Supporting Information

Chamberless NDIR CO$_2$ Sensor Robust against Environmental Fluctuations

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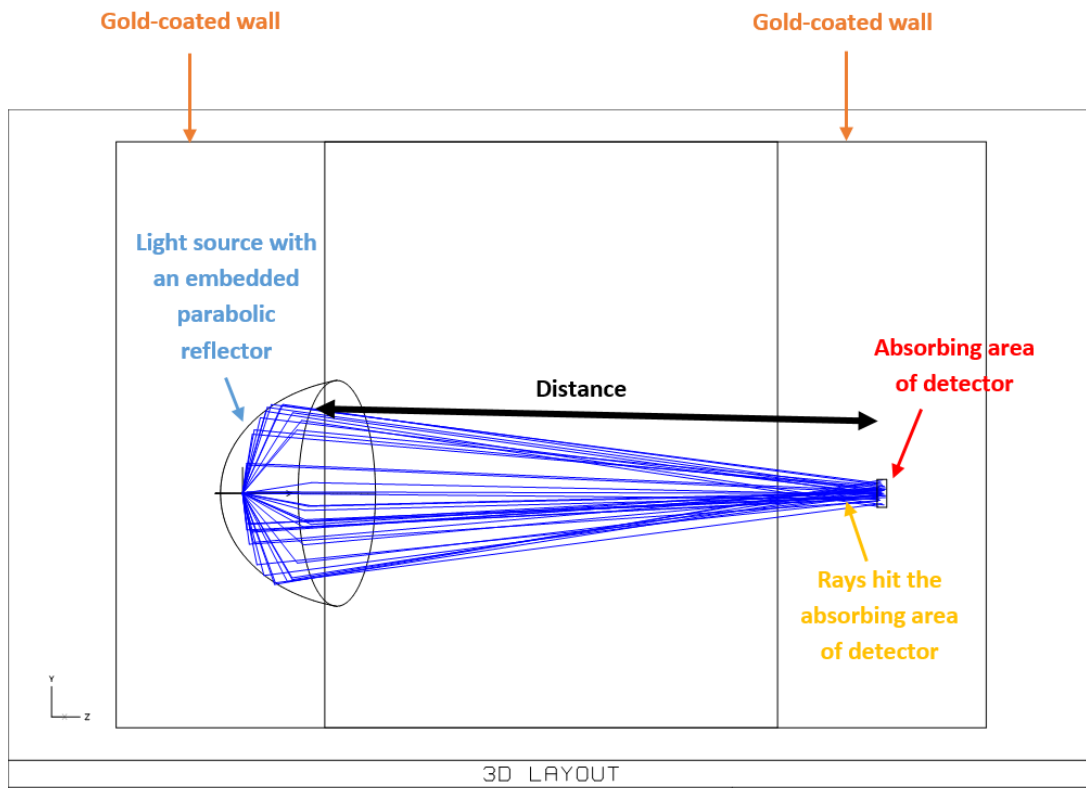Islamic Azad University, Tehran, Iran.

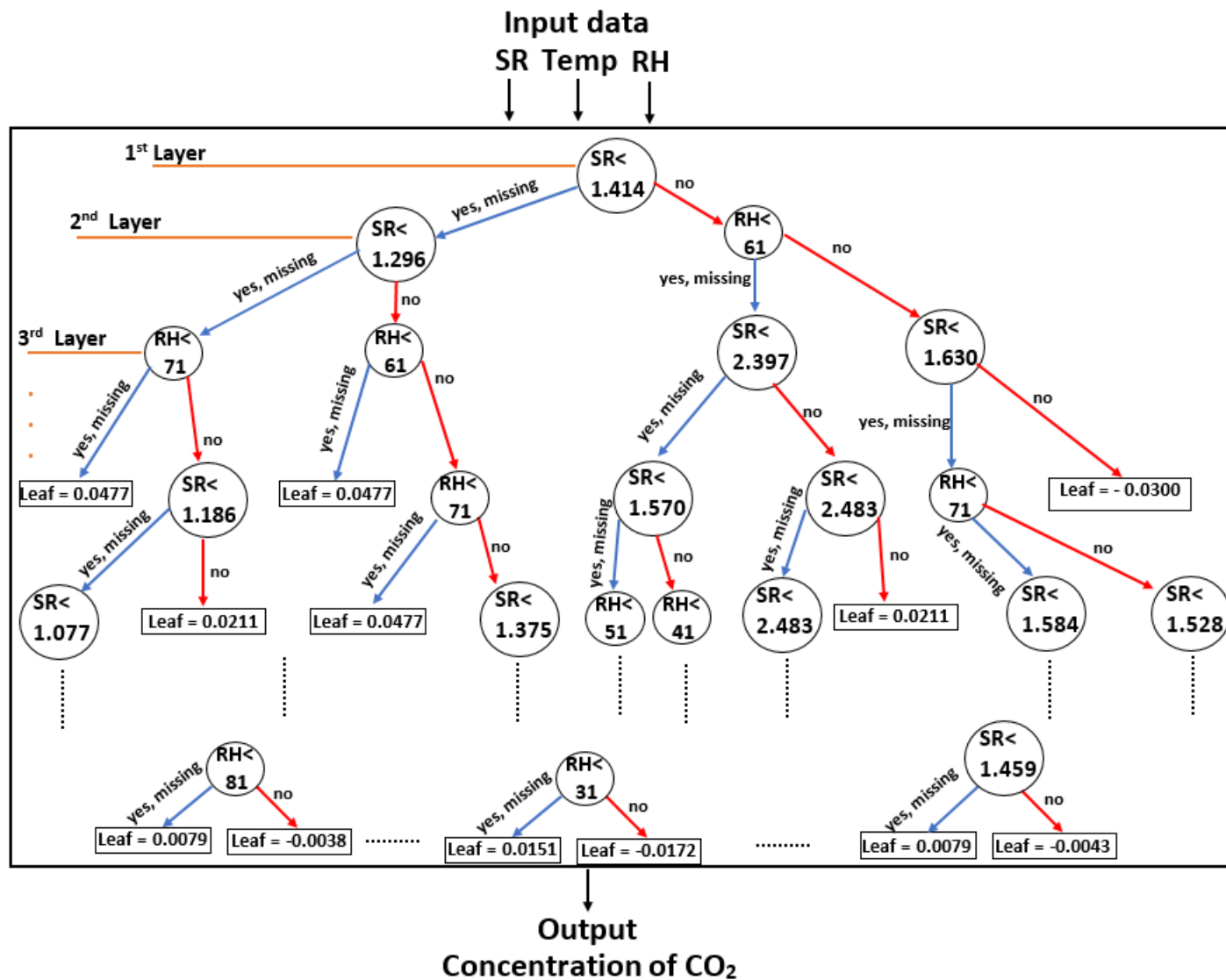Fig.S1. Drawing of Zemax ray tracing simulation for chamberless sensor.

Fig. S2. The MISO model showing the three inputs, the created decision tree by the XGBoost algorithm, and the output. The dashed lines in the figure show that the presented decision tree is a shortened version. The first, second, and third layers of tree are shown.

Table S1
Simulation results of total hits and total power for NDIR
sensor in 4 different distances.

Distance (mm)	Total Hits (#)	Total Power (mW)
10	835	1.95
20	26028	59.17
30	16496	37.51
40	5538	12.27

Table S2
Comparison of 5 commercial CO_2 gas sensor with the
current proposed sensor.

Sensor name / ref	Measurement Range (ppm)	Accuracy	Response time (T_{90})	Working RH range (%)	Working Temp range (°C)	Design structure	Compensation Temp & RH	Self-heating
GUARDIAN® NG [1]	0-3000	±2% of full scale	= <30	0-95	Not Available.	• Equipped with a tube in its input sample line that might be condensed. • Dual wavelength technology.	No	Yes
SPECIAL GUARDIAN NG [1]	0 – 1000	±10% range	Variable (determined by bit switch and firmware)	Sensitive to large changes in humidity depending on gas and range	0 - 45	• Equipped with a tube in its input sample line that might be condensed. • Dual wavelength technology.	No	Yes
smartGAS BASICEVO[2]	0-10000	Not available	appr. 60 s	0-95	-10 - 40	• Dual beam and dual wavelength.	No	Yes
smartGAS FLOWEVO [2]	0-10000	Not available	≤ 9.9 s	0-95	0 - 50	• Dual beam and dual wavelength.	No	Yes
Semeatech IRM300SS [3]	0-5000	±50ppm ±5% reading	60 s	0-95	0 -50	Single wavelength	No	Yes
Current Sensor	400-2200	~ ± 1% of full scale	60 s	15-85	25-50	• Single beam and single wavelength. • Drift-like compensation for RH and Temp.	Yes	No

References:

[1]   E. Sensors, Accessed: Feb. 1, 2021. [Online]. Available: https://edinburghsensors.com/.

[2]   smartGas., Accessed: Feb. 1, 2021. [Online]. Available: https://www.smartgas.eu/en/ .

[3]   SemeaTech,   Accessed: Feb.   1,   2021.   [Online].   Available:
       http://semeatech.com/m/view.php?aid=193.