Safe-to-Touch: Tracking Touched Areas in Public Transport

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Abstract. Risk areas for smear infections in public transport stay generally unnoticeable for passengers. However, touching a handrail can be similar to shaking hands with a thousand people. Although prior research looked into self-cleaning materials to tackle such issues, little has been done to make touched areas more transparent to passengers. In this work-in-progress, we present our idea of "Safe-to-Touch", a handrail indicating prior touch points until completed self-cleaning. We prototyped a first interactive version and introduced the idea, including photos of it, in an online survey with 52 participants. Our preliminary results showed that 98.1% of participants would probably change their touch behaviors according to our handrails' indications and would appreciate the increased transparency.

Keywords: touch surfaces, public transport, interactive handrail.

1 Introduction

Handrails in public transports are touched daily by thousands of people. Hence, these shared touch surfaces pose a high risk for smear infections. In a study with undergraduate students, Fierer et al. found that each student carried a minimum of 150 different bacteria species on one hand alone [3], which can be distributed via common touch surfaces. Prior work in material science and engineering approached the topic by researching self-cleaning materials and infection risk-reducing mechanisms [1]. However, little has been done to communicate increased risk areas to passengers and to enable them to consciously avoid previously touched areas.

In this work-in-progress, we introduce our idea for "Safe-to-Touch", a handrail coated with copper, a material with self-cleaning properties. In addition to being self-cleaning, the handrail can track touched areas for 120 minutes and indicate its increased smear infection risk with light indications. According to Querido et al. [2], 120 minutes is the time frame in which copper self-cleans 99% of its surface. In this first step, we aimed to build a simple setup that only communicates its touched areas and their state to its passengers. The idea is to enable passengers to make a more active, conscious choice about where to touch public transport. It could increase passengers' socio-spatial awareness of other passengers' touch behaviors by making touch traces visible, potentially decreasing the smear infection risk. We see the relevance of this topic in the recently increased awareness of hygiene and the insecurity in recognizing infection sources, which have evolved throughout the COVID-19 pandemic.

We approached this topic in a user interface design course with "revealing human traces" as an overarching project theme. Considering the motivation mentioned above, we applied a user-centered design approach beginning with desk research about passengers' behaviors and infection risks in public transport. Based on our findings, we developed the idea of "Safe-to-Touch". We developed an interactive prototype, which we evaluated in an online survey ($N = 52$) to gather feedback on the concept and its design. The results showed that all participants who used handrails in public transport would probably adapt their touch behavior according to our prototype's indication. Below, we give a short overview of prior research about public transport measurements before presenting "Safe-to-Touch" and our online study results in more detail.

2 Related Work

Prior work discovered that the infection risk via shared touch surfaces in public transport is high and exponentially increasing [4, 5]. The majority of work focused on tracking and identifying the infection risk, excluding potential countermeasurements. Others explored potential solutions in the form of self-cleaning materials [1], mechanisms[1] or behavioral guidelines[2] for passengers.

Regarding handrails, Vargas-Robles et al. [6] showed that the majority of passengers (99%) interacted with handrails during their rides, contributing to the bacteria exchange. The mass of bacteria even resettled already 5 to 30 minutes after cleaning handrails. Therefore, this leaves a small time frame for passengers not to get in contact with others' bacteria in public transport.

However, only very few studies approach the topic from a Human-Computer Interaction (HCI) perspective, which focuses on passengers as end-users in a real-time and in-situ interaction. Hence, we see a gap in the current research discourse, which opens a broader range of design opportunities.

3 *Safe-to-Touch*: Development and Testing

We applied a user-centered design approach, beginning with desk research. This was followed by the concept development and prototyping of "safe-to-touch". Finally, we evaluated it in an online survey with 52 participants.

Our desk research revealed a gap in communicating areas of increased smear infection risks to passengers. We decided to focus on handrails in particular, because more than 99% of passengers are touching them.

[1] https://bit.ly/39tOEyR, last accessed March, 28th 2020
[2] https://bit.ly/31tQag0 and https://bit.ly/3sC0K0t, last accessed March, 28th 2020.

3.1 Safe-to-Touch Prototype

Based on our prior desk research, we defined some requirements to be considered in the prototyping: 1) Using anti-bacterial materials to reduce infection risks. 2) Revealing touched areas until the completion of the self-cleaning process. 3) Creation of sub-sections so that passengers can vary touch positions according to the indication. 4) Applying an easy-to-understand indication to enable immediate decision making and touch reaction.

Based on those requirements, we built the first low-fidelity prototype to iterate on the indication design. We compared color choices, positions, and sizes using modeling clay and cardboard. After making several grip tests, we decided to create a pole with three subsections. Each included an independent indication consisting of an LED strip that changes color according to the current touch state. The handrail differentiates between three states: 1) default, untouched, 2) "currently-touched" and 3) "in-cleaning-mode" state, each representing a different phase of touch interaction. We considered the ISO 22324 guidelines for color-coded alerts [3], and chose green for the default, a neutral color for the second touch state, and red for the third. The LED strip was attached along the handrail's length with a slightly raised profile. This made it visible from many angles while leaving as much area as possible for actually gripping the handrail. An Arduino microcontroller measured the time passed since the last registered touch on each section.

3.2 Online Survey

We conducted an online survey with 52 participants of mixed age groups. 32 of them were 18 to 28 years old, ten were from 29 to 45, and another ten were 46 and older. All were or had been (before COVID-19) frequent users of either subway, bus, or city trains. We introduced photos of our prototype with the concept idea descriptions to participants, asking them to give their opinions on its design and functionality and their perceptions of hygiene in public transport (on a Likert-scale from 1: negative perception to 5: positive perception).

3.3 Preliminary Results

Thirty-one participants reported on an increasingly negative perception of hygiene in public transport since the beginning of the COVID-19 pandemic. Another 13 remained neutral, and the remaining 8 slightly positive. Considering the handrail, a vast majority (94.1%) indicated that they would feel more comfortable with "Safe-to-Touch" compared to current handrail solutions. Also, 98.1% stated that they would change their touch behavior according to our prototype's indication. The remaining 1.9% explained that they already avoided handrails and hence, would not change their behavior. Participants further indicated that our proposed color combination was understandable.

[3] https://www.iso.org/standard/50061.html, last accessed March 28th, 2020.

4 Conclusion, Limitations and Next Steps

The current status of “Safe-to-Touch” satisfied participants’ interest and needs to be better informed of potential risk areas for smear-infection. The topic is essential because of the increased hygiene awareness, especially with the global pandemic of COVID-19. Prior research focused on automated, nontransparent measurements or behavioral guidelines handed out to passengers. However, little research was looking into real-time, real-place feedback, which is a contribution of our poster. However, our study also has some limitations. First, our concept and prototype are still in an initial state, even though they can be further improved by, e.g., integrating self-cleaning mechanisms that speed up the process. Also, our evaluation approach did not make people interact directly with the prototype but relied on the provided pictures and the description. For future steps, it might be helpful to use thermochromic paint or other touch-reacting materials to indicate touched areas more precisely and leave more surface as alternative touch places for passengers. Also, to properly test the color indications’ effect, we will try the handrail in an actual usability study with users approaching the handrail from different angles. Finally, we wish to spark an interesting discussion about the design opportunities for revealing passenger-to-passenger touch interactions in public transport with this poster.

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