Response to Reviewer 2 Comments

Topic:

Using the IBM SPSS SW Tool with Wavelet Transformation for CO₂ prediction within IoT in Smart Home Care

Authors

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5/03/2018

First of all, we would like to thank the reviewer for the constructive remarks on the first version of this paper. We think that the new version of our manuscript includes all the suggested changes. We believe that the quality of the present version has improved greatly; it adequately addresses all the comments and provides clear explanations.

Below we provide a brief account of how the issues pointed out by the reviewer have been addressed in the paper.

This manuscript examines the possibilities of increasing the accuracy of CO₂ predictions in Smart Home Care using IBM SPSS software tools in the IoT to determine the occupancy times of a monitored SHC room, based on the measurements from the indoor and outdoor temperatures and relative humidity. This is a fine contribution to the literature on this subject and is definitely worthy of publication. I thoroughly enjoyed reading this manuscript. I have only minor corrections/comments that I think will clarify the text:

(1) Line 261-264, page 7. The sensing accuracies of the two selected indoor and outdoor temperature sensors are quite different, 1K and 0.1K, respectively. The reviewer is wondering why the authors choose this sensor combination, and would this make any differences for the analysis and prediction carried out later on? And for the relative humidity sensor, the typical sensing accuracy for commercial sensor should be 1-2%. Again, would 1% accuracy relative humidity sensor help to improve the prediction? What are the sampling frequencies for all these three sensors? Are they sampling at the same frequency and are they synchronised?

Response 1: Outdoor sensor To (°C), (AP 257/22) is KNX sensor implemented in Weather station for operational and technical functions control in Smart Home. For HVAC control in SH is used BACnet technology - (QPA 2062 sensor). There is interoperability between KNX and BACnet technology through KNX/BACnet gateway. Visualization is performed in DESIGO INSIGHT SW tool. For data, saving is in DESIGO INSIGHT irregular interval data storage. In SW Tool PI System, which is connected with DESIGO INSIGHT through PI OPC BACnet interface, is possible settings of the desired
interval for data processing with soft-computing methods. In the next experiments, we will use sensors with higher accuracy with possible settings of the desired interval in low cost solving. Interval storing data from all three sensors is 1 minute. Data of all three sensors are synchronized for data processing.

(2) Equation 1, page 8, may miss right bracket?

Response 2: Equation 1 was repaired with right bracket.

\[ \phi_j(X) = \frac{1}{\sqrt{2\pi\sigma_j^2}} \exp\left(-\frac{1}{2}\sum_{p=1}^{2}\frac{1}{\sigma_j^2} (x_p - \mu_j)^2 \right) \times \frac{1}{\sqrt{2\pi\sigma_j^2}} \exp\left(-\frac{1}{2}\sum_{p=1}^{2}\frac{1}{\sigma_j^2} (x_p - \mu_j)^2 \right) \]

(3) Line 293, page 8. ‘high frequency part of the signal’, what is the frequency of this high frequency component? Does this related to the sampling frequency mentioned in (1);

Response 3: In this sentence (line 293), we wanted to point out that the predicted CO2 signal contains rapid oscillations, so called glitches, which do not have the origin in the original CO2 signal. Due to presence of these occurrences, we employed the Wavelet filtration to obtain a smooth trend of the CO2 signal, while these oscillations are removed. We maybe used the inappropriate term ‘high frequency component’ for these oscillations. We wanted to express that these signal segments have oscillating character. In our system, we use the sampling frequency 1Hz/minute, which is enough for the Smart home operational and technical functions measurement and control. We reformulate the sentence from the line 293. Nevertheless, we also devoted to the time-frequency analysis of the CO2 signal to mapping the signal stationarity within the time and discover frequency spectrum of the mentioned oscillating glitches. We subtracted the original CO2 signal from the filtered signal to identify parts of the activity corresponds with these oscillations which are removed by the Wavelet. Consequently, we applied the STFT (Short-Time Fourier Transform,) to locate the time-frequency PSD (Power Spectral Density) spectrum of these oscillations. Based on the results published in the manuscript, we estimate the average frequency range: \(0.8;1\) Hz.

Original sentence (line 293): Based on the experimental results, the predicted CO2 trend contains glitches representing high-frequency part of the signal.

Modified sentence: (line 244): Based on the experimental results, the predicted CO2 trend contains glitches representing fast change part of the signal.

(4) Fig. 5, page 11. What is E (Ix) in the figure? Figures 5-8 presents the history data of CO2, indoor temperature, Blinds and Slats. How about the history data for relative humidity and outdoor temperature, as discussed before?

Response 4: E (Ix) in the figure 5. is Illuminance waveform
Figure. 5 The reference (measured) CO2 concentration course and Illuminance $E_{(lx)}$ course (12.11.2018) in room R203 in SHC for ADL monitoring.

History data for relative humidity and outdoor temperature were added to the Figure 6.

(5) Line 394, page 11. ‘VI. The 393 window was opened partially at 11:36:07, VII. The window was closed at 11:36:07.’ The timing for VII may not be correct

Response 5: The time for VII point (Figure 6) was changed - 14:00:35.

(6) Line 513, page 16. ‘the highest linear correlation (0.998)’ may not be correct, according to table 7.

Response 6: It had been corrected (“relevantly high linear correlation value (0.895)”)

(7) Figure 12, page 19. The reviewer is curious about the selection of 15th May. Firstly, 15th May 2018 is a Tuesday, why the accumulation of CO2 started in the late afternoon, rather different from the ones presented in Figs. 5-8. Secondly, the two history data (Fig. 12 and Fig. 5) have very different pattern, and obviously, the one shown in Fig. 5 should be much more common. Does this also imply that the proposed prediction methodology works better for the ones similar to Fig. 12? If not, the authors should perform further comparison for other days to demonstration the capability of the proposed method.

Response 7: The intervals of the experiment were chosen at random. The pattern of the signal does not have a major impact on the results. The experimenter had been repeated for 12 of May with the following results:

Table 6. Trained models – Training period: 12th of May 2018

<table>
<thead>
<tr>
<th>Order of measurement (Model Number)</th>
<th>Number of neurons(-)</th>
<th>Accuracy (%)</th>
<th>testing</th>
<th>validation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Linear correlation</td>
<td>MAE</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>88.9</td>
<td>0.927</td>
<td>0.064</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>97.8</td>
<td>0.972</td>
<td>0.026</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>98.0</td>
<td>0.971</td>
<td>0.022</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>96.7</td>
<td>0.940</td>
<td>0.037</td>
</tr>
<tr>
<td>5</td>
<td>200</td>
<td>98.1</td>
<td>0.937</td>
<td>0.035</td>
</tr>
<tr>
<td>6</td>
<td>250</td>
<td>95.0</td>
<td>0.921</td>
<td>0.035</td>
</tr>
<tr>
<td>7</td>
<td>300</td>
<td>95.7</td>
<td>0.941</td>
<td>0.031</td>
</tr>
<tr>
<td>8</td>
<td>350</td>
<td>95.7</td>
<td>0.941</td>
<td>0.031</td>
</tr>
<tr>
<td>9</td>
<td>400</td>
<td>95.7</td>
<td>0.941</td>
<td>0.031</td>
</tr>
</tbody>
</table>
The model number 3 trained and validated using data from 12th of May 2018.

Further comparisons of implementation of designed method are in:


(8) What is the unit of the vertical axis in Fig. 12 and Fig. 13? May be better to be in ppm, as shown in Figs. 5-8.

Response 8: As it was explained in section 4.2.1. Pre-processing, prior to the analysis, the data were normalized (using min-max method), therefore the CO2 values do not have any unit. The normalization had been reversed and CO2 values had been converted back to ppm (Fig. 12 – Fig. 14).

On the behalf of all the authors, I would like to once again, express our gratitude for the reviewer’s support and advice.

Best regards,

Jan Vanus