Affordable escalator handrail sanitizer

2020 Group 11-08

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Abstract

Pathogenic bacteria can adhere to a large variety of surfaces, with one of them being escalator handrails. Current research has shown and proven that escalator handrails contain a large number of bacterial colony-forming units. When the escalator handrails are contacted by the hands of users, the bacteria can, in turn, be transferred to their hands. When they touch their faces or any opened wound, the pathogenic bacteria can enter their body and cause a bacteria infection. The project served to design a device that can kill bacteria that had adhered onto the handrails, which can decrease the spread of bacterial infections. The final product used the linear motion of the escalator handrail to drive a wheel mechanism that triggers the spray of the anti-bacterial solution onto a targeted section of the handrail. Due to its low operating and maintenance cost, it is much more practical than current solutions which can easily cost up to a few thousand dollars for each device.

1. Introduction

Bacteria are single-celled organisms, which have many different types and appearance. A subset of them is pathogenic bacteria, which is known to cause many diseases such as Strep throat and food poisoning. Bacteria colonies can easily adhere to different surfaces upon contact. This mostly happens when a user carrying the bacteria transmits it onto the surface by ways such as sneezing or merely touching it. Due to the number of users coming into contact with the escalator handrail, they are proven and shown to contain even more bacteria colony-forming units than a toilet seat. (RTHK, 2019)

Despite escalator handrails being a site for bacterial transmission, current products are expensive and inefficient. One of the products is the WeClean escalator sanitizer designed by South Korean company Swit, which was installed in select escalators around Singapore undergoing a trial to disinfect the handrails. The device targets the coronavirus instead, thus was only pushed out at around May 2020. However, the design of the device is complex, thus amounting to a 9800 dollars price tag per device. It contains unnecessary features such as using Ultraviolet Light to sterilize the handrails, which is ineffective. This is seen from recent research conducted by a group of scientists internationally in which Ultraviolet light was concluded to be needed in large amounts to render the virus unable to reproduce, in which a prolonged exposure was also needed. (Medrxiv, 2020) Furthermore, a research conducted recently showed that prolonged exposure to Ultraviolet light is needed to destroy bacterial cells, in which the continuous motion of the escalator handrails makes it impossible for prolonged exposure to the Ultraviolet lamp in the product designed by Swit. Lastly, the hefty price tag of 9800 dollars for a device that only disinfects a single handrail makes it impossible to be fitted into many escalators in Singapore due to cost issues.

2. Proposed Solution and Solution Design

The product would be a portable and lightweight device that was also able to dispense anti-bacterial solution on the escalator handrails reliably and efficiently. A portable and lightweight device allows the user to remove and reinstall it at various locations easily. A reliable antibacterial solution dispenser is able to work without failing during usage, and will be able to function properly for a few months without needing to be repaired. An efficient antibacterial solution dispenser dispenses antibacterial solution at regular intervals and dispenses it such that not too much antibacterial solution is dispensed, therefore wasting some of it, while still dispensing enough to keep the escalator handrails adequately clean.

2.1: First Prototype

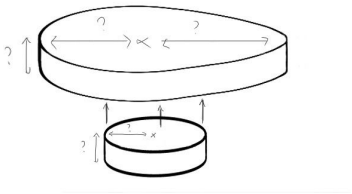


Fig. 1: irregularly-shaped wheel

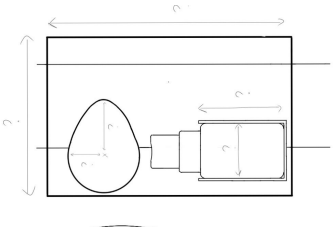


Fig. 2: top view

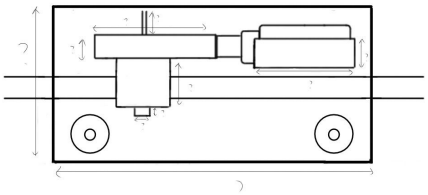


Fig. 3: side view

The first prototype developed made use of an irregularly-shaped wheel to knock the trigger every revolution. The escalator handrail was positioned beside the wheel to turn the wheel. When the wheel went through one revolution, it knocked the trigger of the spray bottle, as part of it was sticking out. The solution was proposed as the irregularly-shaped wheel was driven by the motion of the escalator handrail via a bigger wheel. This allowed the antibacterial solution to be sprayed reliably and at regular intervals, resulting in the intervals reliant on the motion of the escalator handrails and the circumference of our bigger wheel. When the wheel knocks onto the trigger, an amount of antibacterial solution will be sprayed. Furthermore, the prototype was cheap. We selected plastic as the main material as it is easily obtainable, and is very durable, allowing us to reproduce our device easily, while still ensuring the quality of the device. Because the device did not involve complicated technology, thus we do not need to use any specialised equipment, which tends to be very expensive. Also, the prototype was reliable. It allowed the

escalator handrails to be sanitized thoroughly. By spraying the antibacterial solution at regular intervals, the device was dependent on the motion of the escalator handrails and the circumference of the larger wheel, to prevent it from spraying stationary escalator handrails. Tp add on, the prototype was also efficient. It made sure that antibacterial solution was spread out properly on the escalator, yet not spraying too much such that some of it was wasted, keeping the handrails adequately clean. This was done by varying the size of the larger wheel, in order to control the number of revolutions, and as a result, sprays per unit time. Finally, the device was portable. As the product only had dimensions 17 cm by 15 cm by 7 cm, it was a lot less bulky than current designs. As such, it could be deployed conveniently at various locations.

However, this prototype was still lacking. When the wheel knocks onto the trigger of the spray, an excessive amount of noise was produced. Also, wear and tear was caused from the wheels knocking on the button repeatedly, which could damage parts of our device and cause it to become unreliable quickly.

2.2: Second Prototype

While the second prototype primarily made use of the same concept to spray the antibacterial solution, one important and major difference was how the energy generated from the motion of the escalator is converted to energy used to compress the trigger.

Instead of an irregularly shaped wheel, the design made use of a rod attached to a “point” on the circumference of the wheel. As the wheel rotates, the “point” varied in distance from the trigger of the antibacterial solution. As the mentioned rod was attached to the “point”, the rod was moved back and forth, hitting the trigger every time the wheel completes one rotation. (Adapted from Mir, 2017)

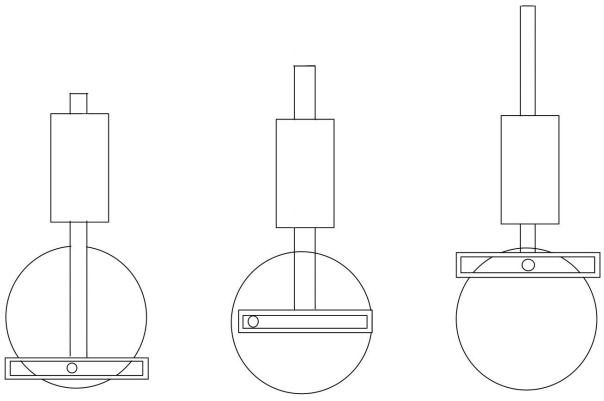


Fig. 4: sketch of mechanism

The proposed solution was able to solve a few of the previous prototype's problems (the noise produced and the wear and tear due to friction) while maintaining the efficiency and reliability of the original design. While there were still certain inconsistencies, i.e, friction, that might cause failure of the design, they were rare and negligible.

Again, the second prototype had the dimensions of 17cm x 15cm x 7cm. The wheel had a diameter of 5cm, with a circumference of ~15.7cm which allowed the antibacterial solution to spray once every ~15.7cm the escalator handrail travels. The "point" was placed 0.25cm away from the center of the wheel causing the trigger to be pushed down a suitable length of 0.5cm. The length was adjustable by varying the distance of the "point" from the center of the circle. The variable length accommodates for different sizes of spray bottles and also allows the user to decide how much of the antibacterial solution is to be sprayed. The size of the the hole that the escalator handrail fits through was increased to 10cm x 4cm so that the prototype would be suitable for most of the commercial use escalators.

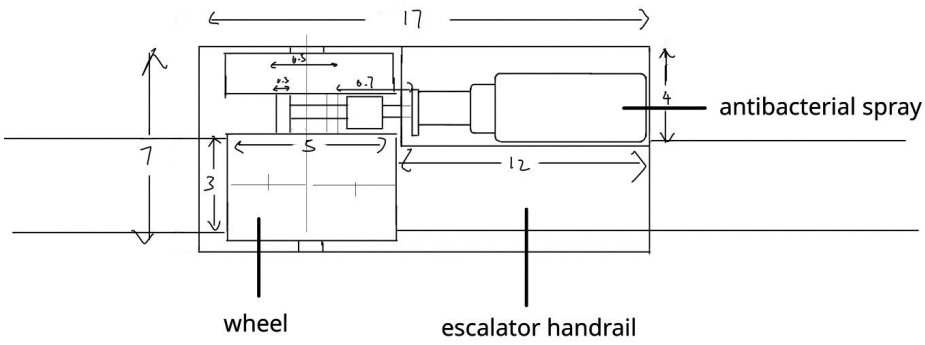


Fig. 5: side view of prototype

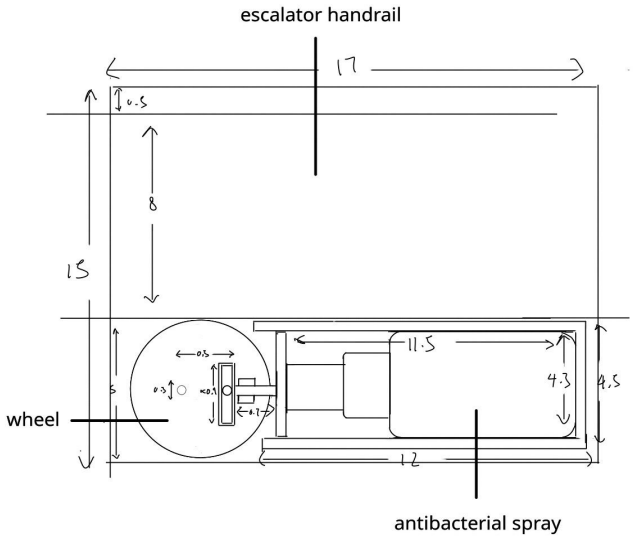
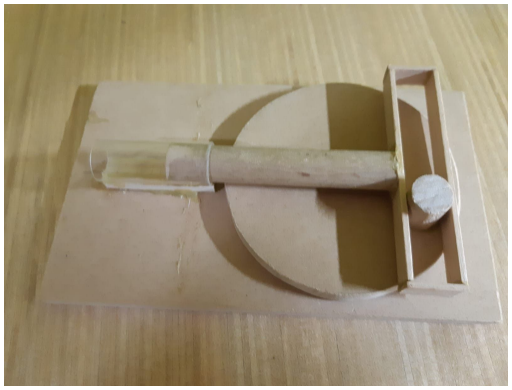


Fig. 6: top view of prototype



Fig, 7: Picture of mechanism

3. Future work recommendation

The future plan of the group includes major improvements to the design of the device and the creation of a functional prototype, and the testing of the prototype to ensure the functionality of the device.

Firstly, the project group will aim to further enhance the prototype to decrease wear-and-tear of the parts caused by the bar knocking onto the screw bolt during the revolutions. Possible solutions are replacing the screw bolts with ball bearings or changing the material of the bar, allowing it to absorb the impact caused by hitting the screw bolt.

Secondly, methods to firmly attach the device onto the escalator handrails will be further examined, to ensure that the product will not topple off the escalator handrails or be accidentally knocked off by a user. Possible solutions will be using metal bars to grip onto the underside of the escalator handrails or using suction cups onto the side of the escalator.

Thirdly, the group will redesign the components of the spray device to add indicators showing the volume of anti-bacterial solution left and allow the spray container to be opened and closed easily for refills of the anti-bacterial solution.

Lastly, the positioning and scales of the components can be changed for them to be complementary to the shape of the container, allowing it to be compact and space-efficient. Also, the design needs to be tested to ensure that the droplets antibacterial liquid sprayed onto the handrails will not diffuse into the device, interfering with the components in the device.

4. Referencing and citation

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