Remote heart rate monitoring with contactless ambient technology using machine learning for aging population

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Purpose As the global population continue to age, tracking vital signs such as heart rate becomes crucial (Dias & Paulo Silva Cunha, 2018). However, traditional methods for monitoring these vital signs, particularly through wearable sensors, often present challenges. As noted in the study (Vijayan, Connolly, Condell, McKelvey, & Gardiner, 2021), wearables can be cumbersome for users, particularly older adults who may find these devices uncomfortable or intrusive, potentially leading to low adherence and compromising the reliability of health data collection. However, the rise of non-invasive Ambient Assisted Living (AAL) technology offers a more accessible solution (Lussier et al., 2020). By utilizing sensors embedded within the living environment, AAL systems can continuously gather vital health data without requiring direct interaction or causing discomfort to the individual. This research focuses on merging effortless smart home ambient technology and machine learning to predict the heart rate of old individuals. The primary aim is to accurately monitor heart rate during daily activities using non-intrusive, remote methods facilitated by AAL technology, without requiring active participation from the subjects. **Method** This study was conducted in a specially designed smart home environment (Figure 1) equipped with a wide range of non-contact ambient sensors, which were used to collect environmental, electrical, and presence data. Heart rate benchmark data was collected using the Empatica E4 wristband. Forty participants were selected and instructed to perform 23 specific daily activities, organized into five practical phases, within this smart home setting. The data collected from the smart home environment and the heart rate readings were subsequently analyzed using five widely used machine learning methods: Support Vector Regression, K-Nearest Neighbor, Random Forest, Decision Tree, and Multilayer Perceptron. **Results and Discussion** The machine learning models delivered notable predictive results, averaging a Mean Absolute Error of 7.329. Notably, the Random Forest model excelled above the rest, registering a Mean Absolute Error of 6.023 and a Scatter Index at 9.72%. This model excelled in identifying the correlation between daily activities and fluctuations in heart rate, showcasing a peak R^2 value of 0.782 during the activity of morning exercises. The proposed non-invasive method offers a novel perspective on remote monitoring heart rate variations across daily living activities. This study's insights hold substantial relevance for public health. Leveraging contact-free smart home tech to estimate heart rate during everyday tasks allows health professionals to grasp a person's cardiovascular health more holistically. Such insights pave the way for tailored interventions, preventive actions, and lifestyle changes, ultimately aiming to lower cardiovascular disease risks and enhance overall health.

References

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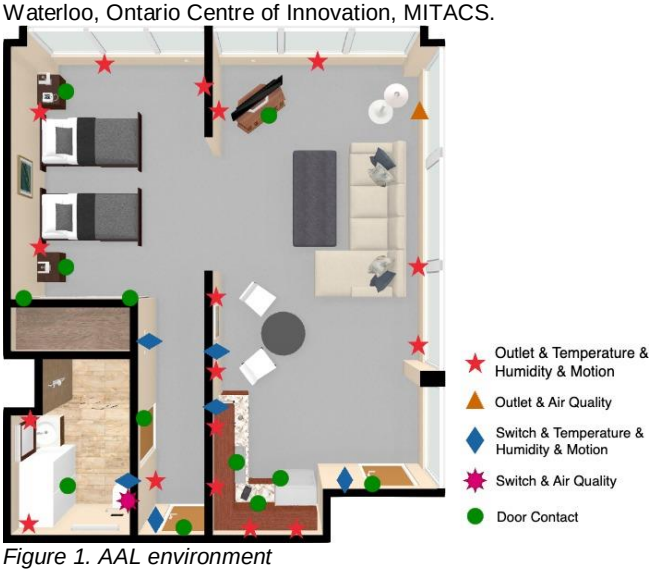

Figure 1. AAL environment