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Article

Cost Efficient Automated Fog Spraying Machine: A Covid-19 Hand Sanitization Solution

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Abstract: As a result of the introduction of new infectious illnesses, key infection prevention measures were implemented. Now, a new coronavirus (SARS-CoV-2) epidemic has expanded swiftly, causing the coronavirus illness 2019 (COVID-19). Many microorganisms spread illness via hospital surfaces due to environmental pollution. This virus has been associated to close contact between persons in tight situations such as houses, hospitals, assisted living, and residential institutions. Aside from health care settings, public buildings, faith-based community centers, marketplaces, transportation, and corporate environments are prone to COVID-19 transmission. Physical contact to the sanitizer device may cause for spread Covid virus. That's why we have proposed an automatic fogger mechanism-based hand sanitizer that may able to reduce covid risk. Disinfectant fog will flow when object will pass through the machine. This project will save cost, time and wastage along with Covid spreading risk. This project is about designing a good healthcare system. In recent years, sophisticated automation has influenced the health industry. Health care in poor nations is costly. So, the project is an attempt to tackle this issue.

Keywords: Covid-19; hand sanitization; fogger; disinfectant; automation; hand spray

1 Introduction

Hand sanitizer is essential during the Corona period. Because it is capable of eradicating the Covid-19 virus. However, using a standard sanitizer bottle poses a significant risk. This hand sanitizer bottle may be a source of the virus's spread if an infected person presses the bottle trigger. We can help address this by using a carton of automatic hand sanitizer [1]. We don't have to trigger anything with our hands because it's automatic. Simply put your hand near the bottle. The bottle will be triggered automatically. It is now well accepted that hand cleanliness is a critical component of infection prevention and control [1]. Health Care Professionals are now reverting to the fundamentals of infection prevention via simple methods such as hand hygiene in the face of rising illness severity and treatment complexity, as well as a worldwide pandemic of MDR pathogen infections [2]. White et al. [3]

conducted a relevant study that found a 14.8%–39.9% decrease in upper respiratory disease symptoms among university students who improved their hand hygiene. The Corona Virus (Covid19) is wreaking chaos in the world. People have been unable to leave their homes since the World Health Organization declared it a pandemic disease, and thousands have died as a result [4]. As the worldwide Covid-19 crisis worsens, hand washing and sanitization are now an essential requirement in daily life. Automatic mist-based sanitizer dispensing systems are a valuable asset in the fight against the Corona virus. This contactless dispensing system allows you to sanitize your hands without coming into contact with the sanitizing surfaces, which helps to reduce cross contamination and spread [5]. Clark et al. [6] have compiled a research on fogging decontamination efficiency by the use disinfectant of super-oxidized water for the of the surroundings. They demonstrated that Sterilox fogging is risk-free, easy to implement, and has the potential to cut levels of microbial infections by a proportion that is almost 10^7 lower than before and showed decontamination efficiency approximately 99%. When both hands are put beneath this contactless dispensing device, it sprays an alcohol-based sanitizer in our proposed device. The type of disinfectant may vary based on usage. Because of its low price and high efficiency, alcohol based sanitizer is of choice for fog sanitizer [7].

The foamy mist-based solution requires just 5 to 6 mL of sanitizer, assuring maximum efficiency. In a single action, it sprays a complete cone of spray mist for 12 s [6]. Contactless technology uses an ultrasonic sensor to ensure no contact and excellent operating precision while disinfecting both hands at the same time. It might be wall-mountable, with LED displays to show the process's on/off state and progress. Large Capacity Tank allows for extended periods of use, minimizing the need to replace it regularly. The quantity of sanitizer in the jar may be seen. Respiratory infections, such as coronavirus (COVID-19) spread when membrane or droplets containing the virus enters our body the eyes, nose, or throat. In most cases, this happens naturally. Hands are one of the most common ways the virus is transmitted from one person to another person [8]. At this pandemic moment, one of the most important ways to prevent the expansion of a virus is to wash hands repeatedly with soap and water [9]. WHO advises us to wash our hands with soap and water for at least twenty seconds [10]. Because of washing hands several times, a huge amount of water is wasted every day. Also, buying a good antiseptic soap increases the cost. Also many people in various workplaces feel uncomfortable and annoyed to wash their hands repeatedly with water and soap [11]. For reducing the spread of COVID-19 along with saving water we may implement a hand sanitization machine that will sanitize our hands using fog/water vapor. Using fogging as a disinfection strategy is a relatively recent development [12]. Currently, research on this topic is increasing. Moreover, scientists are working to improve the features of various automatic hand sanitizers currently in the market. Our technology allows us to manage the particle size of the fog with help of actuator [13], which is smaller than the particle size of liquids, allowing for more mobility and penetration to deeper areas. Presurre mechanism may utilize in actuator in that case [14]. This ensures thorough disinfection [15]. Chemical compounds that can be turned into fog may be utilized to disinfect. Fog machines or fog generators may be used to achieve this effect. With this in mind, we've created a fog generator that works well.

2 Problem Statement

Currently the Covid epidemic is spreading very fast. We know Covid is a deadly disease. The whole world is terrified of this disease and millions have died [4]. Like Covid-19, respiratory diseases spread rapidly through the hands [16]. So hands should always be kept sterile and clean for prevent the disease. Hand sanitizer is a good way to prevent Covid but now the problem is that many people do not want to use hand sanitizer using within analog method [17]. Manual use of hand sanitizers used in analog methods may increase the risk of reverse infection rather than reduce the risk of

infection [18]. The manual hand sanitizer is usually hand-touched and hand-to-hand contact can help spread the infection [16]. Fig. 2 shows the manual hand sanitizer. Moreover, the manual hand sanitizers that are currently available in the market consume more times. On top of that, the hand sanitizer's antiseptic chemicals are harmful to young children [7]. Since alcohol is used to make a large number of disinfectants, many large offices hire extra people to sanitize everyone in the office. This increases the cost of any organization. Many people are reluctant to use liquid hand sanitizer since it keeps the hands wet for a long time after use. Moreover, they run out very quickly. On the other hand, disinfectant chemicals are a little expensive. Alongside, many people are reluctant to use the hand sanitizers that are currently used because of its cost. The same amount of liquid that can disinfect 5 people can be used to disinfect more people with a spray machine [19]. Anyone is usually attracted to use digital automated systems. People are usually attracted to everything that is easy and where they find comfort. And with these problems in mind, our project has been thought through.

2.1 Objective

Our main objective is to prevent infectious diseases like COVID-19 through automated systems as it is said, prevention is better than cure. Disinfection by fogging is a novel and successful technique. Due to the smaller particle size of a fog (which may be regulated with available equipment), it has more flexibility and entry to deeper surfaces [20]. This results in a more thorough and efficient disinfection than spraying liquids, which is why fogging is preferred. It is possible to disinfect vast areas, such as hospitals, nursing homes, quarantine facilities, and isolation centers, by the use of fogging equipment. With the objective of effective disinfection, we bring you the concept of fogging technique. For the same, an efficient fog generator has been designed by us for disinfection of any surface and inanimate objects [21]. Our machine uses thermal fogging differently it generates vapor of disinfectant liquid on passing with high pressure through a narrow heated copper pipe. This allows us to achieve our target of inhibition of the transmission of virus from inanimate objects to human beings [22].

3 Literature Review

There are some works has been done to disinfect something through fogging spray machines since it is necessary to determine the correct and efficient disinfectant to kill the germs. There has been a lot of research on disinfectants as well as fogging machines. Report says a spray-fog approach utilizing a quaternary ammonium disinfectant, according to previous research, is an effective alternative for antifungal treatment in hospital wards [23]. Sterilox Hypochlorous Acid Solution was tested for surface inactivation of the human norovirus using both liquid and fog applications by Park et al. [24]. Allard et al. [25] did a study on seed treatment via fog machine. They reported When compared to typical ozone treatment, the goal of this research was to demonstrate that seed management by fog of ozonated water represents an extremely promising alternative technique in terms of both health and environmental benefits. The authors suggest that the use of HOCl solution in the form of a liquid or fog is likely to be beneficial in cleaning common locations in order to limit NV exposures and, as a result, prevent viral dissemination via fomites. Jensen-Jarolim et al. [26] presented a reported a fog matching in which they have looked at the possibility of a link between a disco fog machine and shisha intake and acute type hypersensitivity to cinnamon aldehyde in both patients and normal well condition participants. Cutts et al. [27] reported fogging technique for hospitals and found effective disinfection via fog spray machine. They also reported, dry-fog disinfection has the potential to enhance hygiene measures since it can disinfect a vast area in a short period of time.

Boyce et al. [28] emphasizes the significance of hand hygiene and goes through the various techniques of hand washing in detail. Using a single-use towel or a hot air blower, Khan et al. [29] recommends cleaning the hands with water, lathering them with soap, and then washing them with running water after drying them with the towel. In their study of the effects of wash duration, friction, and soap on hand sanitization, Rundle et al. [30] came to the conclusion that washing one's hands under running water with friction for 20 s is effective, with minimal improvement when soap is added. But they noticed it as time consuming and expensive system. Fog machines are used in many cases. Although there has been a lot of work on fog machines in the past, the use of fog or mist as a sanitizer has been mentioned in this important way. Sanitizing compounds are used to disinfect the hands after they have been mechanically removed germs from the body during the hand washing procedure. Jing et al. [31] report that cleaning chemicals like as alcohol and soap may inactivate viruses by dissolving the virus's lipid membrane and revealing the virus's intracellular substance. Jing et al. [31] have identified five distinct kinds of hand sanitizers: Gel, foam, cream, and spray are some of the options. There are two types of foggers (thermal fogger and cold fogger), using for airborne disinfection in the indoor and outdoor area mentioned by Jing et al. in their paper [31]. Different types of thermal fogger have been described in cited paper [31]. The thermal fogger is used in houses and certain outdoor areas for airborne purification [32]. Teifke et al. [33] reported, in the medical field, an effective infection control strategy has always been critical. This has been brought into even sharper light by the Corona outbreak. Disinfection of different surfaces may now be accomplished using a variety of new technologies, in addition to the traditional ones. Dry fog disinfection, which has been a problem for a long time in the food business, might be a viable option.

4 Methodology

The methodology of the proposed project is summarized in Fig. 1. Following the flow diagram, first of all it is necessary to determine the best disinfectant chemical. Since our main goal is to disinfect our hands, there is no substitute for determining the right germ-killing chemical. Disinfection by fogging efficiently terminates SARS-CoV-2 [34]. Here we have chooses disinfectant 70% Isopropyl alcohol with water which will be converted as a fog [35]. As a disinfectant, Isopropyl Alcohol is the most often encountered and extensively employed in the pharmaceutical industry as well as hospitals, cleanrooms, and the manufacture of electronic or medical equipment. And later in 2nd step, it is necessary to make the electronic circuit for the production of fog from the disinfectant liquid. We will make the fogger circuit that converts liquid into fog water vapor with Sonar sensor, ATmega328P, relay [36]. We have used 113 KHz piezoelectric disc to create the fogger circuit. In this project the fogger circuit is connected to the ATmega328P microcontroller to get the instructions needed to make the fog from the fogger circuit when put hand to disinfect into the machine. In 3rd step and 4th step, The whole hand sanitization fogging system is contained by a chamber [37]. The chamber is designed so that our hands can easily enter. Ultrasonic sensors attached to the chamber can easily detect our hands. As soon as the detection, it transmits the data to the microcontroller. According to the information sent by the microcontroller, in the fifth step relay becomes active and the relay active the fogger circuit in the next step. As soon as the signal is received in the next step, smoke starts coming out from the fogger circuit.

The fogger circuit is placed inside the chamber in such a way that the fog falls straight on the hand after entering. The fogging process continues for some time. This is usually done to prevent wastage of disinfectant liquid.

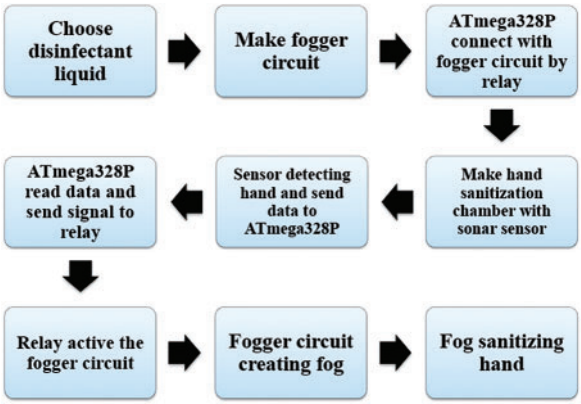

Figure 1: Process flow

4.1 System Design

The conceptual design of fogging Machine is demonstrated in Fig. 2 and summarized in consist of different parts which mention as follows:

- A sanitization chamber
- Refill tunnel
- Hand penetrate space
- A sanitizer liquid tank
- Fan

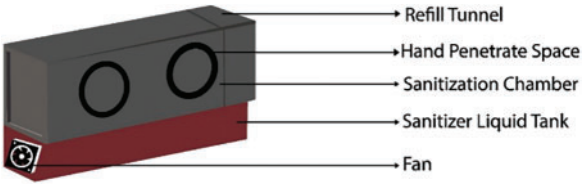

Figure 2: Different parts of the fogging machine

The designed system will be confined inside a Chamber. There will be two service holes in the chamber through which we can get our hands inside. Two holes have been rounded to facilitate hand access. There will be a refill tunnel on one side showed in Fig. 3. With the refill tunnel, we will be able to refill the disinfectant after it has run out. There will be a hole in the mouth of the refill tunnel through which we can easily insert the disinfectant through the bottle. The bottom of the chamber contain a liquid tank which will be filled with a liquid disinfectant. At the top of the chamber there will be the electronics circuit through which the fog will be produced form the liquid. Fogger circuit will deactivate, as the sensor of electric circuit will detect nothing. Moreover, a fan has been added to the device as an extra portion which can control the flow of fog. The speed of the fan is controlled in such a way that it can easily control the fog expansion. We can use this device in two ways. If we want to use it as a portable device, we will use batteries. And if we want to use it in a big office, we can also use the plug for giving electrical power for which there will be a wire at the back of the chamber.

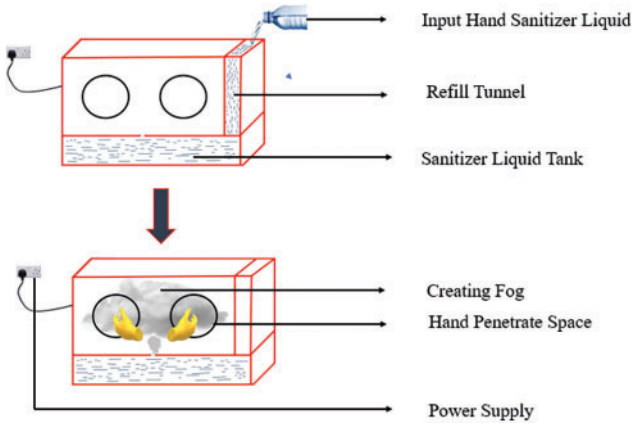

Figure 3: Design of fogging machine

5 Model Architecture & Device Implementation

5.1 Block Diagram

The Fig. 4 below shows the block diagram of the system. The block diagram presents how the system of fogging will work.

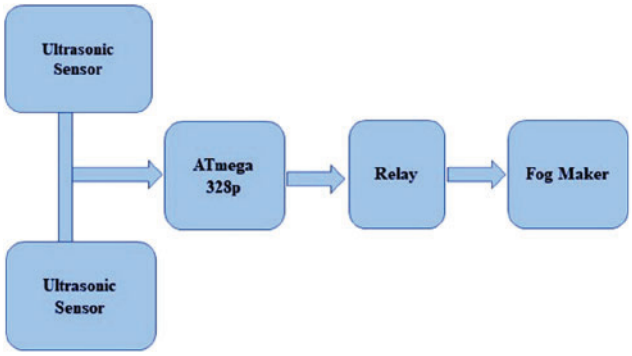

Figure 4: Block diagram of the system

Ultrasonic sensors are an important part of the system. The presence of hands or body parts can be detected by ultrasonic sensors. When standing in front of the fogging machine or touching the front of the fogging machine, it is sensed by the ultrasonic sensor and then the signal is transmitted to the microcontroller through the ultrasonic sensor. The sonar sensor calibrated that only the hands are detected. When the hand enters the chamber sonar sensor detects the hand. The sensor sends data to ATmega328P, which always reads sensor data. ATmega328P input pin connects with sonar sensor and output pin connects with the relay. When the hand is detected by sonar sensor and read ATmega328P then ATmega328P output pin is high. As soon as the signal reaches a mega microcontroller it is transferred to the relay module. ATmega328P output pin sends the signal to relay which connects with relay signal pin. When the relay gets a signal from the ATmega328P then the relay works otherwise relay doesn't active [38]. The relay module then activates the fogger circuit Relay active to the fogger circuit and fogger circuit creating fog. The fog sanitizes the user's hands which enter the chamber. When a user removes his/her hands from the chamber, it will off the fog flow as sonar detect nothing in empty chamber.

5.2 Working Principle

Each electronic device operates by a set of principles called working principles. A working principle is a rule that is sufficient to allow work to be completed. The working principle of our fogging machine is given below:

- At first, we will need a power supply that starts the fogging circuit.
- The hand sanitizer liquid store in the sanitizer liquid tank.
- We will input hand sanitizer liquid through the refill tunnel.
- When we will insert our hand within the hand penetrate space, the sonar sensor will detect our hand and send data to the ATmega328P microcontroller.
- ATmega328P microcontroller will read data and start the fogger circuit.
- The fogger circuit will create a fog that will sanitize our hands.

5.3 Schemetic Diagram

The schematic diagram has been shown in Fig. 5 below. This schematic diagram has been created with Fritzing software which shows arrangement and connection of the fogger circuit.

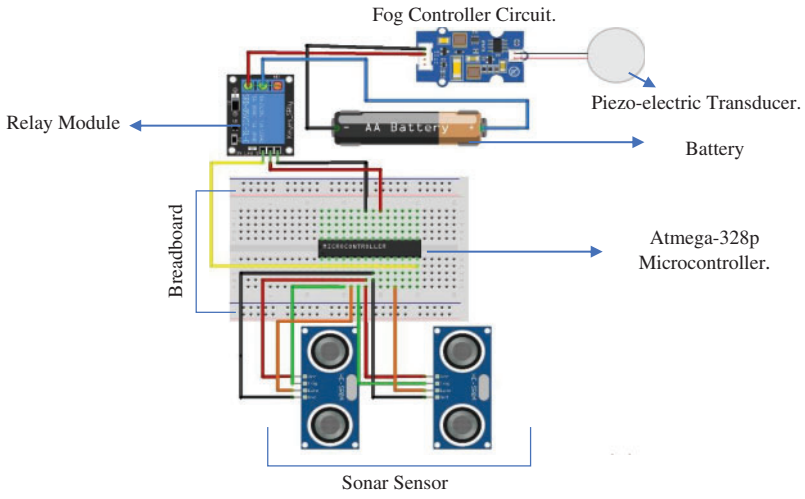

Figure 5: Schematic diagram

5.4 Device Implementation

The product that designed for this device has been successfully developed using necessary equipment. The whole system is housed in a cardboard box, as shown in the Fig. 6 below. We have created square shaped cardboard box or chamber for easy installation anywhere also for less weight as can easily move to anywhere. There are two holes in the surface of the chamber through which to enter hand. Hard cardboard has been used to prevent smoke from escaping easily and also for make it some weight. The circuit is installed at the top of the cardboard chamber and is arranged so that it falls straight from the top to the surface of the hand. We used plastic glue to connect the necessary components, including the circuit, to the cardboard when creating prototype. On the inside of the cardboard is a liquid tank is installed where the disinfectant will be stored. We settled up the system at our university student residence hall to test the prototype and to check the efficiency of the device. Below is the first picture of Fig. 6 shows the frontal face of the fogging machine and Fig. 7 demonstrate the device installed in our hall. A description of the parts and components that make up the whole

system is discussed in the System Design section. We built this prototype device based on the drawing design.

5.5 Prototype & Outcome

Our proposed project has been able to work properly. We've tested the system with a number of people and have been successful every time. People's hands have been successfully disinfected through fogging the chemical. The successful fogging process of the fogging machine is shown in the Figs. 6 and 7 below. Here is a red mark on the image given where the smoke or fog comes out.

Figure 6: Implemented device structure

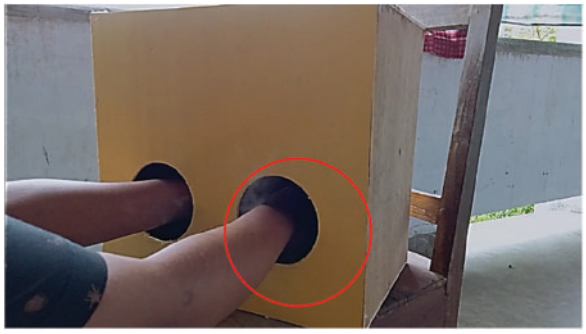

Figure 7: Prototype and working of the device

Using this device or system at home, in the office or in a corporate space can be very successful in reducing the risk of spread of COVID-19. It also saves expenses and time. One can easily disinfect their hand or any object using this machine. We will be benefited in many ways by implementing this fogging machine based Hand Sanitizer.

This fogging machine has various Advantages. It's listed below:

- The particle size of fog is much smaller than the particle size of other liquids. Thats why we can save liquid and money both.
- It does not adhere to any surface.
- 10 microns and smaller fog particles (can be controlled by actuator). Presurre mechanism may utilize in that case. Smaller droplets result from greater pressure, while bigger droplets result from lower pressure [14]. The size and form of the actuator nozzle can also be modified to

regulate particulate size. The size of the drops produced by a nozzle can be adjusted to produce a variety of effects, from a thin mist to bigger droplets [39].

- Enhanced particle mobility. As a result, it's more likely to spread. With a less quantity of disinfectant, cover a larger area.

6 Conclusions

A combination of object, individual, and space sanitization will be required to control the spread of COVID-19. SARS-CoV-2, like other coronaviruses, has an outer lipid envelope, making it more sensitive to disinfectants than non-enveloped viruses like rotavirus, norovirus, and poliovirus. COVID-19 virus spreads by close contact and respiratory droplets. Covid-19 is a deadly disease and it spreads widely in any area. And so prevention of Covid is much more important than cure. Since covid spreads through the air, there is no substitute for using hand sanitizer to prevent it. The ultimate objective of any sanitization procedure is to eliminate the virus and render it inactive. Mechanical sanitization, removal sanitization, thermal sanitization, and chemical fogging disinfection are all methods of sanitization that may be employed alone or in conjunction with one another. Fogging, jets and sprays, fumigation, and UVC irradiation, fogging are all methods of disinfection that may be used on spaces and objects like body parts. In this report we have highlighted our invented fogging machine which will give us a solution of Hand Sanitizing in order to reduce spread of COVID-19 and reduce its risk.

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Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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