Applications of Non Intrusive Load Monitoring in Smart Homes.

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Introduction

Though the increasing energy demand and growing rate of ageing population seem to be two divergent fields, improving one can help tackle issues related to the other one. However, this can not be achieved without information about individual appliances consumption.

Consumer Perspective of NILM services

Consumer's acceptance is a main obstacle towards achieving full potential of NILM services. The acceptance is governed by many concerns (e.g. effects on health, cost and installation visits).

Research Question	Description of the approach	Validation	Expected Outcomes
			- Implementation in respect
RQ 01: How can deep models for NILM be improved?	Evaluation of the transformer model for multi-task NILM	Experiments on real energy data (e.g. Uk-Dale)	with NILMtk - An analysis of the cause- effect relationship between the observed results and the errors made by the

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Related Work

Non-intrusive Load Monitoring (NILM): is the process of identifying what appliances are operating in a household through an analysis of the aggregate power [1].

Type of appliances Two- Multi Infinite Drawbacks Approach Description state state state Computationally Find the best Combinatorial intractable when Optimisation combination of the number of Techniques states of the appliances (e.g. [2]) appliances increases

Appliances states

Research questions

The research goals of current and future analysis of the author are to contribute to the improvement of existing NILM approaches, establish a set of user's requirements for SM based systems and finally evaluate how such systems can influence decision making in smart homes. The three main expected contributions of the research project are:

- A. Investigate the effect of the Transformer architecture for multi-task NILM on disaggregate performance.
- **B.** Investigate user's preferences and concerns towards smart metering services generally and NILM in particular.

C. Investigate the effect of NILM based services on

decision making in smart homes.

(В)

What is the user attitude towards those

			model
RQ 02: what is the user attitude towards energy services? and how can the acceptance and engagement of costumers with NILM based services be improved?	Case study of customers from a Carinthian energy utility in Austria.	Questionnaire (Conjoint Analysis)	- A set of user's requirements and preferences.
RQ 03: how can NILM services support decision making in smart homes in the case of elementary family and the case of elderly people living alone?	Design of an intelligent home energy management system that supports AAL services.	- Focus Groups in the Living Lab	Effect of design elements on user's intention and attitude. An assessment of NILM services in the AAL domain.

Methodology description for the research project.

Conclusion



services? and how can the acceptance and engagement of costumers with NILM based services be improved? A set of user's requirements _ _ _ _ _ for NILM services nprov of cor C Improve the how can NILM services reliability support decision making in of these How can deep services smart homes in the case of elementary family and the models for case of elderly people living NILM be alone? improved? Applicability of Effect of design NILM services for choices on ADLs monitoring human behaviour

Methodology

As a first step in evaluating the research proposal, the author implemented an energy measurement system based on open-source solutions in a living lab environment [5] and conducted a set of experiments that showed great potential for NILM approaches in the domain of Ambient And Assisted Living (AAL).

The results revealed by the current research project will help energy utilities to offer better energy services and avoid risky deployment of smart meters. The overall goal of the project is to evaluate the potential of NILM based ICT systems to influence decision making in smart homes (RQ 03) which rely on both accurate data (RQ 01: improving already established NILM approaches) and user's requirements for such services (RQ 02: user's concerns and requirements).

References

1. Makonin, Stephen, and Fred Popowich. "Nonintrusive load monitoring (NILM) performance evaluation." Energy Efficiency 8.4 (2015): 809-814.

2. Hart, George William. "Nonintrusive appliance load

monitoring." Proceedings of the IEEE 80.12 (1992): 1870-1891.

3. Paradiso, Francesca, et al. "Context-based energy disaggregation in smart homes." Future Internet 8.1 (2016): 4.

4. Kelly, Jack, and William Knottenbelt. "Neural nilm: Deep neural

networks applied to energy disaggregation." Proceedings of the 2nd

ACM International Conference on Embedded Systems for Energy-Efficient Built Environments. 2015.

Key-words co-occurrence from WebOfScience search engine (TS= Non- intrusive load monitoring OR Non intrusive appliances load monitoring), Oct. 2020

Applications of NILM in Smart Homes

- Most common application of NILM is improving energy efficiency through energy management Systems.
- Recent applications of NILM are related to activity monitoring of elderly living alone to offer them a certain level of security in a non-intrusive manner.



The architecture of the implemented System

The table below summarises the different methods that will be employed to properly address the RQ of the project.

5. Bousbiat, H., Klemenjak, C., Leitner, G., Elmenreich, W.:

Augmenting an assisted living lab with non-intrusiveload monitoring. In: 2020 IEEE International Instrumentation and Measurement Technology Conference(I2MTC), pp. 1–5 (2020)

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