Multi-view Stacked CNN-BiLSTM (MvS CNN-BiLSTM) for urban $PM2.5$ concentration prediction of India's polluted cities

Thesis submitted in partial fulfilment

for the Award of

DOCTOR OF PHILOSOPHY

in

Subject

By

SUBHAM KUMAR

Under the supervision of

NAME OF Supervisor

Department of Computer Science and Information Technology

School of Computational Sciences, Information and Communication Technology

MAHATMA GANDHI CENTRAL UNIVERSITY

Motihari, East Champaran, Bihar-845401

Jan,2025 MGCU2021CSIT4029

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I, **Name of Scholar** certify that the work embodied in this **Ph.D.** thesis is my own bonafide work carried out by me under the supervision of **NAME OF Supervisor** and the co-supervision of **NAME OF Co-Supervisor** for a period of **4 Years** from **2nd jan 2025** to **10th jan 2025** at **Mahatma Gandhi Central University** and (Name of the Institution where work has been carried out partly or fully). The matter embodied in this **Ph.D.** thesis has not been submitted for the award of any other degree/diploma.

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Abstract

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Acknowledgment

This M.Tech **ReportType** is the result of hard work, upon which many people have contributed and given their support. I have made this dissertation on the topic **"ReportTitel ."** I have also tried my best in this dissertation to explain all the related detail. I would like to express my sincere gratitude towards my Superviser **Supervisor**, Department of **Department**, for providing excellent guidance, encouragement, inspiration, and constant and timely support throughout this **Degree** dissertation work. He taught me how to pursue the right aim towards the work, and showed me differnt ways to approach the research problem. His wide knowledge and logical ways of thinking have been great value for me, and his understanding and guidance have provided the successful completion of the Dissertation work.

First and foremost, I would like to express my gratitude to our beloved Dean of the Computational Sciences, Information and Communication Technology and Head of Department of Computer Science and Information Technology **HodName**, for providing his kind support in various aspects. A special thanks to all the Respected Teachers of the Department of Computer Science and Information Technology.

I am always grateful to the university, our Hon'ble Vice chancellor **Vc** for providing such a good research environment.

Special thanks to Ph.D scholar, especially **Ritika Singh**, **Surbhi Kumari**, **Ibrahim Momin**, **Naushad Ahmad** and my friends **Tej Prakash**, **Gajendra Patel**, **Abhijeet Kumar**, **Amod Kumar**, **Rana Kumar**, **Krishna Murari**, **Rajan Kumar**, **Suraj**, **Md. Aamir Sohail**, **Shahzeb Khan**, and all my lovely juniors for their invaluable feedbacks, care, and moral support during this endeavor.

Mother and **Father**, it is impossible to thanks adequately for everything you have done, from loving me unconditionally to rising me in a stable household, where your

persistent efforts and traditional values taught your children to celebrate and embrace life. I could not have asked for better parents or role-models. You showed me that anything is possible with faith, hard work and determination.

Name of Scholar
MGCU2021CSIT4029
Degree(CSE)

Dedicated to my . . . .

Table of Contents

List of Figures

List of Tables

List of Abbreviations

USA United States of America

List of Symbols

F force

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Multi-view Stacked CNN-BiLSTM (MvS CNN-BiLSTM) for urban $PM2.5$ concentration prediction of India's polluted cities.

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Chapter 1

Introduction

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1.1 Introduction

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Paragraph2

Paragraph3

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1.1.1.1 pm2

loram12

Chapter 2

Literature Review

2.1 Literature Review

Paragraph

Paragraph

Table 9.1 REFRENCE OF TABLE

Table 2.1: Summarizing of Related work to pridict $PM_{2.5}$

Paper	**Proposed Model**	**Data Source**	**Forecasting Object**	**Benchmark Models**	**Results**
...	...	...	...	...	...

Chapter 3

Basics Related Roncepts

3.1 Basics Related Roncepts

3.1.1 Machine Learning

Paragraph

Chapter 4

Methodology

4.1 Methodology

Table 4.1: 17 Indian cities dataset, with start and end dates and sample counts.

DataSets	**Fast_Day**	**Last_Day**	**No of Samples**
BHIWADI	20-12-2017 15:00	02-12-2022 16:00	43394
JODHPUR	01-12-2015 00:00	02-12-2022 16:00	61409
SINGRAULI	08-12-2017 11:00	03-12-2022 01:00	43695
ANKLESHWAR	04-02-2019 18:00	03-12-2022 00:00	33535
LUDHIANA	01-05-2017 00:00	03-12-2022 01:00	49010
DURGAPUR	06-12-2020 15:00	03-12-2022 00:00	17434
YAMUNA_NAGAR	03-01-2019 14:00	02-12-2022 16:00	34299
CHARKHI_DADRI	03-03-2020 15:00	02-12-2022 17:00	24099
JIND	10-01-2019 09:00	03-12-2022 01:00	34145
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SONIPAT	01-01-2019 00:00	02-12-2022 17:00	34362
DHARUHERA	04-01-2019 12:00	02-12-2022 04:00	34265
AMBALA	08-01-2019 12:00	02-12-2022 09:00	34174
HISAR	10-01-2019 10:00	03-12-2022 00:00	34143
FATEHABAD	09-01-2019	02-12-2022	34160

Table 11.1 :

Chapter 5

Results and Analysis

5.1 Results and Analysis

Table 5.1: All Datasets RMSE.

DataSets	BiLS-TM	CNN	GRU	Seq2-Seq	V-LSTM	S-LSTM	CNN_ Bi-LSTM	CNN_ LSTM	GRU_ Bi-LSTM
BHIWADI	23.13	57.2	22.34	24.2	19.6	48.14	45.98	43.5	35.3
JODHPUR	27.54	26.68	32.94	22.35	22.08	50	40.87	43.55	52.63
SINGRAULI	10.92	15.5	27.34	21.61	13.63	17.79	50.61	22.2	26.5
ANKLESHWAR	18.53	16.68	37.15	23.78	18.38	46.28	62.85	68.72	69.38
LUDHIANA	8.4	11.12	22.14	10.1	8.3	21.15	25.66	24.76	23.77
DURGAPUR	6.14	8.27	20.34	9.48	8.78	15.28	9.62	13.76	24.39
YAMUNA_NAGAR	37.34	34.57	56.27	36.33	38.18	66.14	72.39	45.63	74.13
CHARKHI_DADRI	18.42	20.43	27.96	18.43	18.06	40.71	46.16	45.27	43.48
JIND	24.17	26.42	34.35	25.85	19.41	79.22	62.13	43.59	50.95
KURUKSHETRA	27.14	72.03	43.56	27.32	26.7	65.77	39.71	88.12	53.74
SONIPAT	12.56	15.98	22.4	15.41	10.9	43.02	24.01	22.96	46.77
DHARUHERA	26.74	28.93	34.6	24.06	25.19	53.18	31.93	35.01	46.22

AMBALA	22.58	28.96	41.08	19.92	16.92	57.43	40.71	34.14	63.85
HISAR	28.34	66.79	47.93	33.98	30.99	63.29	43.16	49.1	62.46
FATEHABAD	14.37	38.36	72.71	15.51	15.58	38.38	74.38	76.75	72.64
BULANDSHAHR	7.39	8.87	19.79	11.19	7.2	14.98	9.61	13.16	11.51
MUZAFFARNAGAR	11.88	16.13	13.72	14.2	12.75	22.21	15.91	23.6	21.9

Table 5.2: Average Rankings of RMSE by (N*N) Friedman Test

Algorithm	Ranking
BiLSTM	2.1176
CNN	4.2941
GRU	5.7059
Seq2Seq	3.1176
V-LSTM	1.7059
S-LSTM	7.1176
CNN-BiLSTM	6.5294
CNN-LSTM	6.9412
GRU-BiLSTM	7.4706

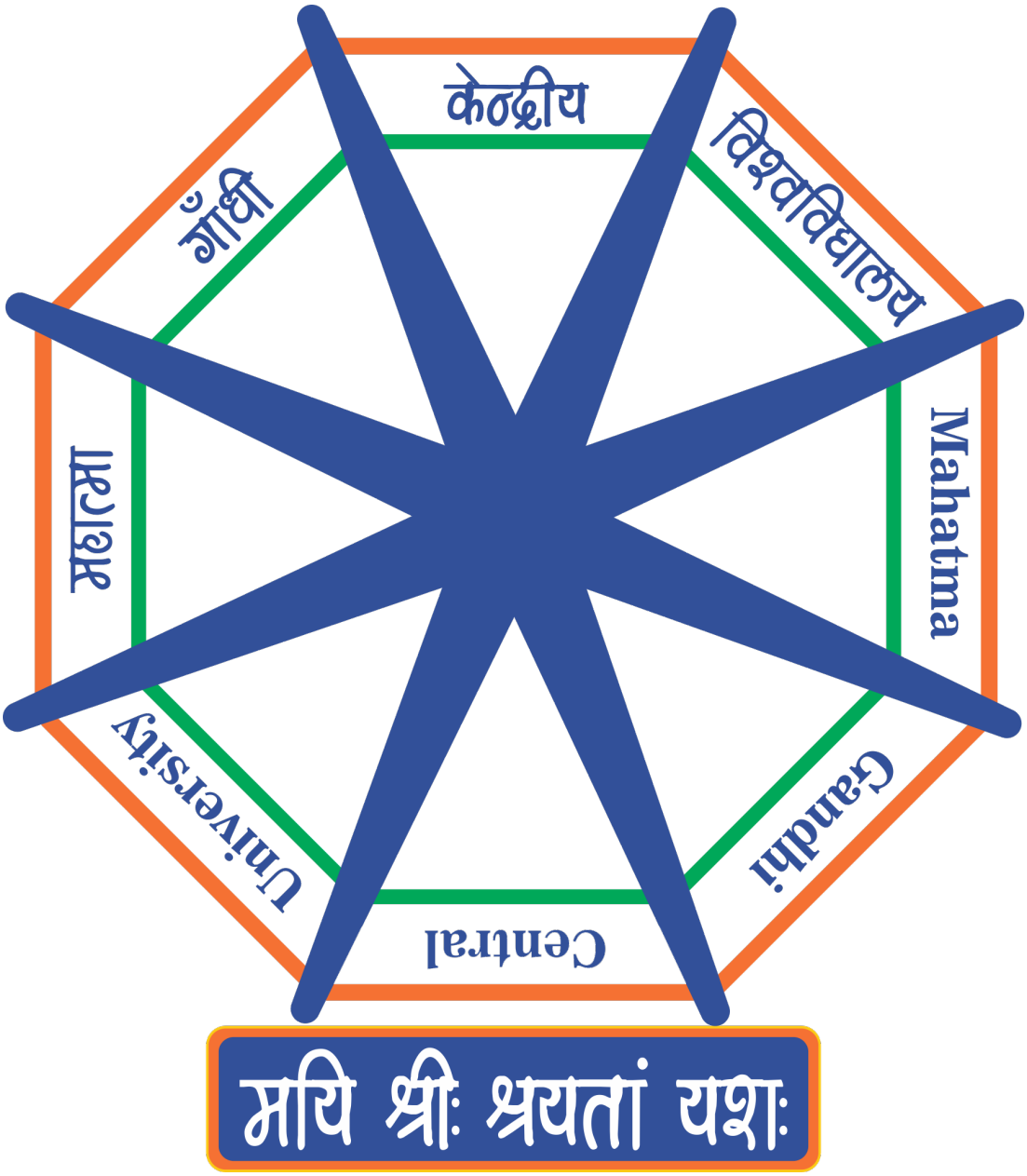

Figure 5.1: Actual vs Predicted of BiLSTM for All Datasets

Chapter 6

Conclusion

6.1 Conclusion

Chapter 7

Introduction

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7.1 Introduction

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Paragraph2

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Chapter 8

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8.1 Results and Analysis

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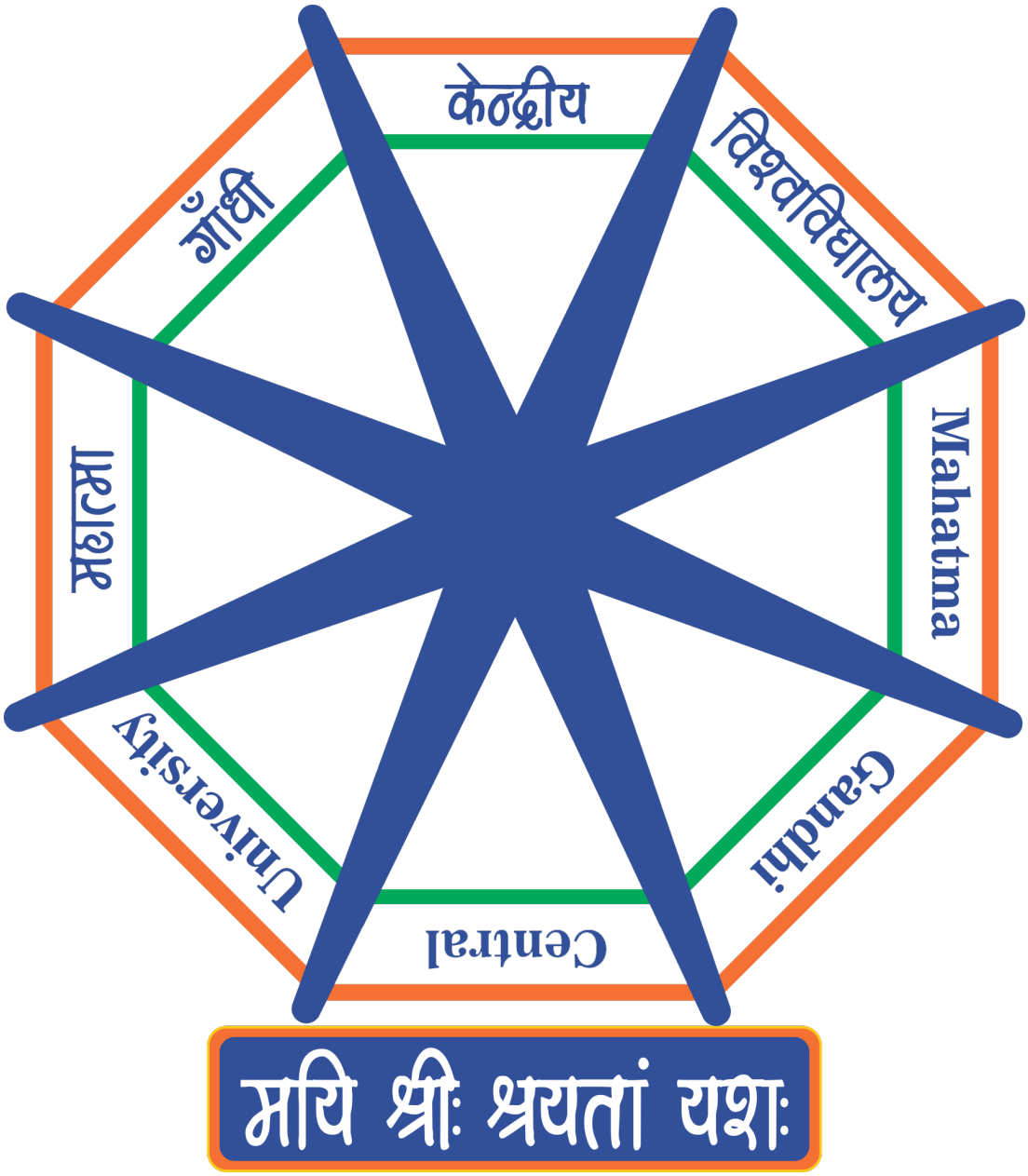

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Chapter 9

Literature Review

9.1 Literature Review

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Chapter 10

Basics Related Roncepts

10.1 Basics Related Roncepts

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AMBALA	08-01-2019 12:00	02-12-2022 09:00	34174
HISAR	10-01-2019 10:00	03-12-2022 00:00	34143
FATEHABAD	09-01-2019	02-12-2022	34160

Table 11.1 :

Chapter 12

Conclusion

12.1 Conclusion

References

[1] Nairita Sarkar, Rajan Gupta, Pankaj Kumar Keserwani, and Mahesh Chandra Govil. Air quality index prediction using an effective hybrid deep learning model. Environmental Pollution, 315:120404, 2022.

[2] Ghufran Isam Drewil and Riyadh Jabbar Al-Bahadili. Air pollution prediction using lstm deep learning and metaheuristics algorithms. Measurement: Sensors, 24:100546, 2022.

Appendices

Chapter A

Supporting Information

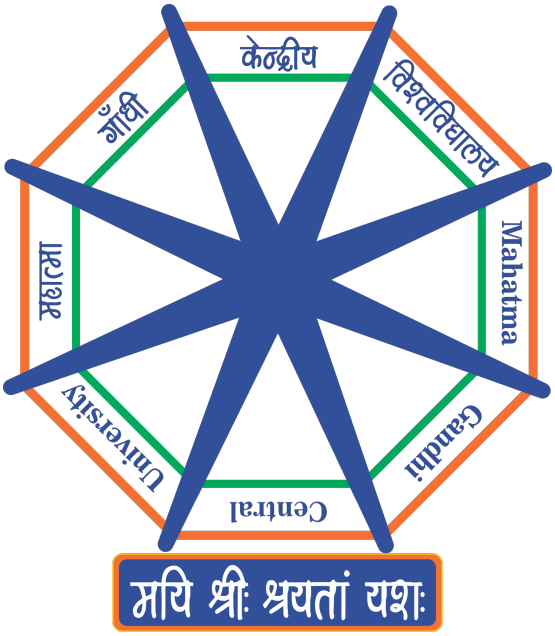

Figure A.1: Caption of image 2.

Chapter B

Supporting Information

Figure B.1: Caption of image 2.

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