11-09

Construction of a hook-like device to prevent skin contact with common surface to prevent the spread of COVID 19

Foong Zi Heng 3A1 08

Affan Pathan 3P2 01

Lin Xin Yao 3A1 18

Wong Zen Joi, Lionel 3A1 31

2020

Abstract

The current COVID-19 Pandemic has resulted in many people being more mindful of the cleanliness of objects around them, and thus more conscious when in contact with common surfaces. As such, there is a rise in demand for appliances such as self-disinfecting coating and devices to minimise contact with common surfaces and reduce the transmission of viral particles onto one's hands. One such device is a hook-like device. However, current market products are expensive yet incapable of allowing people to comfortably turn door handles with the device. Thus, we have created a hook-like device which is cheap and effective in turning door handles to cater to the general public who are unable to afford the expensive current market products and still be able to reduce their contact with potentially virus-contaminated common surfaces such as door handles, reducing the risk of getting infected with diseases. The use of PLA has been proven to be good antibacterial material (Maróti, P., Kocsis, B., Ferencz, A. *et al.,* 2019) and thus effective in reducing the risk of transmission of diseases. This, together with the implementation of a padding, has resulted in our product being comfortable to use, efficient and effective in its purpose.

Introduction

The COVID-19 Pandemic has been one of the most difficult global health crisis the world has ever faced in the modern ages, with countries facing great challenges in trying to control the spread of the disease. There has been more than 20 million recorded cases, and more than 700 thousand people have perished from being infected by the virus. From this health crisis, many people have become more concerned about their health and hygiene, and will do anything to reduce the chances of being infected or spreading a contagious disease, such as SARS-CoV-2, which has caused the current pandemic that we are currently facing. Door handles are one of the most commonly touched areas, and thus possess a risk of transmission of contagious diseases through direct contact with such surfaces. According to the Centers of Disease Control and Prevention in the United States, diseases such as SARS-CoV-2 may remain viable for hours to days on surfaces made from a variety of materials. This shows that contagious diseases can remain on these commonly touched surfaces for long periods of time, and thus can risk infecting thousands of people.

There have been several proposed solutions to minimise direct contact with door handles. The most common solution is the development of a hook-like device so as to grip these surfaces while minimising direct contact with the surfaces and thus reducing the risk of infection. However, current market products have been proven to be expensive and have several issues, of which the most common one is the limited space for grabbing the device, and the difficulty of turning door handles due to the shape of the handle and the grabbing part, which results in hands getting cramped and injured by the use of such devices. Moreover, the price of these devices are very high, which results in many people not willing to buy or even being able to afford to possess such a device, which will result in people just directly touching door handle surfaces, which will result in the risk of transmission of diseases in the community. Thus we decided to create a hook-like device which addresses all the problems the current market products have, and thus make it easier and more efficient in using such devices, and thus results in the minimisation of direct contact with door handle surfaces, and thus reduces the risk of transmission of contagious diseases.

Proposed Solution

The final product is a hook-like device consisting of a circular hook large radius so as to fit larger door handles. The product also consists of a handle which is rectangular and not enclosed so as for the users to use it more comfortably. There is also a padding on the inner circumference of the hook so that there is more grip and friction when in contact with the door handle, which will prevent the device from easily sliding off the door handle when pulling it down.

2.1.1: First Prototype (Wooden Prototype)

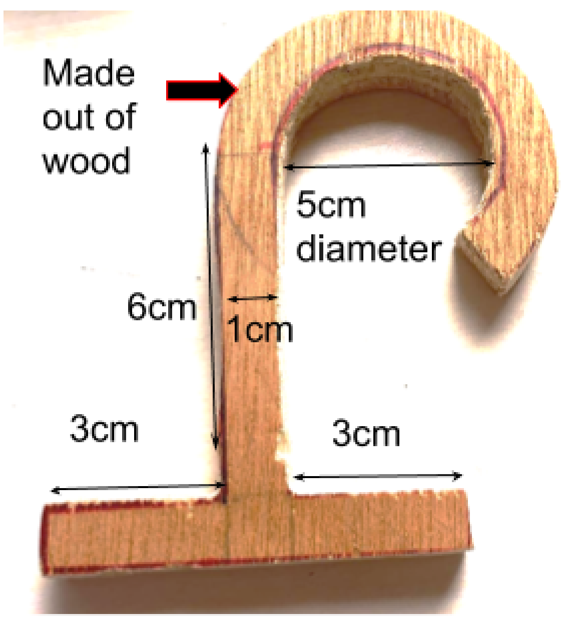

Fig. 1 showing a picture of our first prototype

The first prototype was made out of wood. The thickness of the wooden hook was 1cm, with the prototype having a 5cm diameter. This allowed the device to be used on larger door handles. However there were several problems with the device. The first issue with the hook was that it was cut by hand and not by machine. This resulted in the device having uneven edges which resulted in the device not being so comfortable to use. The material was also the main problem with the effectiveness of the device. The device is made out of wood, which is porous. This thus resulted in the possibility of viruses and harmful bacteria being able to go into the device and breed there, which renders the device useless in achieving its aim. The material is also quite weak, which would result in a risk of breaking when pressure is exerted on it when it is in use, as was evident when the device began to make cracking sounds when using it to pull down the door handle. Thus this product was ineffective in achieving its aim of risking transmission of diseases.

2.1.2: Second Prototype (3D-Printed device)

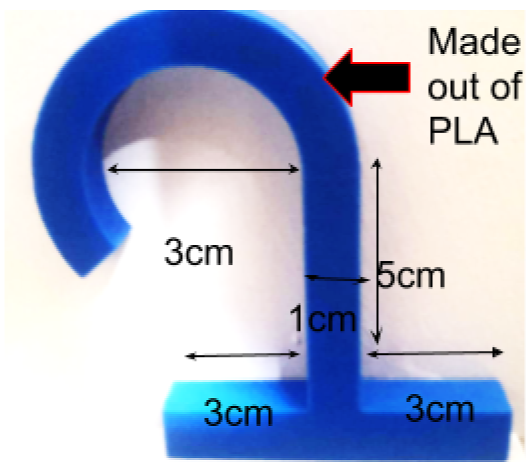

Fig. 2 showing a picture of our second prototype

The second prototype was 3d-printed and made with Polylactic acid (PLA). We used PLA-based materials have been shown to be good antibacterial materials and can be used for various biomedical devices (Maróti, P., Kocsis, B., Ferencz, A. *et al.,* 2019). This will in fact allow us to achieve the aim of reducing risks of transmission of diseases as it is not a suitable breeding ground for bacteria and viruses. Furthermore, we decided to make a 3D-printed model as it reduces the risk of human error and results in the device to be smooth and more comfortable for the users to use it. However, with this prototype, several problems arose. Firstly, the diameter and length of the hook was reduced as we wanted to see if we can make it easier for the users to carry it while still being able to use it on large door handle surfaces. However, this proved ineffective as the length of the hook was too short, resulting in the fingers touching the handle surface directly when in use, which immediately rendered the prototype ineffective in achieving its purpose. Moreover, the diameter was too small, preventing it from properly hooking onto larger door handles. We also realised that since the hook had a smooth outline, the hook would often slip off the door handle when pulling it down. This resulted in the addition of components in our final prototype shown below.

<u>**2.1.3: Final Prototype (3D-Printed device)**</u>

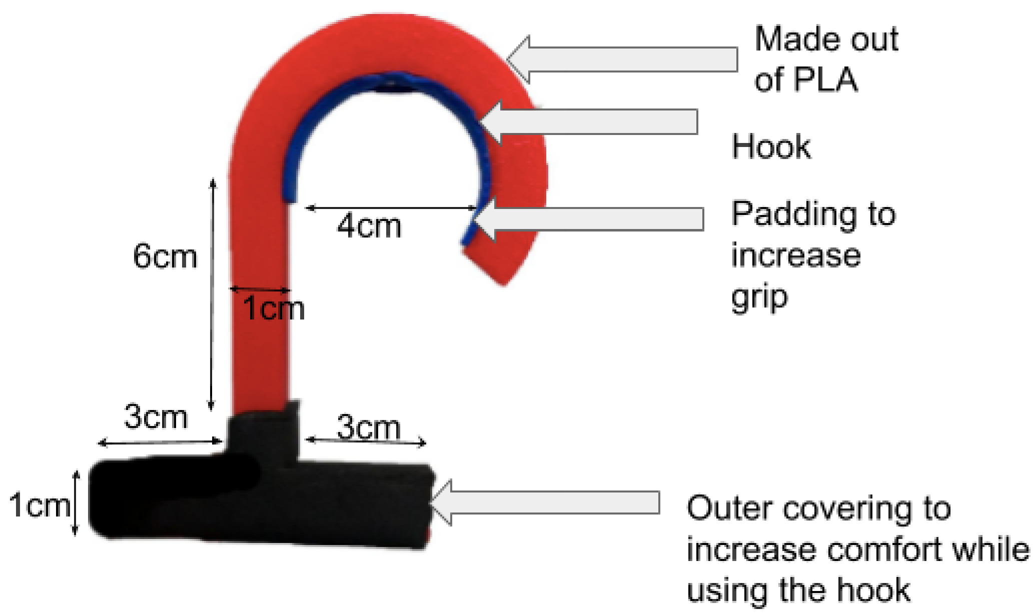

Fig. 3 showing a picture of our third prototype

The final prototype was also 3D-printed and made out of PLA. This prototype is similar to the 2nd prototype, but with improvements made on it. The diameter of the hook was increased back to 4cm so that it can fit larger door handles easily so that it can be used over a larger variety of door handles. The length of the device was also increased back to 6cm so that there was enough space for larger hands to grab the device and use it on door handles and not directly come into contact with the handle surfaces, which would thus achieve its aim in minimising direct contact with door handle surfaces and in turn reducing risk of being infected with a disease. The device is also equipped with a padding made of styrofoam, so as to increase friction with the handle surface when in contact with it.

Fig. 4a showing the position of hook before pulling it down

Fig 4b showing the position of the hook after pulling it down

Fig. 5a showing the position of hook before pulling it down

Fig 5b showing the position of the hook after pulling it down

The device also has an outer covering at the handle of the device so that the users can use the hook more comfortably. The device thus is successful in its purpose in minimising direct contact with door handle surfaces and in turn reducing risk of transmission of diseases, while increasing comfort when using it, and increasing efficiency by the addition of the padding in the hook.

2.2: Why is our hook better than current market products?

Our hook is better than current market products for a number of reasons. First, our hook is much cheaper than the current market products. Current market products are very expensive, with prices averaging above S$15, with some reaching prices of over S$25. The price of PLA is around US$25, which is around S$34 (Flynt, 2017). Since the mass of our product is only 0.02kg, which is lighter than the market products due to the use of a lighter material, the cost of making 1 hook device is around $1 when including the price of styrofoam used for the padding and the outer covering. This shows that our product is much cheaper than the products currently available, which definitely is cost-efficient as compared to other products.

Our hook is also much more comfortable and efficient to use. As seen in current market products, there is very limited space to grab the device, and coupled with the orientation of the handle portion, it will result in the hands getting cramped and injured due to the large force exerted on the fingers when pulling down the door handles. Our device solves this issue by leaving the handle portion as an open space, and having a vider length so that more fingers and larger fingers can be placed to use the device, resulting in a decrease in average force exerted on the fingers. The device also has an outer covering made out of styrofoam, a soft material, which cushions the fingers, allowing users to use the device more comfortably. Current market Products are also made of materials which are smooth, and do not contain any material to increase friction with the handle surface when in contact with it, which results in numerous occasions of slippage. The addition of the padding in our hook increases friction between hook and door handle thus it prevents slippage when pulling down the door handles, which results in our device being more efficient than current market products.

2.3: Other uses

Our device can be used for all pol-like structures, such as handrails and poles in common areas such as shopping malls, buses and trains. Our device can also latch onto hand straps in buses and trains.

Fig. 6 showing our device used for latching onto hand straps in MRT trains

Fig. 7 showing our device used for grabbing poles in MRT trains

Future work recommendation

We could make the hook adjustable to fit door handles that are bigger. We could also add a permanent anti-microbial coating such as silver or use antimicrobial PLA to 3D print. We did not have enough time to include the coating on our prototype or use antimicrobial PLA to 3D print as we were unable to gain access to these resources due to Covid-19 restrictions. Silver has been used for its antimicrobial properties for many years, and it was shown to be quite effective against p. Aeruginosa. Silver coating has provided a statistically significant reduction in bacteria presence. Also, future project development is needed to ascertain its antibacterial properties from the coating.

Conclusion

Our hook is effective at grabbing, pulling and pushing commonly used surfaces such as door handles with ease. It is user friendly and cheaper than similar products in the market. Limitations include incompatibility with door knobs and maintenance of wear and tear of the product.

To test if our product is effective in reducing the spread of the coronavirus through contact with door handles, we could carry out the following procedures:
Add harmless bacteria onto a door handle. The participant will first use his bare hands to grab the door handle, and hold onto it for 5 minutes. Then take a sterile swab and swab a finger thoroughly. Culture this specimen onto a plate and label it "Specimen A". Remove bacteria on hand thoroughly. Next, the participant will use the prototype to grab the door handle, and hold onto it for 5 minutes. Then tak a sterile swab and swab the same finger thoroughly. Culture the specimen onto another plate and label it "Specimen B". Incubate the plates at 310 K for around 30 minutes to 1 hour. Compare the 2 specimens and see if specimen B has reduced bacterial presence. Repeat the experiment 3 times under similar conditions.

Acknowledgement
We would like to acknowledge and extend our deepest gratitude to the following individuals;
Our school mentor, Madam Chan Hwee Sing, for providing us with guidance along this whole journey. Madam Chan has been very supportive and was always there to help us when we were in need. She helped us change our project to the current project we are doing and helped us complete it within the span of 2 months.
The SRC lab staff for providing us help and materials for the project.
The Makerspace staff for providing us with help and advice.

Referencing & Citations

Cleaning and Disinfection for Households. (n.d.). Retrieved August 09, 2020, from https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/cleaning-disinfection.html

Getting your workplace ready for COVID-19. (n.d.), Retrieved August 09, 2020, from https://www.who.int/docs/default-source/coronaviruse/getting-workplace-ready-for-covid-19.pdf#:~:text=When%20someone%20who%20has%20COVID,%2C%20nose%20or%20mouth.

Home. (n.d.). Retrieved August 09, 2020, from https://www.statgeartools.com/hygiene-hand/

No-Touch Handheld Door Opener or Closer with Key-Chain-Hole to Easy Hanging. (n.d.). Retrieved August 09, 2020, from https://www.amazon.sg/No-Touch-Handheld-Opener-Key-Chain-Hole-Hanging/dp/B088TMQR7Z/ref=asc_df_B088TMQR7Z/?tag=googleshoppin-22

Open, hold & close doors safely. (n.d.). Retrieved August 09, 2020, from https://www.hygienehook.co.uk/

Parker-pope, T. (2020, May 28). What's the Risk of Catching Coronavirus From a Surface? Retrieved August 09, 2020, from https://www.nytimes.com/2020/05/28/well/live/whats-the-risk-of-catching-coronavirus-from-a-surface.html