Contactless In-Bed Posture Detection using Load Cell Sensors and Artificial Intelligence

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INTRODUCTION

Pressure injuries (PIs) affect 1 in 4 patients in Canadian healthcare and cost $26.8B annually in the U.S., leading to longer hospital stays, higher costs, and up to 6× increased mortality[1,2,3].

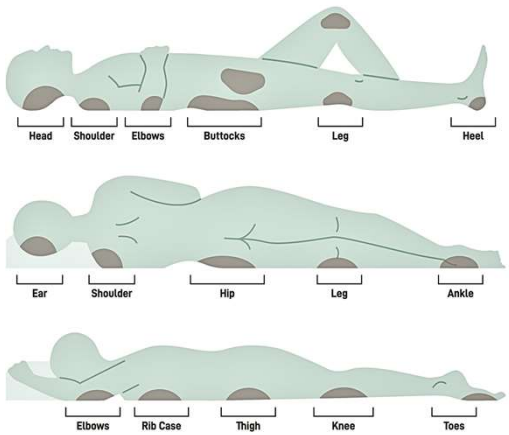

Fig. 1: The primary locations of PI development

Regular repositioning is key to prevention but is often inconsistent due to caregiver workload and limited monitoring tools.

OBJECTIVE

This research proposes a contactless, AI-driven system using the SleepSense sensors to **automatically detect in-bed body positions** and repositioning events. The system aims to remind caregivers in real time to perform timely and personalized repositioning of patients, thereby reducing the risk of pressure injuries and improving overall patient safety and care efficiency.

METHODOLOGY

Dataset: Conducted at a patient room at TRI-UHN with 20 participants (aged 18–65) while performing six postures—supine, left/right lateral, left/right prone, and upright (Fig. 2). Four SleepSense Sensors (Fig. 3) used under the bed legs measured load signals with 1Hz, while 3 cameras provided ground-truth labels.

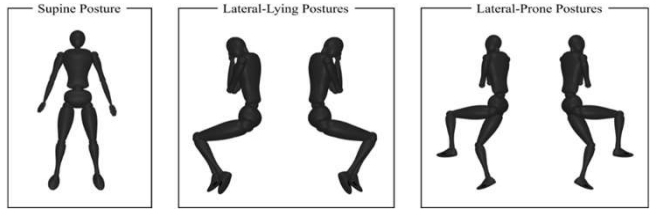

Fig. 2: The five distinct body positions considered in this study.

Fig. 3: TochTech SleepSense placements

Methods: Data segmented into 5–30 s windows for feature extraction. *Features*: Average Pressure, Mean Absolute Pressure, Peak Pressure, Cumulative Pressure, Pressure Variance, Mode Pressure, and Turn Frequency. *Models*: LR, DT, KNN, SVM, NB, RF, XGBoost. *Cross Validation*: 5-Fold. Fusion: Single sensor (4 models), combination of 2 (6 models), 3 (4 models) and all 4.

RESULTS

Fig. 4 shows single-sensor results, with S3 performing best. F1-scores for 2, 3, and 4-sensor setups were all > 97%.

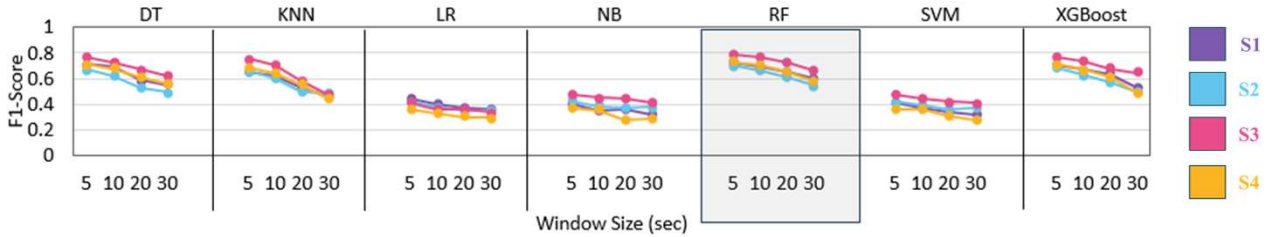

Fig. 4: The F1-Scores of single-sensor models across different window sizes.

CONCLUSION

DT models performed best with 5–10 s windows, indicating shorter segments capture richer temporal patterns. The current limitation, generalizability, will be assessed using LOSO in our future study.

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