Improving Building Energy Demand Prediction Using Machine Learning Approach

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1. Introduction – Prediction of energy consumption and electrical load forecasting for a building is a necessary task to evaluate and capture energy savings opportunities and drastically improve building energy management. Machine learning methods and data driven techniques have being used to improve these predictions. One of the most widely used technique is the multiple linear regression. This technique has been validated and does not require extensive computational time. However, it suffers from low accuracy in addition to other issues such as collinearity and multicollinearity. In this paper, an improved mathematical technique using Kernel Principal Component Regression (KPCR), a nonlinear regression technique, is presented to remediate the issues currently exist in the multiple linear regression approach when dealing with nonlinear systems. This method shows an improved ability an improved prediction ability over the multiple linear regression technique. A case study using the proposed methodology is presented for validation using the experimental data obtained from an actual office building. The experimental results obtained from the case study show that the KPCR predictions method outperforms the multiple linear regression in predicting peak values of electrical load demand. In addition, the results show that the proposed method reduced the overall average prediction error of the building energy consumption.

2. Experimental - The performance of the KPCR is used to investigate the cooling capacity requirement and the corresponding energy consumption for a building. A one-day ahead prediction of the energy consumption using an hourly historical data of the energy and corresponding outside weather conditions, namely, the dry bulb temperature, the relative humidity and the solar radiation, is evaluated by both multiple linear regression and the kernel principle component regression. The experiments utilized only the weather data, however, other factors such as human comfort may also affect the energy consumption. In the current paper, the root mean square error (RMSE) and the mean absolute percentage error (MAPE) are selected as indicators to evaluate the fitness of the adopted model to the real measured data.

3. Results and Discussion - The analysis of the experimental data and the corresponding statistical analysis is indicate that, in average, the KPCR results lower lower error. In addition, KPCR is able to provide satisfactory provision of the peak consumption of the building throughout the day, whereas the MLR tends to overestimate the consumption. Thus, KPCR offers a better tracking performance of the real energy consumption. Image 1 shows a sample of the results. The drawback of using KPCR is the increased computational complexity that is introduced by the additional matrices' calculations.

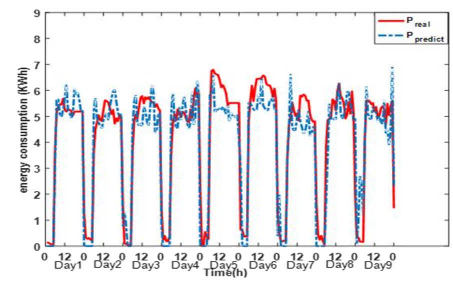

Image 1: Real vs. predicted AC energy consumption using KPCR

4. Conclusions – The current results shows that using the Kernel Principal Component Regression (KPCR) technique for to building energy demand prediction outperforms the traditional MLR and improves the ability to forecast on a small time-interval and provides better insights on the peak of the energy consumption.