A Novel Methodology To Improve Hand Hygiene Compliance Using Computer Vision and 3D Depth Sensors

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Hospital Acquired Infections (HAIs) result in more than 100,000 fatalities and cost more than $35 billion annually in the USA alone. More than 50% of HAIs can be prevented by following proper handwashing guidelines. However, the current compliance rate in hospitals is less than 40%, and the only proven method for improving compliance requires human vision, which raises privacy concerns. Therefore, the primary objective of this project was to evaluate if a computer vision-based system could accurately evaluate handwashing actions based on de-identified images(to protect privacy) and provide real-time alerts to improve compliance at an affordable cost. After trying several depth sensors, a 3D depth sensor with a global shutter sensor and active IR stereo vision produced the best results. This depth sensor was used to capture silhouette videos of different handwashing and non-hand washing actions for different scenarios. We used multiple compression algorithms to reduce the compute requirements for processing. In addition, we augmented the region of interest in the 3D space to enhance the resolution. We developed the computer vision model using TensorFlow, Keras, and ADAM optimizer. After several iterations, the model achieved 99.56% accuracy in classifying handwashing and non-washing frames and produced results in less than 300 microseconds on a low-cost CPU. This enabled accurate measurement of the duration of washing, enabled real-time alerts using Raspberry Pi4 and LED lights, and improved compliance. The system costs less than $300. This system can be extended to monitor other conditions, including but not limited to seizures, immobility, etc. as well.

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