proxima
LIGHTING SOLUTIONS

January 2021

UV Disinfection in Public Transportation

UV Disinfection in Public Transportation

Part 2 (Airplane)

Introduction

This text addresses UV disinfection in airplanes. Airplane is a place where microorganisms can potentially be transferred. Due to the widespread outbreak of the coronavirus the current debate revolves around whether passengers travel by plane or not. Many tried to alleviate fears of flying during the pandemic by UVGI[1]. However, few studies have investigated the inter-relationships among UVGI and removing infectious pathogens. There is a small list of airlines who are now using ultraviolet light to disinfect parts of their airplanes. Dimer entered into a partnership with Honeywell to bring an UVC system to airlines to reduce certain viruses and bacteria surfaces [1, 2]. Furthermore United Airlines consulted with the Cleveland Clinic in developing the UVC band disinfection process that relies on airline workers using handheld fixtures near surfaces to clean the flight deck of its aircraft, including the many switches, touchscreens, and other surfaces that flight crews regularly touch (Figure 1) [3]. JetBlue Airways which is a major American low cost airline, use robots with extensible UVC arms to disinfect cabins [4]. This is a big win for airlines to disinfect their cabins between flights and make a safe flight for passengers.

Figure 1. A handheld ultraviolet C-band (UV-C) device to disinfect surfaces [3].

1. Ultraviolet germicidal irradiation

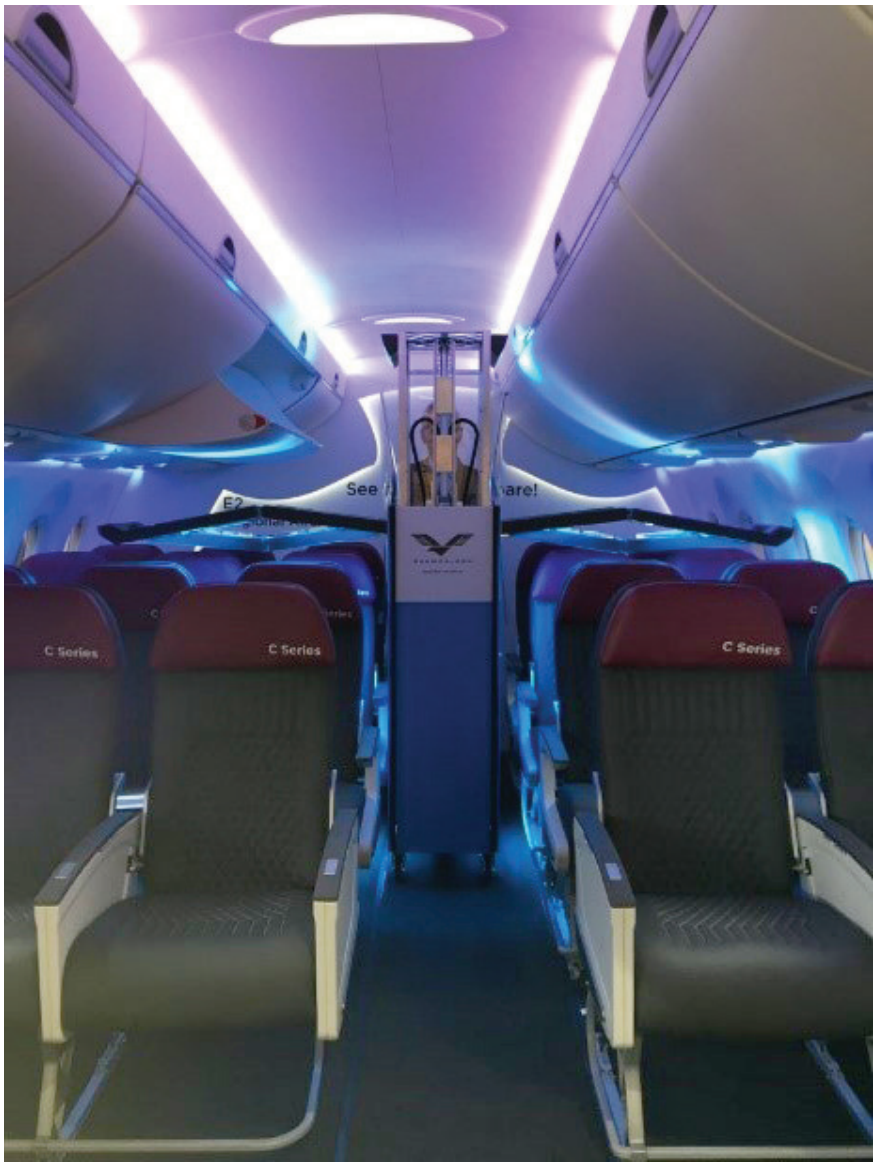


Figure 2. GermFalcon [1].

Airplane

Many prefer travelling by airplane because it is the fastest and safest mode of transport. Furthermore it would be a great choice with SARS and MERS and annual influenza. Companies try to improve cleaning procedures to wipe out coronavirus and other germs inside an airplane. Dimer Company designed a new machine called GermFalcon using ultraviolet light (Figure 2). GermFalcon uses a set of mercury lamps and 100-amps from a lithium-iron-phosphate battery pack to wipe out viruses in about three minutes: two minutes for pass up and pass down the aisle, and a minute for the bathrooms and galley. Although proper power and time and position of the UV-lamps were figured out by iteration on a couple rows of airplane seats and overhead bins, the system hasn't been tested on the coronavirus because of lacking a suitable lab. It is expected to be similar as UV-C disinfection for influenza and other germs but for more safety slowing GermFalcon's roll down the aisle can adjust the dose. The company believes all of the power constraints will be solved when there is an effective UV-C LED [1]. UV-C LEDs are smaller and lighter, consume less power, have a wider spectrum selection and a much higher dynamic range comparing with mercury lamps [5].

JetBlue has started using a new robotic disinfectant machine capable of cleaning the entire cabin in less than 10 minutes with the help of UV light. An airline employee pushes The Honeywell UV Cabin System down the aisle, much like they would a drinks cart and the arms stretch out over seats projecting UV light which disinfects high-touch areas in the cabin, including the bathroom (Figure 3). Eight of these devices are being tested at New York's JFK Airport and Fort Lauderdale-Hollywood International Airport [2, 4].

Figure 3. Honeywell devices [2].

For the purposes of evaluating the necessary UV light dosage and irradiance, optical modeling and simulation can be used to design the right UV light treatment system. Ansys simulation tools can be used to solve the challenges of designing and deploying a UV light treatment system [6]. Xenex organization helped hospitals achieve significant infection reduction results with virus-fighting robots [7, 8]. The motion path for this UV robot is simulated in this study. Besides the light fixtures which are quicker and easier activated were included in the computer model. An autonomous mobile system can cover all the surfaces more efficiently than light fixtures. Figure 4 shows the set of 3D models of a single aisle/4 seats per row airplane cabin for three different conditions: installed UVC light fixtures, original UVC robot design and optimized UVC robot design [6]. An original robot design is like Xenex design which can be seen in Figure 5 and optimized UVC robot design is a robot with arms stretched above the seats.

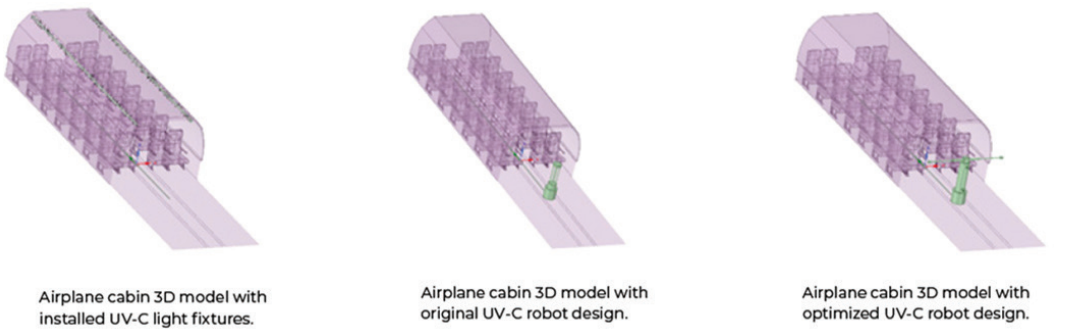
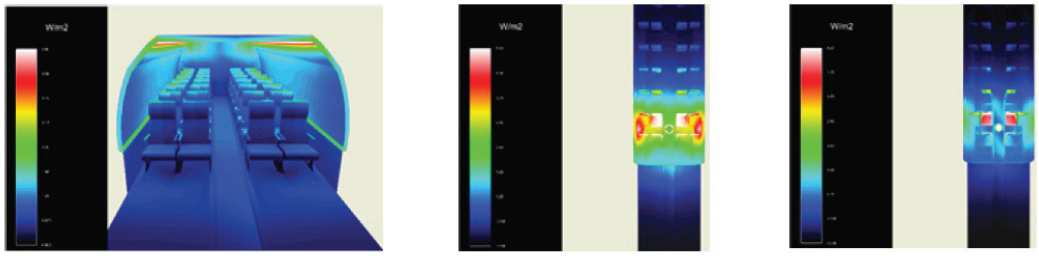


Figure 4. 3D models of a single aisle/4 seats per row [6].

Figure 5. Xenex's disinfecting robot, called LightStrike [8].

This modeling can also quantify the irradiation coverage (W/m^2) of the cabin. Brighter colors in Figure 6 indicate high irradiation, while darker colors indicate lower irradiation. UVC light fixtures cover all the seats but not all surfaces. The second robot design (with arms stretched above the seats) on the left is much better than others [6].



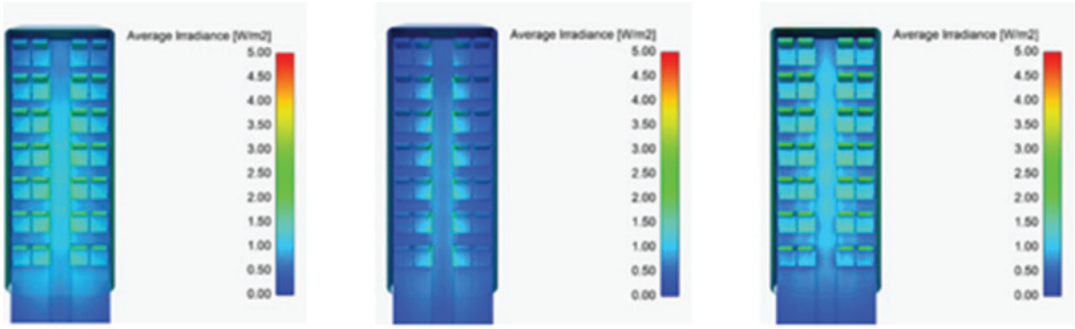
Irradiation (W/m^2) snapshot of cabin interior using UVC light fixtures.

Irradiation (W/m^2) snapshot of cabin interior using original robot design.

Irradiation (W/m^2) snapshot of cabin interior using optimized robot design.

Figure 6. Irradiation differences between three types [6].

Understanding the target dosage is so important for instance for the COVID-19 virus is approximately 600 $\mu J/cm^2$. Based on the type of the UV light the exposure time would be different. Simulation was used to calculate the necessary exposure time to reach the 600 $\mu J/cm^2$ (Figure 7). Robot's necessary motion speed for optimized design would be 0.21 m/s and for original design is 0.034 m/s [6]. The exposure time to reach the 600 $\mu J/cm^2$ is 150 seconds, 600 seconds and 100 seconds for installed UVC light fixtures, original UVC robot design and optimized UVC robot design respectively. Therefore the optimized UVC robot design is 6X better than the original design.



a) Installed UVC light fixtures b) Original UVC robot design c) Optimized UVC robot design

Figure 7. Cumulative irradiation (W/m2) on cabin interior in three conditions [6].

References

[1] IEEE SPECTRUM/ Samuel K. Moore; Flight of the GermFalcon: How a Potential Coronavirus-Killing Airplane Sterilizer Was Born; https://spectrum.ieee.org/tech-talk/aerospace/aviation/germfalcon-coronavirus-airplane-ultraviolet-sterilizer-news. Mar 2020.

[2] Aerospace Manufacturing Magazine/ Michael Tyrrell; Honeywell launches ultraviolet cleaning system for aircraft; www.aero-mag.com/honeywell-ultraviolet-cleaning-airlines-11062020/. June 2020.

[3] LEDs Magazine/ Maury Wright; United utilizes handheld germicidal UV-C products to disinfect flight decks; https://www.ledsmagazine.com/lighting-health well-being/article/14181520/united-utilizes-handheld-germicidal-uvc-products-to-disinfect-flight-decks. Aug 2020.

[4] TRAVEL+LEISURE / Andrea Romano; JetBlue Is Testing a Giant UV Light Machine That Could Disinfect Plane Cabins in Under 10 Minutes; https://www.travelandleisure.com/airlines-airports/jetblue/jetblue-airplane-cabin-disinfectant-machine-coronavirus. July 2020.

[5] Sun KX, Allard B, Buchman S, Williams S, Byer RL. LED deep UV source for charge management of gravitational reference sensors. Classical and Quantum Gravity. 2006 Mar 28;23(8):S141.

[6] Ansys/ UV DISINFECTING SYSTEM FOR AIRCRAFT CABINS; https://www.ansys.com/-/media/ansys/corporate/resourcelibrary/application-brief/uv-disinfecting-aircraft-application-brief.pdf?la=en&hash=454875C5ECF4ED4BBE7E-167AC656DBE49E0EE526. 2020.

[7] CNBC Outbreak /These virus-fighting robots are being used to disinfect hospitals; https://www.cnbc.com/video/2020/02/05/these-virus-fighting-robots-are-being-used-to-disinfect-hospitals.html. Feb 2020. [8] Moore SK. Flight of the GermFalcon: How a Potential Coronavirus-Killing Airplane Sterilizer Was Born. IEEE Spectrum: Technology, Engineering, and Science News. 2020 Mar.