Toby Chappell

CPSC 390

**Artificially Intelligent Sink**

**Problem**

One of the largest issues we are currently dealing with on a global scale is sanitation. With the spread of COVID-19, cleanliness has become of upmost concern with an emphasis on handwashing frequently and effectively. However, while handwashing has just recently come into everyday news cycles due to the outbreak, proper handwashing has always been an issue even in this modern age. Studies have shown that if everyone on a global scale properly washed their hands, a million deaths per year could be prevented [1]. The reason for this is because handwashing helps remove germs from hands which in turn prevents the spread of illnesses and infections. As such, it is important to develop tools and products to help that encourage individuals to partake in proper handwashing.

**Why AI?**

Currently, the global average of people who wash their hands after using the restroom is only 19% [2]. To help alleviate this problem, the idea of this product is to send an alert when someone exits the bathroom without washing their hands. As such, it aims to encourage the consumer to wash their hands when they forget to or simply choose not to wash their hands. While this product can be used by adults, it can be better targeted for children. Around the world, nearly 1.8 million children under the age of five die from diarrheal diseases and pneumonia [3]. It is estimated that a third of these deaths related to diarrheal diseases and a fifth of these deaths resulting from respiratory infections can be prevented with proper handwashing [4]. Furthermore, from a practicality standpoint, how often does a parent ask their children this simple but unforgettable question, “Did you wash your hands?” By using AI to solve this problem, this question never needs to be asked again. Not only that, but it provides certainty if their child washed their hands or not (since quite obviously children are capable of lying). As such, using AI to help encourage proper handwashing helps to improve the hygiene of each household member and to prevent the spread of germs and diseases.

**Solution**

In order to help encourage handwashing in the household, I designed an AI-enabled bathroom sink. In terms of specifications, the sink is motion activated, meaning that when someone places their hands under the sink it starts running. It will then run until the person takes their hands out of the sink. If the user exits the bathroom without washing their hands (or in other words do not activate the sink once), an alert is sent. The greatest challenge with implementing this idea is to determine when to send a message to the recipient. This issue can be solved through the use of planning as seen by the following formulation.

Variables:

P = Person in the bathroom

P’ = Person to send alert to

B = Bathroom

S = Sink (in bathroom)

States:

IN(P, B) = Person is in bathroom

SINK\_ON(S) = Sink is currently on

HANDS\_IN\_SINK(P) = Person has hands in sink

HANDS\_WASHED (P) = Person has washed their hands

ALERT(P) = Person is alerted that someone has not washed their hands

Actions:

Go-To-Sink

P: IN(P, B), ¬SINK\_ON(S), ¬HANDS\_IN\_SINK(P)

E: HANDS\_IN\_SINK(P)

Activate-Sink

P: IN(P, B), HANDS\_IN\_SINK(P), ¬SINK\_ON(S)

E: SINK\_ON(S)

Stop-Washing-Hands

P: IN(P, B), HANDS\_IN\_SINK(P), SINK\_ON(S)

E: ¬HANDS\_IN\_SINK(P), ¬SINK\_ON(S), HANDS\_WASHED(P)

Go-Out-Bathroom

P: IN(P, B), ¬SINK\_ON(S), ¬HANDS\_IN\_SINK(P)

E: ¬IN(P, B)

Send-Alert

P: ¬IN(P, B), ¬HANDS\_WASHED(P), ¬HANDS\_IN\_SINK(P)

E: ALERT(P’)

Initial State:

The algorithm starts running when someone enters the room meaning that the initial state is: IN(P, B), ¬SINK\_ON(S), ¬HANDS\_IN\_SINK(P)

Goal:

In order for the sink to notify the user, the following condition must be true: ALERT(P).

Sequence of Actions:

An alert is not sent assuming the person properly washes their hands. The sequence in which an alert is not sent is as follows: Go-To-Sink, Start-Washing-Hands, Stop-Washing-Hands, Go-Out-Bathroom. If the consumer exits the bathroom without meeting this sequence, an alert will be sent.

Additional Improvements

While the following features are not necessary in order to make the project function properly, they could be implemented in the design as well. For one, the product can keep track of how long the consumer has been washing their hands for while in the bathroom. If they do not wash their hands for the appropriate amount of time (around twenty seconds), an alert can be sent. Additionally, the sink itself can beep or flash a light to notify when they have washed their hands for long enough. Lastly, to help encourage the use of soap, there can be an automatic soap dispenser as well which is triggered during the washing cycle.

**Feasibility**

The solution presented here is actually quite feasible in terms of actual implementation. There would only be two sensors would be required: one to monitor the sink and the other to monitor the doorway. The sensor monitoring the sink should turn on the sink if it senses someone’s hands below the faucet and then send a signal to the other sensor that they washed their hands. In addition, the sensor monitoring the doorway should be able to retrieve a signal from the sink and send an alert if someone exited the room without the sensor receiving a signal from the sink. Lastly, the materials required for this product are relatively affordable in comparison to other products on the market.

One limitation to this design is that it can only really be used in a household setting. The reason for this is because this design can only be applied to an enclosed area and should be somewhere where handwashing is essential. Moreover, it doesn’t take into account that there are other activities that should require handwashing besides using the restroom. For instance, handwashing is important when preparing food, taking out the garbage, or caring for someone who is sick [5]. Since these activities don’t take place in an enclosed environment like a bathroom, they would not (and could not) be accounted for. However, while this may not be a perfect solution to the ensurement of handwashing when appropriate, it would help improve and encourage the general sanitation of the household.

**Timeframe**

Since automatic faucets are becoming more frequently seen in everyday life and the additional components are already available, this product has the potential to be implemented now. However, since this product is more tailored for families especially with young children, it is highly unlikely that this will become “commonplace” in the home. As such, the product should be able to be implemented fairly quickly and can be sold at an affordable price, meaning that it could potentially become a “household product” in only a few years.

**Works Cited**

[1] V. Curtis and S. Cairncross, “Effect of washing hands with soap on diarrhoea risk in the community: a systematic review,” *Lancet Infect Dis*, vol. 3, no. 5, pp. 275–281, May 2003, doi: 10.1016/s1473-3099(03)00606-6.

[2] M. C. Freeman *et al.*, “Hygiene and health: systematic review of handwashing practices worldwide and update of health effects,” *Trop. Med. Int. Health*, vol. 19, no. 8, pp. 906–916, Aug. 2014, doi: 10.1111/tmi.12339.

[3] L. Liu *et al.*, “Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000,” *The Lancet*, vol. 379, no. 9832, pp. 2151–2161, Jun. 2012, doi: 10.1016/S0140-6736(12)60560-1.

[4] A. E. Aiello, R. M. Coulborn, V. Perez, and E. L. Larson, “Effect of hand hygiene on infectious disease risk in the community setting: a meta-analysis,” *Am J Public Health*, vol. 98, no. 8, pp. 1372–1381, Aug. 2008, doi: 10.2105/AJPH.2007.124610.

[5] “When and How to Wash Your Hands | Handwashing | CDC,” Apr. 23, 2020. https://www.cdc.gov/handwashing/when-how-handwashing.html (accessed May 19, 2020).