

Utilizing Machine Learning and Wearable Devices for Stress Detection in Remote Community-Based Alzheimer’s Disease Dyads

Md Saif Hassan Onim¹, Nancy Wolff², Brian Carter², Elizabeth Rhodus, PhD, MS, OTR/L³ and Himanshu Thapliyal⁴

¹University of Tennessee, Knoxville, TN, USA, ²University of Kentucky, Lexington, KY, USA,

³Behavioral Science, University of Kentucky, Lexington, KY, USA, ⁴Southern Methodist University, Dallas, TX, USA.

Contact Author(s): hthapliyal@smu.edu

INTRODUCTION

- Stress significantly affects older adults’ health, behavior, and quality of life.
- Stress in Alzheimer’s disease → behavioral and psychological symptoms of dementia (BPSD) → increased caregiver burden → unplanned clinical escalation.
- Self-reported stress annotation → vulnerable to bias and cognitive impairment.
- Caregivers’ stress annotations → strengthen labeling + context around BPSD-related events.
- Use **machine learning** + **Empatica E4** data + caregivers’ label → **detect stress** in community-dwelling adults with **Alzheimer’s disease**.

METHOD



Fig. 1: Empatica E4 Wearable Device

- Total study design:** 20 older adults and Empatica E4 that continuously captured physiological data.
- Signals collected from Device:** Skin temperature (TEMP), heart rate (HR), blood volume pulse (BVP), and electrodermal activity (EDA).
- Caregivers’ instructions:** Capture behavioral and activity logs with 3 class ground truth labels: relaxed (0), low stress (1), or high stress (2)
- Current feasibility study:** Data from 6 of 20 rural, community-dwelling older adults aged ~77 years on average.

EXPERIMENTAL RESULT

Evaluation: Accuracy, Precision, Recall and F1 Scores for ID disjoint cross validation. Accuracy represents the proportion of correctly identified stress states, while the F1-score reflects the tradeoff between precision and recall across classes.

Table 1. Performance of Supervised Machine Learning Models for Multi-Class Stress Detection

ML Model	Class	Precision	Recall	F1 Score	Support	Accuracy
KNN	relaxed	0.85	0.95	0.90	9987	81.53%
	low stress	0.37	0.17	0.24	1755	
	high stress	0.09	0.00	0.01	258	
	weighted Average	0.76	0.82	0.78	12000	
Decision Tree	relaxed	0.86	0.88	0.87	9987	77.21%
	low stress	0.31	0.28	0.29	1755	
	high stress	0.07	0.05	0.06	258	
	weighted Average	0.76	0.77	0.77	12000	
Random Forest	relaxed	0.86	0.90	0.88	9987	78.47%
	low stress	0.33	0.26	0.29	1755	
	high stress	0.03	0.02	0.02	258	
	weighted Average	0.76	0.78	0.77	12000	
SVM	relaxed	0.84	1.00	0.91	9987	83.43%
	low stress	0.61	0.04	0.07	1755	
	high stress	0.00	0.00	0.00	258	
	weighted Average	0.79	0.83	0.77	12000	

DISCUSSION

- Support vector machine (SVM) performed **best:** 83.43% accuracy and 0.77 F1-score. K-nearest neighbors (KNN) had **similar** results.
- Strong overall classification with balanced performance.
- Decision Tree and Random Forest was comparatively **worse:** accuracies of ~78%.

CONCLUSION

- Our findings support **supervised** multi-class **stress detection** in older adults with **dementia** using **wearable** sensors + **caregiver-informed** labels.
- Lays groundwork for wearable-derived **digital biomarkers** in dementia care.
- Future work → time series **prediction model** + validate with **larger cohort**.