

Ultrasonic Floor Cleaning - StarGlider

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1. Background

The aim of the project is to design and build a prototype device that will use ultrasound to clean flat surfaces such as floors. Applications for ultrasonic floor cleaning could include: improving wheel adhesion on train tracks [1], nuclear decontamination and decommissioning [2], and hospital floor cleaning. The latter could reduce the amount of microbes on hospital surfaces before they can infect patients and become resistant to antibiotics, therefore decreasing cases of hospital acquired infection [3].

2. Introduction

Several sectors have identified the need for improved surface cleaning in scenarios for which ultrasonic cleaning may have a role if suitable technology were to be developed. Applications include improving wheel adhesion on train tracks [3-5] and in nuclear decontamination and decommissioning [6, 7]. Although the StarGlider ultrasonic floor cleaning device has applications to both sectors, perhaps its most significant contribution will be to the cleaning of floors and other flat surfaces (patient tables, trays, operating tables etc.) in the hospital environment. Little is known about the correlation between floor cleanliness and hospital-acquired infections [8-10], but it would be unthinkable to omit floor cleaning from either routine or 'deep' cleaning of hospitals, given current knowledge of how poor cleaning procedures affect the spread of microbes (even though such knowledge is based primarily on studies of 'hand-touch' sites such as door handles, taps and switches [11,12]). Techniques might be improved with the use of ultrasound, with particular emphasis on floor cleaning.

3. Materials and Methods

During this project, an inexpensive ultrasonic device for cleaning flat surfaces was constructed. Design elements included acoustical modelling, flow optimization and choice of power electronics (details confidential). The operation by which cleaning is achieved resembles that described for StarStream® [13,14]. However, details of the device, and the absolute dimensions of the area to be cleaned, are confidential as the University is currently in negotiation with a manufacturer. As such, relevant details have been omitted or obscured, and the area cleaned has been expressed only as a percentage of the total area contaminated.

4. Experiment

- Testing took place in a Perspex tank the base of which was inclined at an angle of $\sim 10^\circ$ to remove water from the device (figure 1).
- Videos of the stationary StarGlider cleaning mascara from the Perspex floor were taken from underneath the tank.
- Image processing was used to assess what percentage of the original mascara was removed in what time. The cleaning capabilities of the device were measured by recording how quickly an area of mascara could be removed.

5. Results

StarGlider consistently cleared the mascara contaminant: As quantified by the automated image processing method (which measured only macroscopic contamination), StarGlider removed $\sim 100\%$ of the contamination within 6 s, with 50% of the cleaning achieved in approximately the first 1 s (figure 2).

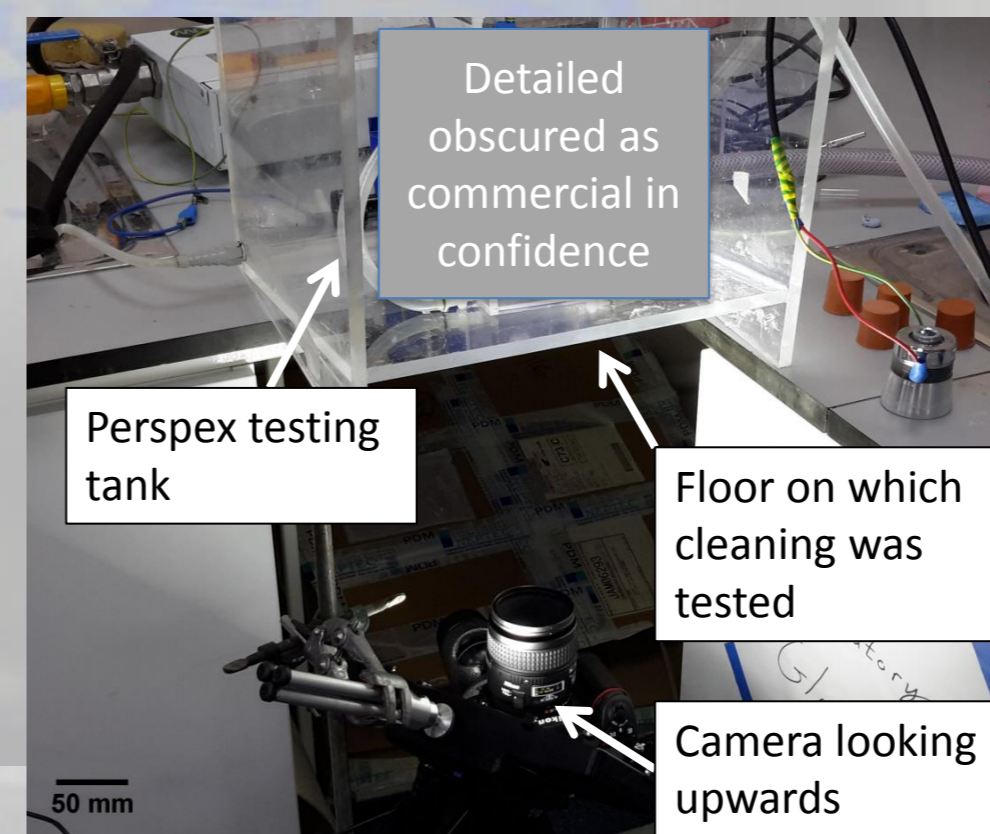


Figure 1: Photograph of the test set up. The StarGlider is purposefully obscured.

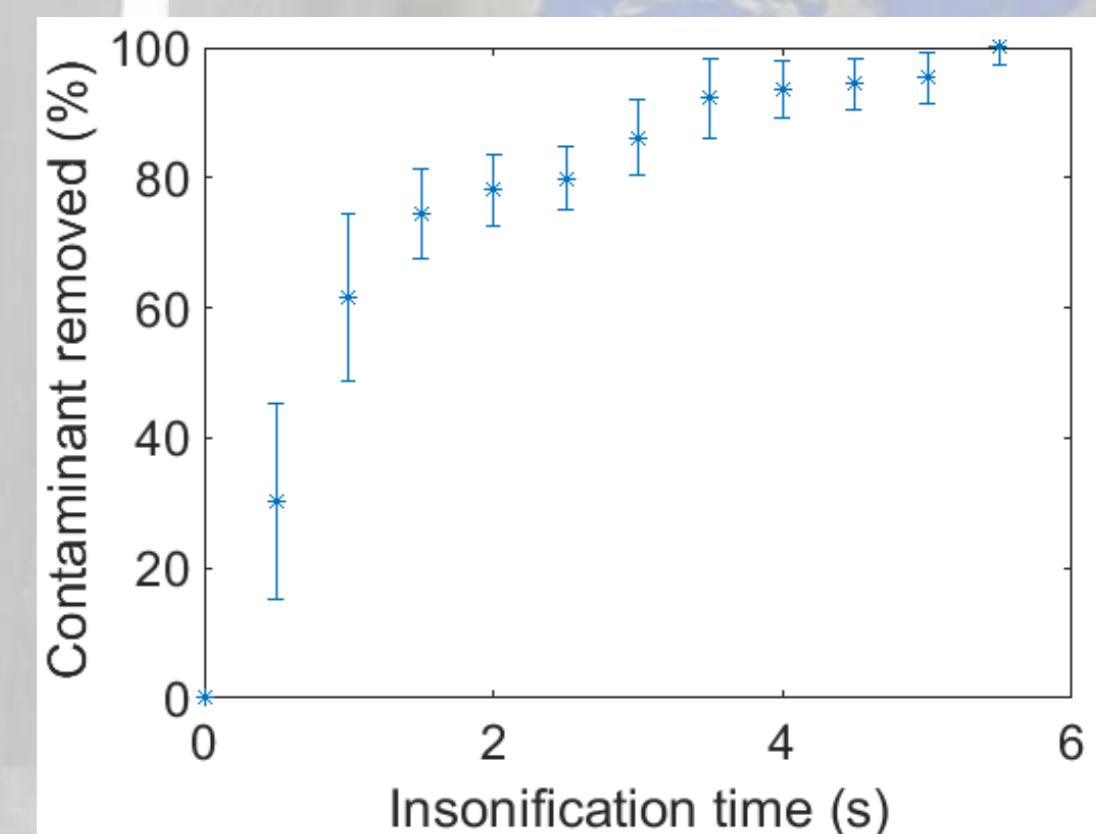


Figure 2: Mean cleaning rate (with errors bars of +/- 1 standard deviation) from 12 experiments.

6. Conclusions and future work

StarGlider proved to be successful on flat Perspex contaminated with mascara. Priorities for future work are:

- Including microscopic examinations into the assessment of the amount of contaminant remaining at the end of cleaning, because it is recognized that when the current methods assess cleaning they cannot resolve microscopic remnants;
- Testing cleaning ability on other floor types, including surfaces containing scratches;
- Testing cleaning in the above surfaces for microbiological contaminants;
- Repeating the above tests for a moving StarGlider;
- Deploying a moving StarGlider prototype on a hospital floor and testing for reduction in microbiological contamination.

7. References

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