Human Behavior Modeling for Residential Energy Consumption

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ABSTRACT
Electric utility companies are interested in load profile (electricity consumption) data for expansion planning. Conventional methods of collecting the load profile data, such as surveys and metering, are tedious and time consuming. Cumbersome data collection processes also pose barriers. We present an innovative behavior model, based on fuzzy logic and activity graphs, which requires minimum input for generating electricity consumption load profiles. The processes also pose barriers. We present an innovative behavior model, based on fuzzy logic and activity graphs, which requires minimum input for generating electricity consumption load profiles. The implementation focuses on modeling the relations between:

- Environmental condition
- Human activity
- Power demand

The rule base in the fuzzy model is dynamic and influenced by the activity graph. Similarly, we can calculate the probability of using different appliances for each activity in each age category.

DAILY ROUTINE OF PEOPLE
Nathan Yau uses data provided by the American Time Use Survey from 2014 to demonstrate how people go through their daily routine [1].

- The daily activity of 1000 people is demonstrated graphically in 30-minute intervals.
- Yau presents the behavior changes of US citizens, categorized according to age and gender [2].
- Six age categories have been considered: 15-24, 25-34, 35-44, 45-54, 55-64, and 65+.
- Each age category consists of two subcategories with respect to gender.
- Activity graphs were developed based on these data.

VALIDATION DATA SET
The Irish CER Smart Metering Project – Electricity Customer Behavior Trial, 2009-2010 [3]. 4232 Irish households over a period of 1.5 years (electricity consumption at 30-minute intervals and prior responded surveys).
- Validation data includes usage data of different appliances, environmental conditions, and prior responded surveys.

CONCLUSIONS
We develop a novel method for predicting the load profile by using a human behavior model.

Our model combines activity graphs and fuzzy logic theory to achieve more realistic load profiles that incorporate uncertainties.

The comparisons shown in the Results section indicate a moderate to strong positive correlation between the simulated results and the smart metering data in [3] (moderate correlations are in the range 0.3-0.7, strong correlations are in the range 0.7-1).

The advantages of our system are that it requires minimum consumer data and eliminates the tedious process of developing surveys, distributing them and analyzing the results.

ACKNOWLEDGMENT
The authors would like to thank “CER Smart Metering Project - Electricity Customer Behaviour Trial, 2009-2010” for the data set that was accessed via the Irish Social Science Data Archive - www.isssdata.ie.

REFERENCES