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Personal Hand Safety Monitoring System

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ABSTRACT

Techniques for monitoring user hand health and safety, estimating risks associated with user hand activity, and generation of suitable user alerts based on the estimated risk are described. With user permission, wearable devices such as AR headsets are utilized to determine a state of health of a user's hands based on user activities and the user's interactions with their environment. Actions such as hand washing, disinfecting, cleansing, etc. are identified. Machine learning models are utilized to identify the user practices based on observed user behavior. Protective hand wear use is identified, and surfaces, objects, and/or people touched by a user during the course of the user's activities are monitored. A hand contamination index for the user is generated based on monitored parameters. Based on the determined hand contamination index and an analysis of a user's potential activity, suitable alerts are generated and provided to the user.

KEYWORDS

- Augmented reality (AR)
- Mixed reality (MR)
- Hand overlay
- Safety alert
- Contamination
- Haptic feedback
- Infectious disease

BACKGROUND

Many infectious diseases, e.g. food borne diseases, respiratory ailments, etc. are spread via human hands. Keeping hands clean is an important step towards avoiding and spreading illness. Many diseases and conditions are spread by users not being aware of the state of health, e.g., contamination, of their hands. Augmented Reality (AR) and Mixed Reality (MR) wearables such as glasses provide an enhanced experience to users. AR glasses include cameras that capture images of the environment surrounding the user that wears the glasses. The captured images include animate and inanimate objects in the user environment, and can provide valuable information about the state of health of a user's hands.

DESCRIPTION

This disclosure describes techniques for monitoring user hand health and safety, estimating a risk associated with user hand activity, and generation of suitable user alerts based on the estimated risk. Per techniques of this disclosure, implemented with user permission, wearable devices such as AR or MR headsets are utilized to determine a state of health of a user's hands based on user activities and the user's interactions with their environment, e.g., other humans, objects, food, etc. The state of hand health is determined by monitoring the types of object(s) handled, people interactions, as well as user practices such as hand washing, use of protective equipment such as gloves, etc.

Machine learning techniques or other suitable techniques are utilized to monitor the state of hand cleanliness based on identification of the types of objects and surfaces that the user's hands came in contact with. Based on the determination of the state of health of the user's hands and/or impending user activity, alerts are generated to provide suitable information to the user.

The alerts may be provided as hand overlay images, haptic feedback, etc., and can serve to indicate how contaminated the user's hands are likely to be, determined based on the people and surfaces that the user was in direct contact with. The alerts can additionally be provided via a real-time display of the headset. The alerts can also be adjusted to specific policies regarding hand health and safety, e.g., such as policies tied to particular locations. Based on user preferences, the hand safety monitoring techniques as described herein can be implemented such that all obtained user data is processed locally on the user's personal device.

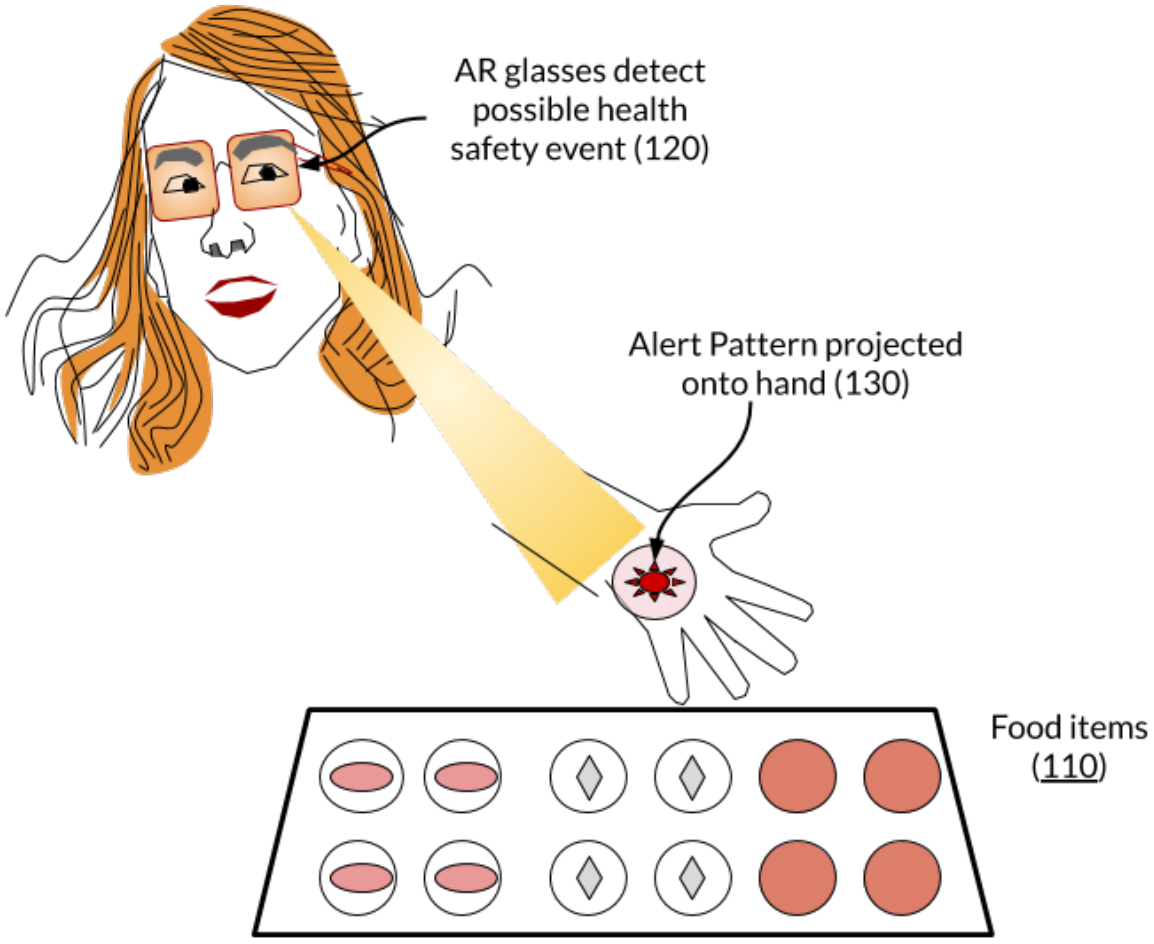

Fig. 1: Suitable alerts are generated based on user interactions

Fig. 1 illustrates an example of the generation of an alert based on hand safety monitoring. In this illustrative example, a user is at a conference and has interacted with many other conference attendees, including shaking hands with many of them. With user permission, the user's interactions are monitored via images received at the camera(s) of the user's AR glasses.

At the conference, the user is detected to be reaching for a food item on a tray (110). The user is also observed, as part of the hand safety monitoring, to not have washed their hands after their prior interactions with other attendees. Based on the observations, it is determined that the activity of the user reaching for the item, having interacted with multiple people and without subsequent hand-washing, poses a risk that meets a predetermined risk threshold (120). A visual alert, e.g. a red pattern, as depicted in Fig. 1, is provided on the user's hands to serve as a reminder to the user (130).

Still further, if the user is observed to continue with the activity, additional alerts, e.g., haptic feedback via the AR glasses or other wearable device, a visible interrupt on the hands or via a display of the AR glasses, or an audio warning via a speaker associated with the AR glasses can also be provided to the user. The type of alert can be selected based on a degree of determined risk posed by the impending user activity.

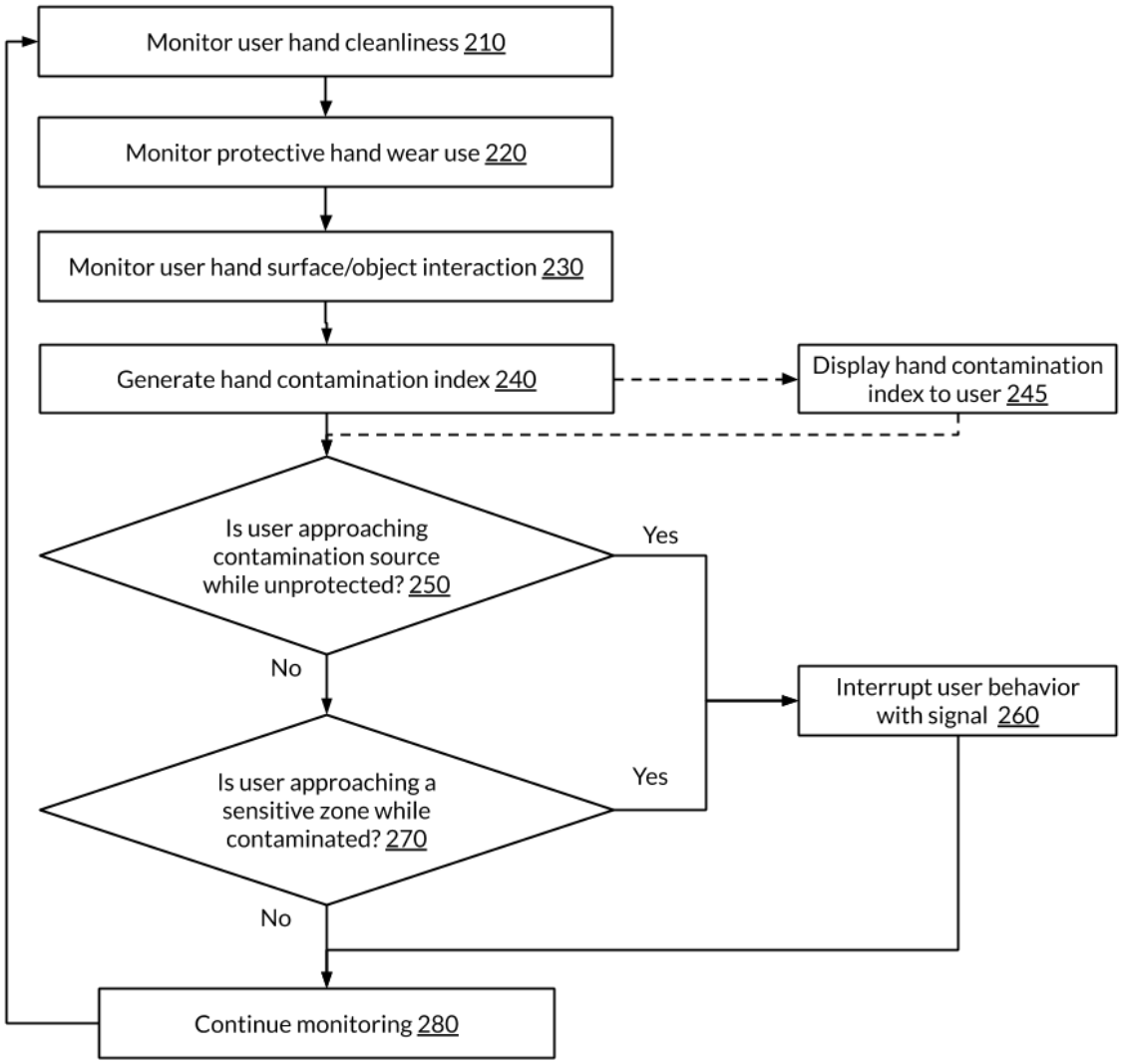

Fig. 2: Monitoring of hand health and generation of alerts

Fig. 2 depicts an example workflow for monitoring of hand health and generation of alerts, per techniques of this disclosure. With user permission, the monitoring of hand health includes monitoring of hand cleanliness (210), of protective hand wear use (220), and of user interaction with surfaces, objects, and other humans (230). In this illustrative example, blocks 210, 220, and 230 are depicted in a certain sequence; it will be appreciated that the blocks can be performed in a different sequence and/or in parallel.

Monitoring of hand cleanliness (210) includes monitoring user practices such as hand washing, disinfecting, cleansing, etc. Machine learning (ML) models or other techniques can be utilized to identify the user practices based on observed user behavior. Protective hand wear use (220) of the user is identified. For example, ML models can be utilized to identify various types of gloves or other protective hand wear utilized by the user as they go about their activities.

The surfaces, objects, and/or people touched by a user during the course of the user's activities are also monitored (230). The touched surfaces are identified and categorized, e.g. organic, metallic, human, pet, etc. Again, ML models or other suitable techniques can be utilized to identify surfaces touched by the user.

A hand contamination index for a user is generated (240) based on the monitored parameters described above. The hand contamination index is a type of threat index and/or risk index that is determined based on an analysis of user hand cleanliness, protective hand wear utilized by the user, surfaces touched by the user, and determination of a statistical likelihood of hand contamination.

Hand monitoring can include an identification of potential surfaces that the user can pass contamination, sensitive zones and locations, such as restrooms, food preparation areas, etc. as well as medically sensitive areas, e.g., hospital rooms, clinics, etc. The hand monitoring can also utilize head mounted cameras and/or simultaneous localization and mapping (SLAM) cameras to determine user actions such as reaching toward their face, ears, etc. Users can also specify safety standards based on individual or group preferences for levels of protection for themselves, surfaces they interact with, and for cross contamination.

The hand contamination index is communicated to the user (245), e.g., by a display via a hand overlay that is indicative of a level (degree) of estimated contamination of the user's

hand(s). For example, a green pattern displayed can indicate that the user's hands have a low level of contamination, and a red pattern can be indicative of a high level of contamination. A visible indication of contamination can be provided via a projected pattern, or using a display of the AR glasses, e.g., using masks.

Based on the determined hand contamination index and an analysis of a user's activity and potential activity, suitable alerts are generated and provided to the user. As part of hand safety monitoring, it is determined whether the user is observed to be approaching a potential contamination source while the user's hands are unprotected (250).

For example, the user may be about to touch a chemically contaminated lab bench without wearing their gloves. In another example, surface contamination can be detected based on live mapped surfaces, e.g., if the user is about to purchase food from a location where food preparation counters haven't been washed adequately. In such a scenario, an alert (signal) is provided to the user (260). Alerts can also be generated based on prior detected contamination events.

It is determined whether the user is approaching a potentially sensitive surface/object while their hands may be contaminated (270). For example, it may be determined that the user may be about to touch a high traffic surface, e.g. a doorknob, while their hands are at a high state of contamination. This can trigger an alert (signal) that is provided to the user (260).

If the user permits, an audit trail of hand protection and safety processes followed can also be generated and/or recorded.

Examples of use

- ***Workplace Policy:*** Bertram works at a sandwich deli. Bertram handles a customer's credit for payment and then goes back to open the deli case to prepare sandwiches. Based

on workplace policy, which requires employees to wash hands before food preparation, a message "REQUIRED: * WASH HANDS *DON GLOVES *," per workplace policy is displayed on Bertram's hands in flashing red. The message serves as an immediate alert for Bertram to take steps to be in compliance with workplace policy. A similar message can be displayed after employee use of a washroom, and if the employee has been detected to not have washed their hands.

- ***Procedure guidance:*** Natalie is a hospital worker and is required to wash or disinfect her hands using a specific procedure that specifies a quantity of soap, a length of time, etc. Natalie receives specific instructions on the procedure, via a display of her AR glasses, as a reminder at a suitable time as well as warnings if it is determined that her disinfection process is out of compliance.
- ***Safety protocols:*** Jose is an engineer at an electronics research lab, where his employer specifies appropriate protection, e.g. safety goggles, anti-static strap, etc. when at his workbench. Based on Jose's identified location, based on his surroundings, and surfaces that he is likely to interact with, Jose is provided with a reminder of suitable protection measures as he approaches the workbench to commence work. In addition to workplace specified protection measures, safety information such as electrical safety information, first aid information, chemical safety information, etc. can be provided to users based on an analysis of identified surfaces, locations, tools, etc. in the vicinity of the user.
- ***Suggested actions:*** Kemar works in a bar, and it is determined that his estimated hand contagion count exceeds a predetermined threshold. As Kemar approaches a restroom or hand-wash station, a suggestion to wash hands is provided to Kemar.

Per techniques of this disclosure, a hand safety monitoring and alert generation system is described that is a comprehensive solution that analyzes user hand activity, their state of protection, and potential risks from other objects and surfaces. The hand safety monitoring system can be effective at promoting user safety and preventing the spread of infection and other contaminants. User awareness of their hand health can also promote user hand hygiene. The system can be gainfully utilized in household, social, general workplace, as well as professional medical settings.

CONCLUSION

Techniques for monitoring user hand health and safety, estimating risks associated with user hand activity, and generation of suitable user alerts based on the estimated risk are described. With user permission, wearable devices such as AR headsets are utilized to determine a state of health of a user's hands based on user activities and the user's interactions with their environment. Actions such as hand washing, disinfecting, cleansing, etc. are identified. Machine learning models are utilized to identify the user practices based on observed user behavior. Protective hand wear use is identified, and surfaces, objects, and/or people touched by a user during the course of the user's activities are monitored. A hand contamination index for the user is generated based on monitored parameters. Based on the determined hand contamination index and an analysis of a user's potential activity, suitable alerts are generated and provided to the user.

REFERENCES

1. Show Me the Science - Why Wash Your Hands?, accessed on July 25, 2020.