Quasi Moment Method Analysis of Greenhouse Gases

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INTRODUCTION

- A greenhouse is an enclosed environment for plant development and growth and waste management [1]-[3]. State variables, which include air temperature, humidity, velocity, and carbon dioxide (CO_2), as illustrated in Fig. 1, are constantly regulated due to the air exchange between the inside and outside for optimum control of crop cultivation and productivity.

INTRODUCTION

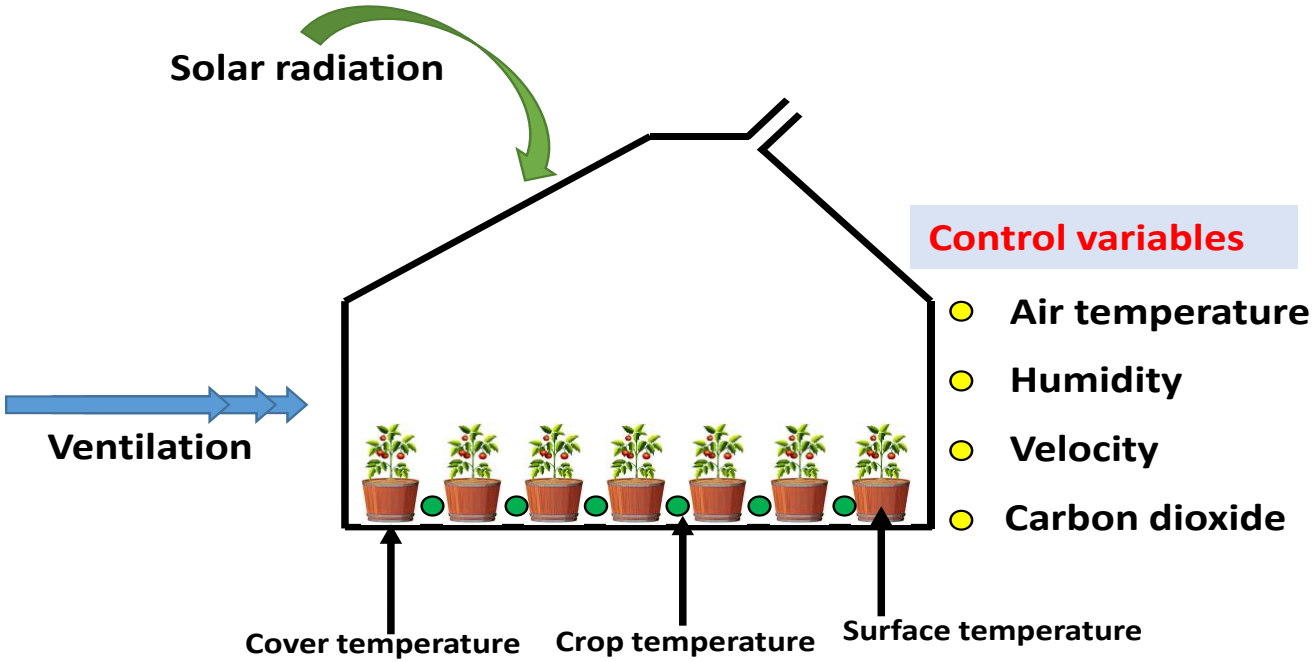


Figure 1: Schematic of a greenhouse climate control problem

INTRODUCTION

- For such models, various numerical methods which include Runge-Kutta, Newton-Raphson [8], the linear regression approach [13], [14], have been applied as solutions to the system.
- However, the convergence problem has received little attention, and also, methods, which can be used to reduce complex procedures, have not been reported.

INTRODUCTION

- Recently, the quasi-moment method has been established as an efficient tool for path loss and energy forecasting modelling [15], [16]. Here, it will be used for the prediction of greenhouse parameters

METHODOLOGY

- The general function for greenhouse gases evaluation is given as

$$y = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \ldots + a_n x^n \quad (1)$$

where is the dependent variable, denotes the independent variables and represents the coefficient of

For simplicity, eqn. (1) can be recast as follows

$$y = \gamma_1 \phi_1 + \gamma_2 \phi_2 + \gamma_3 \phi_3 + \gamma_4 \phi_4 + \ldots + \gamma_n \phi_n \quad (2)$$

METHODOLOGY

- The matrix formulation will then be

$$\begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ . \\ . \\ . \\ \gamma_n \end{bmatrix} = \begin{bmatrix} \langle \phi_1 : \phi_1 \rangle & \langle \phi_1 : \phi_2 \rangle & \langle \phi_1 : \phi_3 \rangle & \langle \phi_1 : \phi_4 \rangle & \cdots & \langle \phi_1 : \phi_n \rangle \\ \langle \phi_2 : \phi_1 \rangle & \langle \phi_2 : \phi_2 \rangle & \langle \phi_2 : \phi_3 \rangle & \langle \phi_2 : \phi_4 \rangle & \cdots & \langle \phi_2 : \phi_n \rangle \\ \langle \phi_3 : \phi_1 \rangle & \langle \phi_3 : \phi_2 \rangle & \langle \phi_3 : \phi_3 \rangle & \langle \phi_3 : \phi_4 \rangle & \cdots & \langle \phi_3 : \phi_n \rangle \\ \langle \phi_4 : \phi_1 \rangle & \langle \phi_4 : \phi_2 \rangle & \langle \phi_4 : \phi_3 \rangle & \langle \phi_4 : \phi_4 \rangle & \cdots & \langle \phi_4 : \phi_n \rangle \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ \langle \phi_n : \phi_1 \rangle & \langle \phi_n : \phi_2 \rangle & \langle \phi_n : \phi_3 \rangle & \langle \phi_n : \phi_4 \rangle & \cdots & \langle \phi_n : \phi_n \rangle \end{bmatrix}^{-1} \begin{bmatrix} \langle \phi_1 : y \rangle \\ \langle \phi_2 : y \rangle \\ \langle \phi_3 : y \rangle \\ \langle \phi_4 : y \rangle \\ . \\ . \\ . \\ \langle \phi_n : y \rangle \end{bmatrix}$$

METHODOLOGY

- provided that

$$\langle \phi_t, \phi_b \rangle = \sum_{n=i}^{N} \phi_t(n)\phi_b(n)$$

$$\langle \phi_t, y \rangle = \sum_{n=i}^{N} \phi_t(n)\, y$$

- The obtained analytical results are used to develop a MATLAB code for computation.

RESULTS AND DISCUSSION

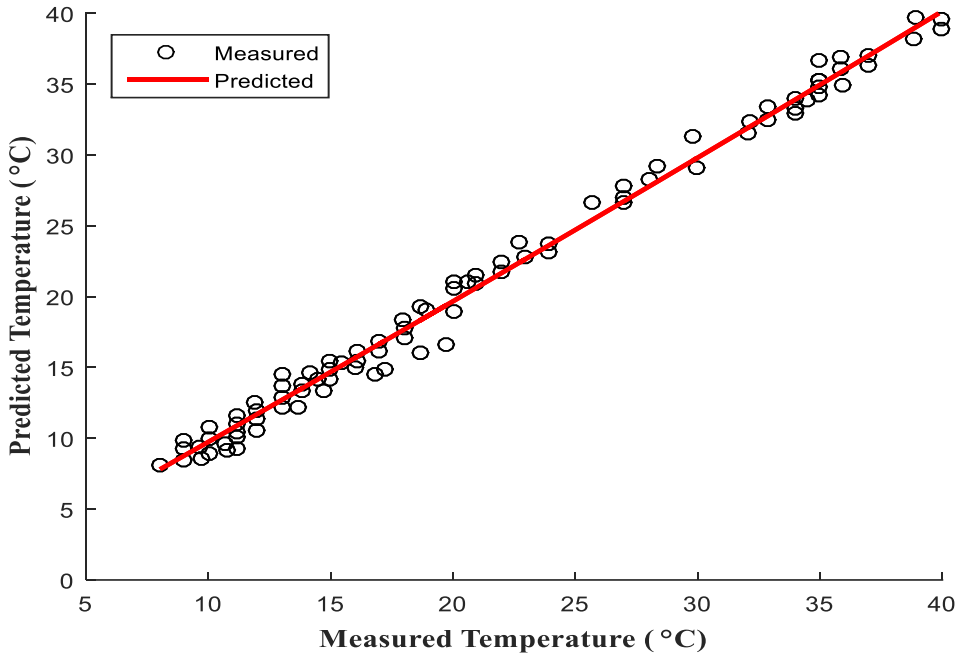


Figure 1: Comparison between predicted and measured inside air temperature T (°C)

RESULTS AND DISCUSSION

Table 1: Comparison of result with the published result

Year	Measurement of emission of CO_2 from gaseous fuel	Result Data from Model (Cole et al., 2017)	Result of the Present Model	Error
1994	4.24	4.12	1.26	2.98
1995	5.25	6.66	3.26	1.99
1996	7.22	9.2	5.73	1.49
1997	7.59	11.75	8.59	-1
1998	9.29	14.3	11.76	-2.47
1999	12.59	16.85	15.17	-2.58
2000	18.84	19.41	18.75	0.09
2001	21.17	21.97	22.43	-1.26
2002	26.8	24.53	26.12	0.66
2003	30.04	27.1	29.76	0.28
2004	41.46	29.67	33.27	8.19
2005	39.34	32.24	36.58	2.76
2006	36.12	34.81	39.61	-3.49
2007	30.61	37.39	42.3	-11.69
2008	43.11	39.98	44.55	-1.44
2009	50.5	42.56	46.31	4.19
2010	63.98	45.15	47.5	16.48
2011	37.86	47.74	48.04	-10.18
2012	41.54	50.34	47.86	-6.32
2013	50.61	52.94	46.88	3.73
2014	45.52	55.54	45.04	0.48

RESULTS AND DISCUSSION

It is observed in fig. 1 and Table 1 that the QMM result outperformed the ublished result for the greenhouse gases prediction.

CONCLUSION

The concept of Quasi Moment Method has been introduced in this paper for waste management optimization. And the results of the model are obtained
through the developed code.

CONCLUSION

Furthermore, the efficacy of the model has been demonstrated through comparisons of the simulation results with the existing data in the literature.

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