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Prototype of a Public Computer System with Fast Automatic Touchscreen Disinfection by Integrated UVC LEDs and Total Reflection

Sebastian Deuschl[1], Ben Sicks[1], Helge Moritz[2], Martin Hessling[1],*

[1]Institute of Medical Engineering and Mechatronics, Ulm University of Applied Sciences, Albert-Einstein-Allee 55, D-89081 Ulm (Germany)

[2]Büchner Lichtsysteme GmbH, Uzstraße 2, 86465 Welden (Germany)

INTRODUCTION & AIM

Background

- touchscreens are becoming increasingly important in all areas of life and can be found in smartphones, tablets, notebooks, ATMs, ticket and vending machines [1]
- when touching touchscreens, pathogens can be transferred from the user's fingers to the display or vice versa, which makes public touchscreens in particular potential carriers of infectious diseases
- unsurprisingly, staphylococci, which include MRSA (methicillin resistant *Staphylococcus aureus*), have been found on every touchscreen in every scientific study worldwide – often together with many other pathogens [2]
- microorganisms can be reduced by UVC radiation (< 280 nm) due to the destruction of their DNA and RNA
- unfortunately, the UVC-sensitivity of human cells impedes conventional UVC-irradiation of touchscreens for pathogen reduction

Aim

- development of a prototype of a public computer with self-disinfecting touchscreen:
  - computer with simple game and different users
  - automatic touchscreen disinfection between two users with a quartz plate and lateral UVC LEDs
  - no risk of irradiating humans
- measurement of the irradiation in front of the touchscreen
- test of the antimicrobial impact

METHOD

Irradiation setup with quartz plate and UVC LEDs

- an additional quartz plate (472 x 300 x 4 mm³) was installed in front of a commercial 19” monitor and 120 UVC LEDs (275 nm) were attached to the side of this pane, which shined directly into the plate (Fig. 2)
- to get touchscreen functions, an IR touch frame of Touchsolutions24 was also installed
- as there was air on both sides of the plate, it acted as a light guide due to the total reflection and the UVC radiation remained in the plate - people were not irradiated
- bacteria on the plate were exposed to the evanescent UVC field or - depending on the model - were radiated, because there was no total reflection at the bacterium-quartz contact surface
- UVC irradiation 10 cm in front of the touchscreen was determined with a Gigahertz-Optik optometer to judge the potential harm to humans by [3]

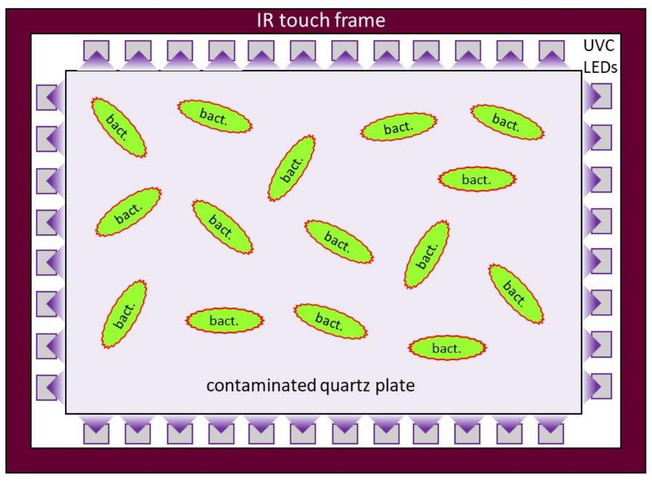

Fig. 1: Schematic top view of the setup with quartz plate, touch frame and UVC LEDs.

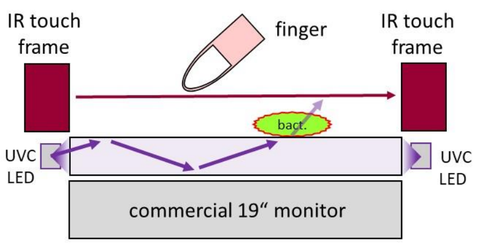

Fig. 2: Schematic cross section of the setup with commercial monitor, quartz plate, touch frame and UVC LEDs.

Microbiology

- test bacterium was *Staphylococcus carnosus* (*S. carnosus*) as it exhibits a similar UVC sensitivity as *Staphylococcus aureus* (including MRSA) [4]
- the touchscreen was contaminated with a home-built spraying device
- at the start and after chosen irradiation times, randomly selected touchscreen areas were sampled with the Eswap kit from Copan and surviving bacteria determined by plating sample suspensions on agar plates and later colony counting

Test computer and application

- a Raspberry Pi Model 4B was used to control the disinfection and run a simply geometric color game written in Python 3.X.

RESULTS & DISCUSSION

Test application

- the application allowed gaming and touchscreen disinfection between users (Fig. 3)

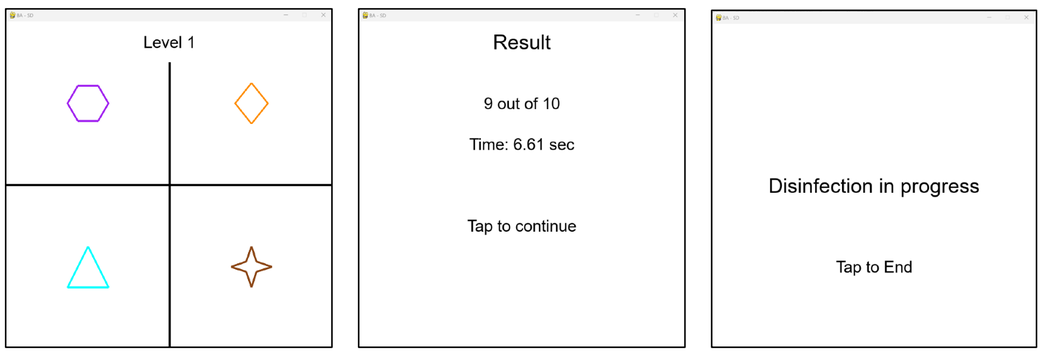

Fig. 3: Example screenshots from the game and the subsequent disinfection.

Irradiation setup with quartz plate and UVC LEDs

- LEDs were operated with total currents of 20 and 350 mA, which was 1% and 17.5% of the maximum LED current, respectively
- the measured 275 nm irradiance in front of the quartz plate was 0.18 and 2.8 µW/cm²
- this results in permissible exposure times of 287 and 18 min in front of a continuously UVC-emitting display (UVC-LEDs were only ever switched on for 25 s or less)

  ⇒ no risk to humans

Microbiology

- at an LED current of 20 mA the bacterial concentration on the quartz plate was reduced exponentially by 3.5 log-steps or 99.97% in 25 s (Fig. 4)
- higher currents will probably lead faster reductions – even below 1 s for a 99.9%

  ⇒ fast touchscreen disinfection possible

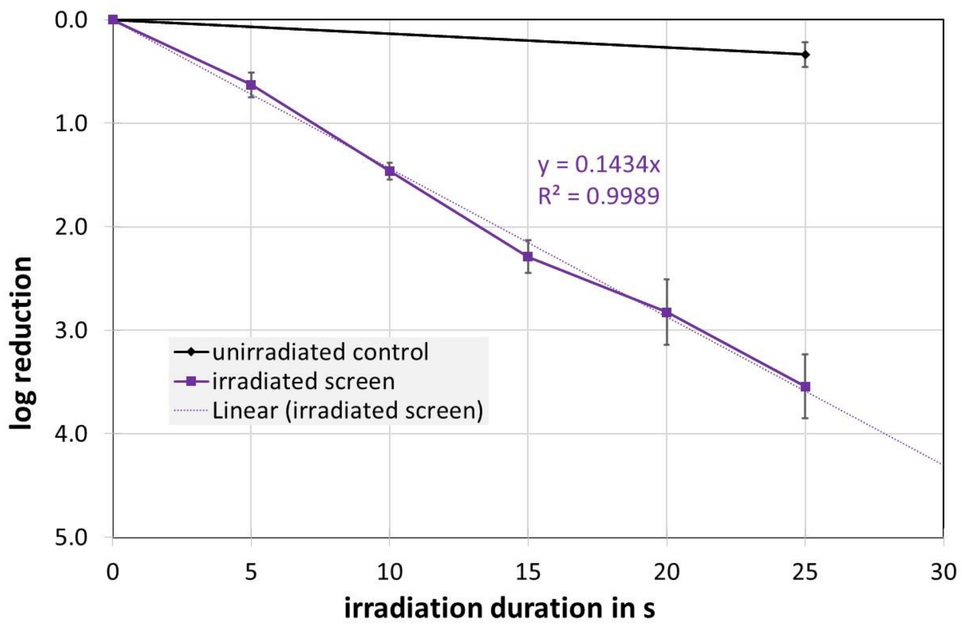

Fig. 5: Average staphylococci reduction with 20 mA LED current in a half logarithmic representation. The error bars give the standard deviation of the single runs, while the linear trend line illustrates the exponential character of the bacterial decrease.

CONCLUSION / FUTURE WORK

- fast microbial reduction on touchscreens with existing UVC LEDs already possible without endangering humans
- microbial tests will be extended to additional microorganisms
- if possible, future touchscreen functions will be realized without touch frame
- if possible, future UVC LEDs with peak wavelengths below 230 nm (Far-UVC) will be installed to further reduce the risk to humans

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