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A personal safety monitor for hands

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Abstract

A system to monitor hands, while a person moves around in his surroundings, and to protect the hands from contamination or harm is disclosed. The person is immersed in a mixed reality (MR) environment and wearing a head mounted display (HMD) device. The HMD device includes an imaging device and a scene categorization unit. A video captured by the imaging device is being fed continuously to the scene categorization unit. The scene categorization unit classifies a scene of the surroundings into a scene category. The scene category can be a sensitive location (for example, a restroom, a medical room, an industrial scene, *etc.*) or a safe location. If the scene is classified as the sensitive location, an object recognition algorithm is utilized to identify objects and surfaces in each frame of the video. A contamination detection unit then performs a template matching of each of the surfaces and the objects identified in each frame with each of a first library of images and a second library of images. The first library of images contains images of sample objects and sample surfaces which are prone to contamination by germs. The second library of images contains images of sample objects, such as tools, materials, equipment, *etc.*, which are harmful/dangerous for the person. Based on results of the template matching, a contamination level or a danger level is displayed as a first virtual overlay on the objects and the surfaces identified in each frame of the video. The contamination level and the danger level are determined based on an analysis of the surfaces and the objects. Thereafter, if the person approaches further to the objects or the surfaces unprotected, a second virtual overlay is displayed that warns the person from approaching towards such objects and surfaces. Further, the system carries out this entire process of monitoring (described above) in a continuous manner.

Problem statement

Keeping hands clean is one of the most important steps one should take to avoid getting sick and spreading germs to others. There are numerous sources of germs, the person is susceptible to. Germs can get onto hands while using toilet, touching an object that has germs on it (for example, if someone coughed or sneezed on the object), or even while shaking hands. Germs from hands may be transferred to food and drinks and then subsequently into body, thus making the person sick. Also, if the person does not wash off her/his hands, germs may spread to other people as well and make them sick. This might lead to diarrhea-related diseases or respiratory infections (for example, cold). Often, antibiotics are

prescribed unnecessarily for these ailments, thus increasing an overuse of the antibiotics across the world. The overuse of the antibiotics further leads to antibiotic resistance and it becomes difficult to treat people.

The present disclosure proposes a novel solution to address the above-mentioned issues.

System and working

The present disclosure describes a system to monitor hands, while a person moves around in her/his surroundings, and to protect the hands from contamination or harm. The person is immersed in a mixed reality (MR) environment and wearing a head mounted display (HMD) device.

The HMD device includes following components:

- A scene categorization unit
- A contamination detection unit
- A proximity sensor
- An imaging device

The imaging device is continuously capturing a video of surroundings in which the person is moving around. The video is being fed continuously to the scene categorization unit.

As shown in Figure 1, a system architecture of the scene categorization unit includes following components:

i. A feature analyzer
ii. A plurality of subtractors
iii. A support vector machine (SVM) classifier

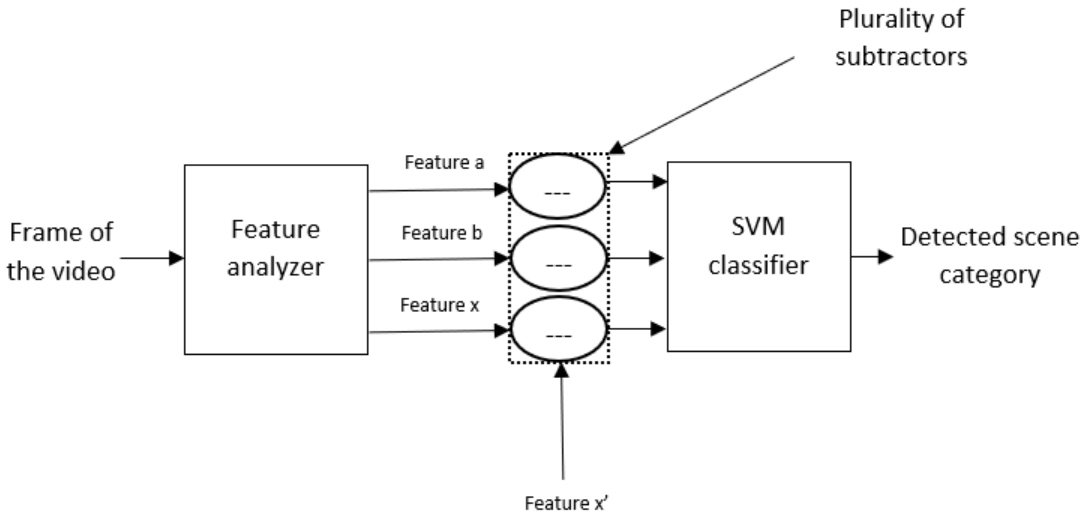

Figure 1: The system architecture of the scene categorization unit

The feature analyzer extracts values of image features from each frame of the video. The scene categorization unit stores reference values of the image features for scene categories in a database (present at a backend and not demonstrated in the Figure 1). The scene categories are a sensitive location (for example, a restroom, a medical room, an industrial scene, *etc.*) and a safe location. The reference values are collected from different experiments, studies, or from third party data providers. The plurality of subtractors obtain differences between the values of the image features and the reference values. The SVM classifier then analyzes the differences obtained by the plurality of subtractors and classifies a scene of the surroundings into one of the scene categories. If the scene is classified as the sensitive location, an object recognition algorithm is utilized to identify objects and surfaces in each frame of the video. The contamination detection unit maintains a first library of images of sample objects and sample surfaces, which are prone to contamination by germs and a second library of images of sample surfaces and sample objects such as tools, materials, equipment *etc.* (electrical, chemical, such as acids, or mechanical in nature), which are dangerous for the person. Each of the first library of images is assigned a contamination score, whereas each of the second library of images is assigned a danger score. The contamination score is assigned based on an analysis of the surfaces and the objects, and a statistical likelihood of contamination thereon. Based on the contamination score, each of the first library of images is assigned a contamination level (low, high or medium). Similarly, the danger score is assigned based on an analysis of the surfaces and the objects, and a statistical likelihood of danger thereon. Based on the danger score,

each of the second library of images is assigned a danger level (low, medium or high). Thereafter, the contamination detection unit performs a template matching of each of the surfaces and the objects identified in each frame with each of the first library of images and the second library of images. Based on results of the template matching, the contamination level or the danger level is displayed as a first virtual overlay on the objects and the surfaces identified in each frame of the video. Thereafter, the proximity sensor measures a distance between the person and the objects or the surfaces. If the distance is below a preset threshold, the object recognition algorithm is utilized to identify whether the person is protected (for example, wearing a protective hand equipment like gloves) or unprotected. The preset threshold is a safety index, which can be set by the person before wearing the HMD device. If the person is approaching to the objects or the surfaces unprotected, a second virtual overlay showing a warning to the person is displayed for interrupting her/him from approaching towards the objects or the surfaces.

Thereupon, the system carries out an entire process of monitoring (described above) continuously or indefinitely as shown in Figure 2.

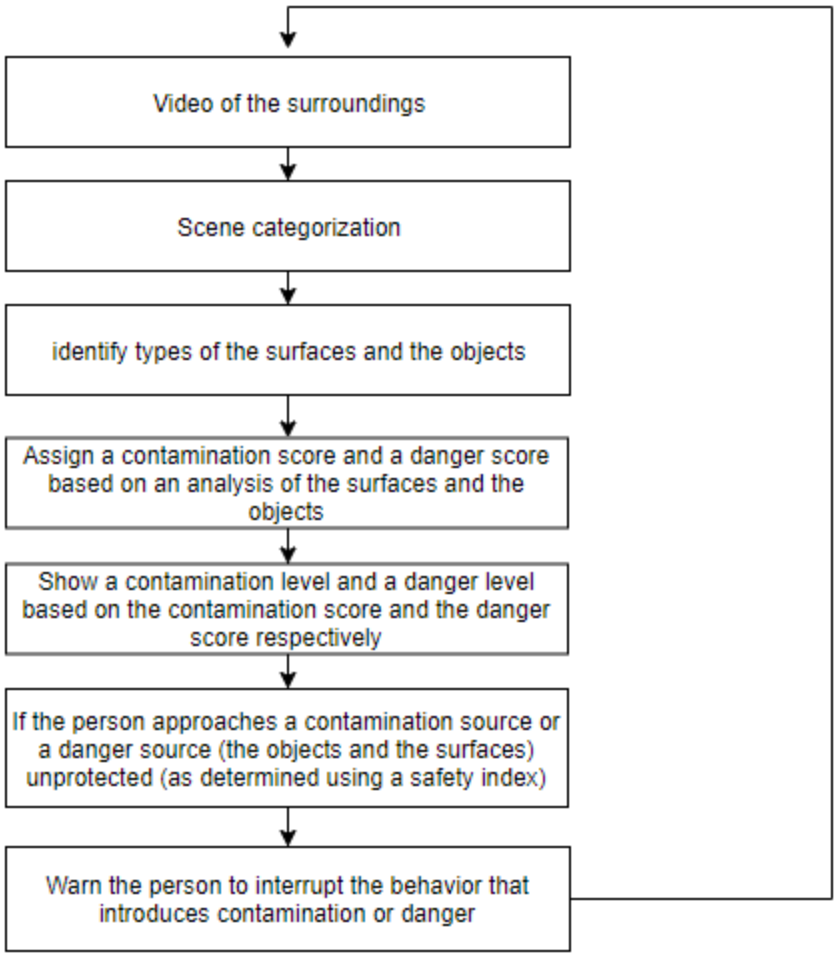

Figure 2: A process flow of the proposed system

Additional embodiments

In an embodiment, the HMD device may also include a handwash monitoring apparatus. The handwash monitoring apparatus comprises a processor. If the scene is classified as the safe location, the processor sets a state of the person's hands as "contaminated" to ensure that the person approaches the safe location with clean hands and does not introduce contamination to the objects or the surfaces in the safe location. The processor then receives frames of a handwashing activity from the imaging device if the person is washing her/his hands. Thereafter, the processor analyzes a mutual motion of the hands to determine if the hands mutually move in desired poses. If the hands mutually move in the desired poses, the processor determines a time duration for each of the poses by registering a count of number of the frames corresponding to each of the poses. The processor assigns a minimum duration threshold for each

of the poses. Thereafter, the processor generates a quality indication of the handwashing activity based on the time duration for each of the poses by comparing it to the minimum duration threshold. If the quality indication is below a predetermined quality standard, then the proximity sensor measures the distance between the person and the objects or the surfaces in the safe location. If the distance is below the preset threshold, the second virtual overlay showing the warning to the person is displayed for interrupting her/him from approaching towards the objects or the surfaces in the safe location. It is notable that in absence of the handwashing activity, the quality indication of the handwashing activity is also below the predetermined quality standard.

In an additional embodiment, the person might be shaking the hands with multiple people. After shaking hands, if the person goes to pick up an eatable, the system may display a bright speckle pattern showing a risk of contamination. If the person continues, she/he might get a more explicit visible interrupt or an audio warning about her/his action.

In another embodiment, the person may be a hospital worker and required to wash or disinfect her/his hands using a specific procedure (for example, using soap, washing until a duration of time or washing thoroughly, *etc.*). In this scenario, the person might receive a specific instruction as a reminder or the warning when the person is out of compliance.

In a yet another embodiment, the person might be working at a restaurant or the like, where the person might be handling customers' payment cards or making change, and subsequently cooking food. Then, by utilizing the present system as a part of a workplace policy of the restaurant or the like, the warning may be displayed to the person. For example, the warning, such as "WASH HANDS AND DON GLOVES", may be flashed on the person's hands in red color.

Conclusion

Handwashing is an important part of hygiene, considering that about 30% of diarrhea-related diseases and about 20% of respiratory infections (for example, cold) can be prevented by proper handwashing. It becomes even more important for children, since nearly 2 million children under the age of 5 die each year from these ailments. But people often forget to wash their hands regularly and a very few use soaps to wash their hands. Also, the surfaces or the objects, which the person touches, may not just contaminate her/his hands but may also be harmful in nature. In these scenarios, the person should wear the protective hand equipment like gloves. With the solution provided in the present disclosure, the person and her/his activities can be monitored as she/he moves around in her/his surroundings. The person then can be

directed occasionally, by means of warnings, to prevent actions that might introduce contamination/germs to the person or her/his surroundings or might be dangerous/harmful to the person. The person might also be instructed to wash her/his hands whenever required.