LIST OF FIGURES

Sr. No.	Figure	Figure Caption	Page No.
1	Figure 1.1	Deep learning model	6
2	Figure 3.1	Layered IoT architecture with different perspectives	31
3	Figure 3.2	Layer wise protocol categorization when compared to ISO model	32
4	Figure 3.3	The message format for the CoAP protocol	36
5	Figure 3.4(a)	Biological neuron structure	41
6	Figure 3.4(b)	Mathematical model of the neuron	41
7	Figure 3.5	An example of a neuron network	42
8	Figure 3.6	Recurrent neuron network unrolling	43
9	Figure 3.7	Internal gated structure of basic LSTM unit/cell	46
10	Figure 4.1	Layered Architecture of proposed air quality monitoring system	53
11	Figure 4.2	Topology design	53
12	Figure 4.3	Detailed working flow of the proposed IoT-based air quality monitoring	59
13	Figure 4.4	MQTT architecture	62
14	Figure 4.5	MQTT connect packet format	63
15	Figure 4.6	Proposed LSTM based model	65
16	Figure 4.7	Moving window over timesteps in time-series	69
17	Figure 4.8	Detailed training and testing framework of proposed forecasting task	70
18	Figure 5.1(a)	Prototype(sensing node)	74
19	Figure 5.1(b)	Deployment at home(indoor)	75
20	Figure 5.1(c)	Deployment rooftop(outdoor)	75
21	Figure 5.2	Some snaps of GUI cum graphs generated from the data at server for monitoring the parameters of home rooftop (site 1: outdoor) and home (site 2: indoor) per one-hour sliding window	77
22	Figure 5.3(a)	Distribution comparison of observed Parameters	78
23	Figure 5.3(b)	Observation of PM2.5, PM10, and CO at the rooftop during day time (site 1: outdoor)	78

24	Figure 5.3(c)	Observation of PM2.5, PM10, and CO at home during day time (site 2: indoor)	79
25	Figure 5.4(a)	Scatter plot of PM 2.5 at the rooftop (site 1: outdoor) over 3 days	79
26	Figure 5.4(b)	Scatter plot of PM 10 at the rooftop (site 1: outdoor)	79
27	Figure 5.5	Screenshots of the python shell at sever	80
28	Figure 5.6	Screenshots of the mobile application	81
29	Figure 5.7	The detailed circuit design of sensor interfacing	82
30	Figure 5.8	Message transmission under event-based transmission	86
31	Figure 5.9	Message transmission for N=3 and various values of delta	87
32	Figure 5.10	System performance over an MQTT protocol: rooftop (site 1: Outdoor) and home (site 2: Indoor)	88
33	Figure 5.11	End to End delay against QoS level in simulation	88
34	Figure 5.12	Throughput of the Sensing Unit	90
35	Figure 5.13	Comparison of MSE of LSTM and RNN	96
36	Figure 5.14	Comparison of MSE of proposed model(FBLSTM) with LSTM	97
37	Figure 5.15	MSE for merge function alternatives	99
38	Figure 5.16	Plotting of MSE per every epoch for training and validation	101
39	Figure 5.17(a)	Performance of the model for various values of dropout parameter under dropout technique	102
40	Figure 5.17(b)	Performance of the model for various values of lambda or regularization factor under L2 regularization	102
41	Figure 5.18	MSE comparison of the proposed model(FBLSTM) under regularization techniques for validation data	103