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Unobtrusive Nighttime Movement Monitoring to Support Nursing Home Continence Care

by Using Accelerometer Sensors and an XGBoost algorithm

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Incontinence in a nursing home

77%

Incontinent residents

39%

Continence decline after 2 years

Impact Quality of Life

ca. €10 PPPD

[1,2,3,4,5]

Smart briefs *(slimme luiers)*

High cost
&
Only for containment products

[6]

Monitoring to support NH continence care

Unobtrusive

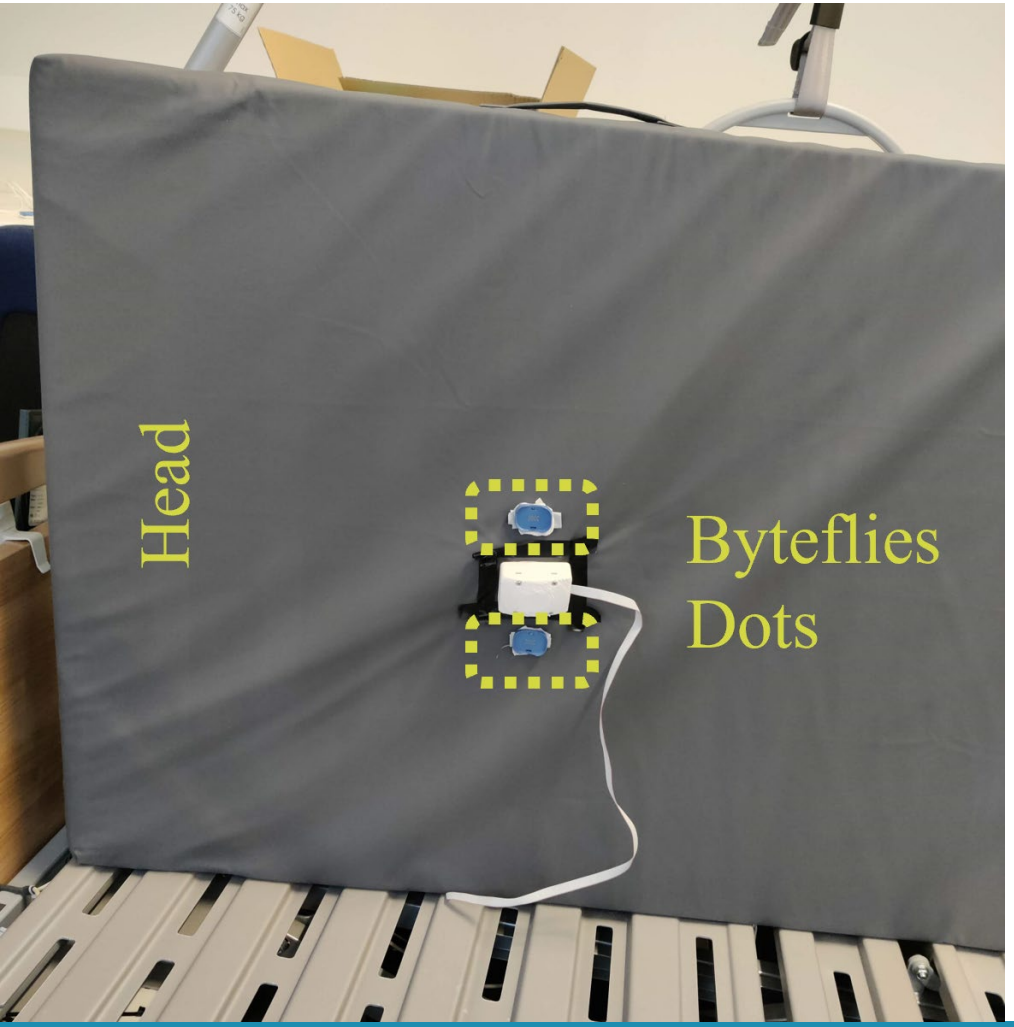
Discrete

Compatible

Unobtrusive monitoring of agitation at night

[7,8]

Nighttime movement monitoring



2 Byteflies **accelerometer** sensor dots

Care bed with **viscoelastic** mattress

6 participants (**adults**)

7 step **protocol** (x5)

Byteflies

[9,10]

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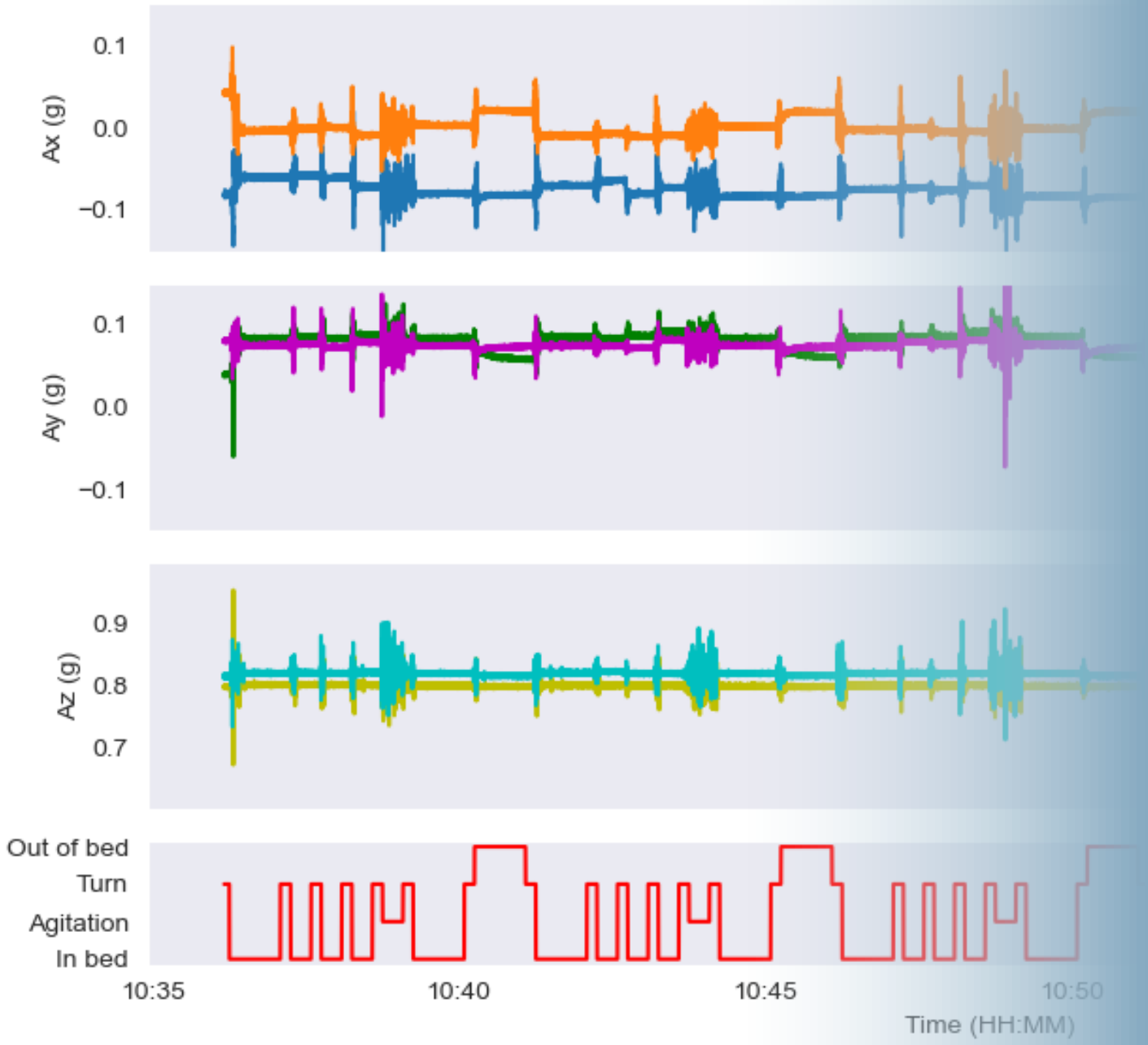
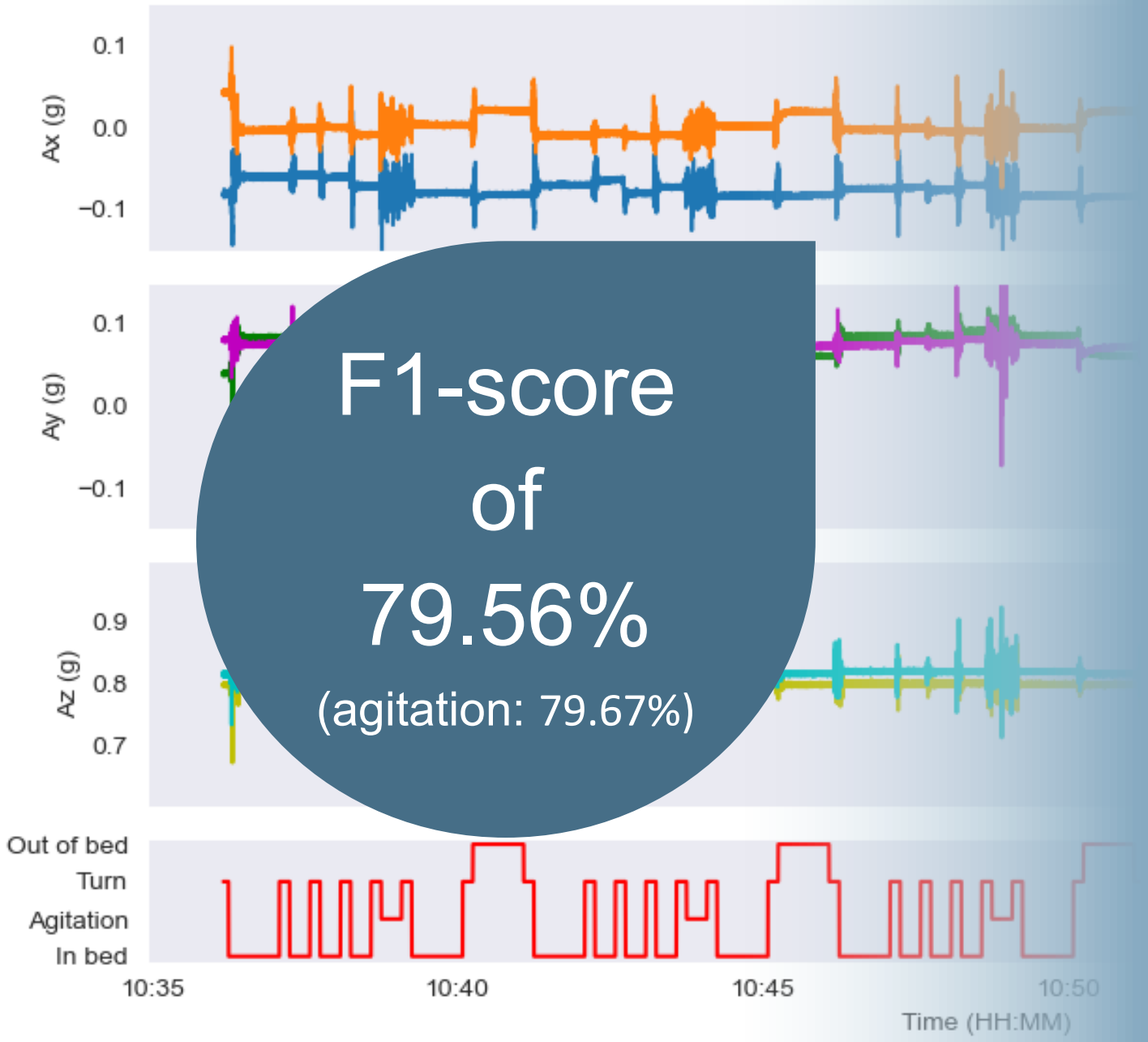


Data categorisation in **4 classes:** In bed, Out of bed, Turn & Agitation

Sliding window of 20s with 50% overlap

1416 selected features via the Time Series Feature Extraction Library (TSFEL)

[11, 12, 13]



F1-score of 79.56%

(agitation: 79.67%)

Data categorisation in **4 classes:** In bed, Out of bed, Turn & Agitation

Sliding window of 20s with 50% overlap

1416 selected features via the Time Series Feature Extraction Library (TSFEL)

Extreme gradient boosting (XGBoost) machine learning algorithm for a limited data set

Leave one subject out cross-validation (LOSOCV) for training and evaluation with 6 iterations

[11, 12, 13]

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Unobtrusive Nighttime Movement Monitoring to Support Nursing Home Continence Care: Algorithm Development and Validation Study

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Limitations and future work

Only 6 iterations (1 per participant).

- A **larger sample size** by including more participants

No NH residents or older adults among the participants

- Agitation based on participants' **own interpretation**
- Simulate nighttime movement differs from **real nighttime movement**

PROCON - Boosting innovation, entrepreneurship and training for PROmoting CONtinence in nursing homes

An Erasmus+ project (Project ID: 101185699) that will foster innovation in NHs, specifically in the promotion of continence in NH residents, through **cooperation and flow of knowledge** among 12 partners (mostly) located in Spain, Belgium, Finland and Canada.

WP2 Technological solution to enhance continence in NHs: **data acquisition campaign** with NH residents

ProCon

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ProCon

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References

[1] World Health Organization. Integrated care for older people: guidelines on community-level interventions to manage declines in intrinsic capacity. World Health Organization, Geneva, 2017. ISBN 978-92-4-155010-9. URL https://iris.who.int/handle/10665/258981. Section: ix, 46 p.

[2] European Association of Urology. An Urge to Act: The Health, Socio-Economic, and Environmental Costs of Continence Problems in the EU. Technical report, Arnhem, The Netherlands, 2023. URL https://d56bochluxqnz.cloudfront.net/media/Socioeconomic_report_UrgetoAct.pdf#asset:4080543@1.

[3] Javier Jerez-Roig, et al. Prevalence of urinary incontinence and associated factors in nursing homes: a multicentre cross-sectional study. BMC Geriatrics, 24(1):169, February 2024. ISSN 1471-2318. doi: 10.1186/s12877-024-04748-1. URL https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-024-04748-1.

[4] Adrian Wagg. Continence in nursing homes: a state of irreversible decline? Nature Reviews Urology, 16(5):278–279, May 2019. ISSN 1759-4812, 1759-4820. doi: 10.1038/s41585-019-0172-8. URL https://www.nature.com/articles/s41585-019-0172-8.

[5] Rita A Frantz et al. Implementing an Incontinence Management Protocol in Long-Term Care: Clinical Outcomes and Costs. Journal of Gerontological Nursing, 29(8):46–53, August 2003. ISSN 0098-9134, 1938-243X. doi: 10.3928/0098-9134-20030801-10. URL https://journals.healio.com/doi/10.3928/0098-9134-20030801-10.

[6] TENA URL www.tena.be/nl/professionals/innovation/smartcare/

[7] Jiaqi Gong et al. Home wireless sensing system for monitoring nighttime agitation and incontinence in patients with Alzheimer's disease. In Proceedings of the Conference on Wireless Health, WH '15, pages 5:1–5:8, New York, NY, USA, October 2015. ACM. ISBN 978-1-4503-3851-6. doi: 10.1145/2811780.2822324. URL http://doi.acm.org/10.1145/2811780.2822324. event-place: Bethesda, Maryland.

[8] R. Lopez et al. Nocturnal agitation: From sleep state dissociation to sleep-related dissociative state. Revue Neurologique, 179(7):675–686, October 2023 ISSN 00353787. doi: 10.1016/j.neurol.2023.07.003. URL https://linkinghub.elsevier.com/retrieve/pii/S0035378723009840.

[9] Byteflies URL https://byteflies.com/

[10] Jane Marino. Tempur-Med: Choosing the correct pressure area care system. British Journal of Nursing, 10(20):1364,November 2001. ISSN 09660461. doi:10.12968/bjon.2001.10.20.9356. URL http://www.proquest.com/docview/199483023/citation/AEA3DA8A96644DE2PQ/1. Num Pages: 3 Place: London, United Kingdom Publisher: Mark Allen Group Ltd.

[12] Marília Barandas et al. TSFEL: Time Series Feature Extraction Library. SoftwareX, 11:100456, January 2020. ISSN 2352-7110. doi: 10.1016/j.softx.2020.100456. URL https://www.sciencedirect.com/science/article/pii/S2352711020300017

[12] Tianqi Chen and Carlos Guestrin. XGBoost: A Scalable Tree Boosting System. In Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, pages 785–794, San Francisco California USA, August 2016. ACM. ISBN 978-1-4503-4232-2. doi: 10.1145/2939672.2939785. URL https://dl.acm.org/doi/10.1145/2939672.2939785.

[13] Payam Refaeilzadeh, Lei Tang, and Huan Liu. Cross-Validation. In LING LIU and M. TAMER ÖZSU, editors, Encyclopedia of Database Systems, pages 532–538. Springer US, Boston, MA, 2009. ISBN 978-0-387-39940-9. doi: 10.1007/978-0-387-39940-9_565. URL https://doi.org/10.1007/978-0-387-39940-9_565