$$e_{measurement} = \sqrt{\sum_{i=1}^{n}\left[\partial x_i{}^2 * \left(\frac{\partial F}{\partial x_i}\right)^2\right]} \qquad (9)$$

The manual occupancy and interior lighting toggle switch measurements collected from the test cell are subject to human error. Although it does not impact the model for the simplest case study, it is an item requiring resolution for occupied cases. For the early data collected, this error can be minimized by cross examining the occupancy data against the lighting status, the door position and plug load data. The data within the time period of this study was analyzed and determined that twice out of twelve occupancy periods were not recorded by the user but was fixed by cross examining the other data points mentioned. Similarly, the door position is an operator dependent measurement. The door is measured in either an "OPEN" or "CLOSED" position with the sensor unable to tell the degree in which the door is open. The operator is asked to keep the door in either the fully open or fully closed position so that the data can be analyzed as "OPEN" having full air exchange with the hallway or as "CLOSED" having minimal exchange. During situations when the operator leaves the door in a partially opened position the state of the cell will still be analyzed with complete air exchange. This is being resolved through the installation of a pair of laser sensors that detect motion into and out of the test cell based on the occupants passing two parallel laser paths.

Future research

This preliminary study has indicated strong potential for the inference of thermal dynamics in building elements due to BAS data. The next stage of research will develop an Adaptive Fuzzy Inference System (ANFIS) for this simplified case and expand it with progressively more input variables. A white box model is also under development and the ANFIS-developed coefficients will be introduced into this white box model to refine the predictive model.

ACKNOWLEDGMENT

REFERENCES

Afram, A. & Janabi-Sharifi, F., 2014. Theory and applications of HVAC control systems–A review of model predictive control (MPC). *Building and Environment,* Volume 72, pp. 343-355.

Amara, F. et al., 2015. Comparison and Simulation of Building Thermal Models for Effective Energy Management. *Smart Grid and Renewable Energy,* pp. 95-112.

Carrascal, E., Garrido, I., Garrido, A. J. & Sala, J. M., 2016. Optimization of the Heating System Used in Aged Buildings Via Model Predictive Control. *Energies.*

Dong, B. & Lam, K., 2014. A real-time model predictive control for building heating and cooling systems based on the occupancy behavior pattern detection and local weather forecasting. *Building Simulation,* 7(1), pp. 89-106.

Harb, H. et al., 2016. Development and validation of grey-box models for forecasting the thermal responce of occupied buildings. *Energy and Buildings,* pp. 199-207.

Huang, H., Chen, L., Hu & E., 2015b. A neural network-based multi-zone modelling approach for predictive control system design in commercial buildings. *Energy and Buildings,* Volume 97, pp. 86-97.

Huang, H., Chen, L. & Hu, E., 2015. A new model predictive control scheme for energy and cost savings in commercial buildings: An aairport terminal building case study. *Building and Environment,* pp. 203-216.

Huang, H., Chen, L., Hu & Eric, 2015a. A new model predictive control scheme for energy and cost savings in commercial buildings: An airport terminal building case study. *Building and Environment,* Volume 89, pp. 203-216.

Huang, H. et al., 2013. *Multi-zone temperature prediction in a commercial building using artificial neural network model,* Hangzhou, China: 10th IEEE International Conference on Control and Automation (ICCA).

Li, X. & Wen, J., 2014. Review of building energy modeling for control and operation. *Renewable and Sustainable Energy Reviews,* pp. 517-537.

Ma, J., Qin, J., Salsbury, T. & Xu, P., 2012. Demand reduction in building energy systems based on economic model predictive control. *Chemical Engineering Science,* pp. 92-100.

Mustafaraj, G., Lowry, G. & J.Chen, 2011. Prediction of room temperature and relative humidity by autoregressive linear and nonlinear neural network models for an open office. *Energy and Buildings,* pp. 1452-1460.