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Ambient Intelligence Application in Healthcare

Advances in artificial intelligence (AI) and contactless sensors are helping to pave the way for use of the so-called ambient intelligence in healthcare. AI-controlled sensors embedded in "metaphorically dark, unobserved spaces" of healthcare can create an ambient intelligence, supporting clinicians in monitoring and treating patients in ways that improve outcomes.

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"Similar to modern driver-assistance systems, this form of ambient intelligence can help clinicians and in-home caregivers to perfect the physical motions that comprise the final steps of modern healthcare," according to a recent review article (Haque et al. 2020).

Decision-support systems are there to guide clinicians in making diagnostic and treatment decisions. When it comes to putting these decisions into physical actions, however, clinicians, patients and their families remain largely unassisted, says the review team from Stanford University.

Many health-critical activities that occur in physical spaces – including hospitals and private homes – remain obscure. Ambient sensing technology, the Stanford team points out, provides a means to better understand the complex interplay between the physical environment and health-critical human behaviours.

Based on the team's review, ambient sensors, together with wearable devices, can illuminate two health-critical environments: hospitals and daily living spaces.

In hospital spaces, for example, use of ambient intelligence can lead to more efficient clinical workflows and improved patient safety in operating rooms and intensive care units (ICUs).

- 230 million surgical procedures are performed yearly with up to 14% of patients experiencing an adverse event. Improving the skills of surgeons is needed to help reduce such errors, but feedback from peers and supervisors can be subjective. One study trained a convolutional neural network to track a needle driver in prostatectomy videos. Using peer-evaluation as the reference standard, the algorithm rated 12 surgeons under high- and low-skill groups with an accuracy of 92%.
- Each year, hospital-acquired infections affect 100 million patients worldwide (with about 30% of ICU patients experiencing a nosocomial infection). Hand hygiene protocols are known to be effective in reducing infections, but measuring compliance is difficult. Ambient sensors have been shown to monitor handwashing activities, i.e. able to differentiate true use of an alcohol-gel dispenser from a clinician passing by a dispenser.

With regard to daily living spaces, ambient technology may help to prolong the independence of older adults. Also, sensors installed around the house could improve the management of individuals with a chronic disease by understanding everyday behaviour.

- Activities of daily living (ADLs), such as bathing, dressing and eating, are essential to the independence of the elderly. ADLs are measured through self-reported questionnaires or manual grading by caregivers, but these methods may be biased and subjective. Earlier detection of impairments to perform ADLs enables provision of timely clinical care. In one study, a depth and thermal sensor inside the bedroom of an old person helped with monitoring 1,690 activities during one month, including 231 instances of caregiver assistance.

Similar to other new technologies, ambient intelligence should undergo rigorous clinical validation before it can be used in clinical practice. Issues around privacy and data protection, as well as ethics questions, must also be addressed.

"Preliminary results from hospitals and daily living spaces confirm the richness of information gained through ambient sensing," the authors wrote. "This extraordinary opportunity to illuminate the dark spaces of healthcare requires computer scientists, clinicians and medical researchers to work closely with experts from law, ethics and public policy to create trustworthy ambient intelligence systems for healthcare."

Source: Springer

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