receiver of the sensor. So, if the user wants to use an IR sensor in any device, He/she must be aware of what kind of surface the IR light would be hitting. This paper also describes the working of an Ultrasonic sensor. An ultrasonic sensor can provide the user with initial information of the distance between two objects. [1].

VI. DESIGN CONSIDERATIONS

a. Functional Requirements

1. We shall be using a 24Volts/2 ampere SMPS (switch mode power supply) to meet all the power demand for the electronic components being used.
2. Conveyor belt shall be required which shall be responsible for the traversing of the objects inside the chamber.
3. We shall be using two 12 Volts/100 RPM DC geared motors with the aim of rotating the conveyor belts.
4. We shall be requiring a Type C U.V light for disinfecting the objects coming.
5. 240 volts AC mains supply would be required for the U.V light. (U.V light might consume up to 11 watts of energy.)
6. Proximity sensor like IR sensor shall be used for detecting the presence of an object on the belt.
7. An Arduino microcontroller would be used as the processor to carry out all the automation operations.
8. Markings would be done on the belt at specific length on the conveyor belt, where the entity would be kept by the operator for the smoother operation of the machine and for the operator's understanding.

b. Development Requirements

1. Rapid prototyping tools for circuit simulation like Proteus.
2. Electronic control units (ECUs) like the microcontroller, proximity sensors, power supply
3. Code generation software tools (Arduino uno compiler).
4. Testing and validation tools (Testing of electronic components according to ISO and validating the work of our product for disinfecting and sanitization.)
5. The hardware to be designed and components to be used such that it should not modify any entity entering inside the chamber. (U.V light to be used shall be lab tested and according to ISO and medical standards which won't affect the luggage.)

c. Performance Requirements

1. Our product shall take around 40 seconds to sanitize one object.
2. It shall be able to sanitize one object at a time inside the chamber (multiple objects at a time won't be accepted.)
3. The conveyor belt shall be rotated at a speed of 30 RPM.
4. The weight of object to be used in prototype shall weigh around 100-150gms.
5. The programming code to be written, shall not take more than 1 second to execute to perform

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the desired operation.

6. If there is any run time glitch the product shall have an exceptional handling mechanism.
7. Product shall have fault tolerance mechanism and self-safe mechanism.
8. The LED light which shall indicate the machine is ready work, should blink immediately as soon as the power supply is given.

VII. SAFETY MECHANISM

A. Fault Tolerance

Our device shall be functionable with objects weighing in a limited range (that is 100-150 grams as mentioned). So, if a person tries to keep a load weighing more than the given range, the device won't work. Keeping a heavy object which is not in the range can cause a problem, as this weight won't be handled by the motor and can bring extra load on the motor moment and can cause damage to the device. So, to avoid such problems we shall be using a special weigh sensor which is to be attached to the rollers. Whenever the operator would be placing an object on the conveyor belt the sensor will detect the weight, if the weight is more than the operatable range device won't function.

1.

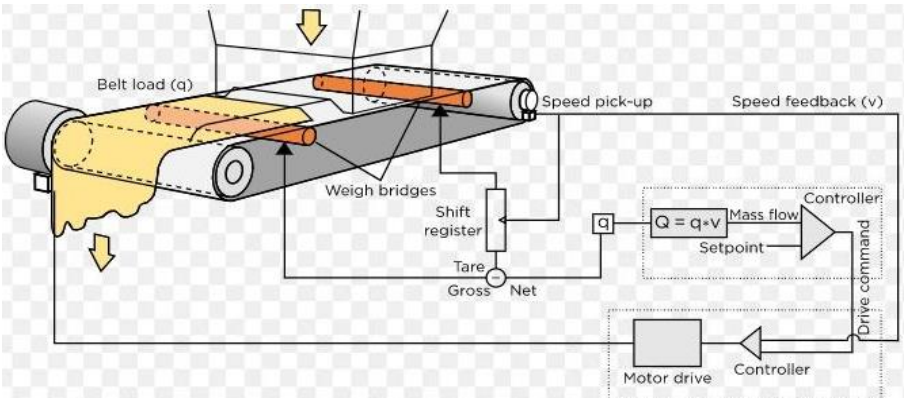

Fig.5 Weigh bridge mechanism

B. Self-Safe Mechanism

The self-safe mechanism is one of the important factors to be considered whenever working with the device. Ultraviolet light which is to be used in the device can cause problems to human skin. Direct exposure to ultraviolet light to human beings can cause ill effects on the human body such as premature ageing of the skin, signs of sun damage such as wrinkles, leathery skin, liver spots, actinic keratosis, and solar elastosis and cause eye problems. We require a self-safe mechanism for handling such a machine.

Exposure can be reduced considerably by the use of personal protection.

1. U.V blocking curtains would be used at the entry and exit of the chamber so that the light won't come out of the chamber.
2. Hand gloves shall be mandatory while operating the device. Also, the use of sunscreen will reduce skin exposure to light.
3. The use of eye protection such as goggles or sunglasses should be mandatory.

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VIII. APPLICATIONS

A. Ultraviolet Sterilization Chamber is designed, to effectively sanitize the surfaces of various products/objects.
B. The major application of this project is the sanitization of luggage and bags at public places like Railway station, Airports, Dock yards, Bus stations.
C. This project will reduce the human efforts of sanitization at public places, as huge number of people travel on daily basis from one place to another so this machine solves the sanitization problem.

IX. CONCLUSION

This pandemic has made us realise how important health and hygiene are for our safety. One should try to understand that keeping yourself clean and sanitized is not enough to fight this deadly virus but we should also try to keep our surroundings clean. Virus-like corona can even get stuck on the surfaces of an object. A device like an Ultraviolet sterilization chamber is really important in public places. This device will help many organisations with sanitization tasks and will also reduce human efforts for the same.

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