

1 An Analytic Real-Time Framework for IoT Based Home 2 Automation System

3 Nazmul Hossain¹, Rafia Sultana², Farzana Akter Lima³ and Md. Arif Rahman⁴

4 ¹ Jashore University of Science and Technology

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6

7 **Abstract**

8 The Internet of Things or IoT means the ability to connect billions of physical devices around
9 the world that are now linking to the internet for collecting and sharing data. Internet of
10 Things (IoT) technologies is used to sense the real-time primordial manufacture data and
11 included the energy alliance data and the provision circumstance data. The Internet of Things
12 (IoT) will approve any contents to be sensed or monitored remotely wherever there any
13 remaining network infrastructure, making amenities for the integration of the actual world
14 into computer-based systems. Real-time narrates the path of flowing media is processing. In
15 the real-time procedure, anyone can entrance information barring to narrate for it and save
16 our time. In our proposed system, we build a system where we calculate real-time. To
17 compute real-time, we need an IoT based automated system. And here we use an IoT based
18 home automation system. We are passing data through the system for collecting data with
19 the help of Cisco Packet Tracer simulator. For calculating real-time performance, we use six
20 performance metrics to evaluate the event detection system performance. They are sensitivity,
21 specificity, precision, accuracy, F1-score, and G-mean.

22

23 **Index terms**— internet of things (IoT), IOT, home Automation, smart home, response time, control system,
24 real-time, performance matric.

25 **1 Introduction**

26 The Internet of Thing (IoT) refers to gathering and sensing data from various apparatus about our daily life
27 corporal phenomena [1,2]. IoT has acquired capacious popularity owing to its extensive market in several sectors
28 such as home automation, healthcare, security, etc. [3]. IoT entangles pervading internet connectivity beyond
29 valuable devices to any province of traditionally daft or non-internet-enabled naturalistic devices and quotidian
30 things [4]. IoT was begotten from machine-to-machine (M2M) interaction. Machines are joining to the objects
31 via a network except for human communication [5].

32 Real-time is a level of computer compassionate that a customer senses as sufficiently early or that qualify
33 the computer to repose up with several processes (for example, to attendant visualizations of the weather as it
34 incessantly mutations) [6]. Real-time is an epithet regarding computers or processes that handle in real-time.
35 Real-time describes a man rather than an engine sense of time [7].

36 Real-time computing (RTC) is a period of computing decision that has inelastic instant constraints. Real-
37 time computing must be committed in a time structure that is relatively invisible to the user [8]. A real-time
38 system is any message processing system which must answer to externally propagated input incentive between a
39 limited and specified epoch [9]. If it overcomes this time bondages, it's output in accomplishment erosion and
40 malfunction of the process [10]. Denoting to the data-scheming system in which a computer takes every moment
41 transforming data, such as knowledge relating to air-traffic monitoring, travel booking procedure and processes
42 it practically to be capable of controlling the origin of data [11].

43 **2 a) Characteristics of Real-Time System**

- 44 ? Time Encirclement.
45 ? Modern Rectification Inference.
46 ? Interwoven.
47 ? Security-Criticality.
48 ? Concurrency.
49 ? Allotted and Recompose Formation.
50 ? Ought Troublesome.
51 ? Usage Hardware.
52 ? Durability.

53 **3 II.**

54 **4 Background and Related Work**

55 In 1970s Minicomputers specially built for dedicating embedded systems such as DOG scanners, onward the
56 necessity for low-latency priority-driven with accessing data and operating systems suchlike Data General's RDOS
57 (Real-Time Disk Operating System) and RTOS's background and foreground scheduling as Digital Equipment
58 Corporation's RT-11 date from this age. On time when the MOS Technology 6502 and the Motorola 68000
59 were exoteric relatives could conduct their abode computer as a real-time system. The chance to deactivate
60 several intermissions allowed for hardcoded loops with fixed timing and the less interrupt latency allowed the
61 impersonation of a real-time system ??12].

62 We implemented and modified our system with this two-existing system. In the procedure 1, Smart home
63 regulating devices are using for guiding the systems by sending data to govern the actuators. Here they also used
64 the home gateway for relating all home appliances and interconnected with the Internet on the open network
65 part, and the home networks also control the home machinery. The home gateway gives the ability to control
66 the connected equipment on the home networks that controlled with smart instruments and passed data through
67 the system and collect data for calculating real-time [13]. In the procedure 2, there submitted a low cost secure
68 mobile phone-based home automation system [14,15]. Appliances at home are linking with the Arduino BT
69 board, and the communication within the mobile phone and the Arduino BT board is wireless [16]. Superfluous
70 apparatus can be connected into the system, and it should be faster enough to actualize the power of wireless
71 technology and be cost effective. In this system, they also are measuring data for calculating real-time [17,18].

72 In our system, we connected all devices with the server and motion sensor for controlling our automation
73 system. We passed data through our implemented process for measuring the time that is needed to turn on/off
74 the equipment. For calculating real-time performance, we implement a virtual system in Cisco Packet Tracer. We
75 use server and motion sensor for connecting the devices. The equipments are light, fan, door, window, sprinkler,
76 webcam and motion detector. The sensor is joining to the SBC-PT Board, which is one kind of networking access
77 board. All equipment attached with the server through a unique IP address. Entering to the server and viewing
78 the activity of the system by home authority there use a laptop. To collect real-time data, we passed packets
79 through the system and putting it to the performance matrices equation for calculating the real-time action of
80 our system. We also build the other two existing methods in Cisco Packet Tracer for comparing our systems
81 performances [19].

82 **5 III.**

83 **6 Proposed System a) System Description**

84 **7 b) User Case Diagram**

85 User case provides a path, how the user gets the entrance license of the system. A user cannot straightly access
86 the arsenal so that they needed to exact authentication. Here also we see equipment internally linked with the
87 system action. Use cases are typically induced by a user to meet the goals detail activities and variants inlaid in
88 gaining the aim [20].

89 **8 Flow:**

90 ? Admin Managing & Controlling Home Appliances Logout. Admin is the prime controller for managing,
91 measuring and controlling the access of the services.

92 **9 Fig. 2: User Case Diagram**

93 ? User Login Using Equipment Logout.

94 To start using the system, the user must use the login interface to log in into the system. When the user wants
95 to control the equipment, they first log in to the service with their password. If their passwords match, then they
96 get the access. After using the device, they are log Out from the process.

97 ? Ingredient Motion Sensor. Light, Fan, Door, Window, Sprinkle connected to the motion sensor. When the
98 sensor detected any person, then it is automatically on/off. ? Ingredient Motion Detector. Webcam connected to
99 the motion detector. If any person passes through a motion detector, then it is automatically on/off. Therefore,
100 we see the passing passenger.

101 **10 c) Layer Development**

102 Layering is the association of programming into individual functional elements that interact in various sequential
103 and hierarchical way, including each layer generally having an interface alone to the layer above and below it
104 [21]. IV.

105 **11 Analysis Of Proposed System a) Data Collection**

106 For calculating real-time, we pass packet through equipment from starting point to end. We pass the packet into
107 two different ways. And the ways are 1) Equipment to server & 2) Server to Equipment. In this process we listed
108 time, some packets are passed that called passing time or true position time. Here true position time denoted
109 as x & y . And some packets are not passed that called obstacle time or false position. We denote false position
110 as x' & y' [22,23]. To calculate real-time, we use six different types of performance metrics. The metrics are
111 Sensitivity, Specificity, Precision, Accuracy, F1-score, G-mean. We can apply all the performance metrics into
112 seven different equipment such as light, fan, door, window, sprinkler, webcam and motion detector. ? G-mean:
113 The G-mean is computing by taking the square average value of sensitivity and specificity.

$$114 \quad G\text{-mean} = \sqrt{\text{Sensitivity} \times \text{Specificity}}$$

115 **12 b) Comparison**

116 Previously we discussed two different systems. We can also implement these systems and passes packet through
117 that systems for calculating the passing time and obstacle time. With the help of performance metrics, we
118 calculate real-time through this passing time and obstacle time. The Graph for Light (Sensitivity): System 1
119 goes zigzag, and system 2 goes from high to low but our system goes from low to high. The Graph for Light
120 (Specificity): Our system's specification is better than other two process because it is an up-ordering line. The
121 Graph for Light (Precision):

122 **13 Comparison of Light:**

123 Our system precision is better than other. The Graph for Light (Accuracy): System 1 and system 2 are creating
124 down order line, but our system is high-ordered. The Graph for Light (F1-score):

125 The value of F1-score in our system is excellent than the other two methods. The Graph for Light (G-mean):
126 We are measuring the value of three systems and plotting the value for generating the graph line, and line is
127 increasing. The Graph for Fan (Sensitivity):

128 For comparing three systems, we saw that our system's sensitivity is better than others. The Graph for Fan
129 (Specificity):

130 We collect data and compare with them and saw that the proposed system is proper.

131 **14 The Graph for Fan (Precision):**

132 From the table and graph, we predicted that the precision of our system is the best than others. The Graph for
133 Fan (Accuracy): System 1 and 2 is down order line. Our system is emersion, so it is enriching the graph. The
134 Graph for Fan (F1-score):

135 Plotting the value and choose a better system and our system is better than others. The Graph for Fan
136 (G-mean):

137 For fan, the G-mean is elder than system 1 and system 2 because it is emergence from others. The Graph for
138 Door (Sensitivity): System 1 rise low to high and low. System 2 is ascent high to low and high. Our system goes
139 low to high without breaking. The Graph for Door (Specificity):

140 Plotting the value and generate the graph for three system and our system graph is better. The Graph for
141 Door (Precision):

142 For metering the effect of the specification of fan we collect and compare data for three system and the proposed
143 system is strong. The Graph for Door (Accuracy): System 1 and 2 are devious, and our system's accuracy is the
144 best because it is a rising line. The Graph for Door (F1-score):

145 Construct the diagram we saw that system 1 and system 2 are decreasing, and our system is increasing. The
146 Graph for Door (G-mean): Our system's G-mean is elder than system 1 and system 2 because it is emergence
147 from others. From the diagram, we saw that our proposed system sensitivity is good than other systems. The
148 Graph for Window (Specificity):

149 For monitoring the effect of specificity, we collect data and compare them and choose the better line. The
150 Graph for Window (Accuracy):

17 CONCLUSION

151 Our system is heightening from system 1 and system 2 because it is a prosperous order line graph. From the
152 table, we plot the value and choose a better system, and the implemented system is the best than others. The
153 Graph for Window (G-mean):

154 We are measuring and plotting the value for the diagram and observe that it is increasing. In modern time
155 almost, people prefer to do their work digitally, so they use the internet to do that work. Through the internet,
156 we connect with those equipments easily which we used in our daily life for controlling that thing. With the help
157 of IoT and the Internet, we can do those activity [24]. We can control and monitor our home equipment when
158 the owner goes outside. For this purpose, this system needs to response in less time because if the materials turn
159 on a long time, it will damage, or its cases more electric bill. We try to remove that problem in our paper. In
160 future, we develop this system for consuming time on demand [25,26].

161 V.

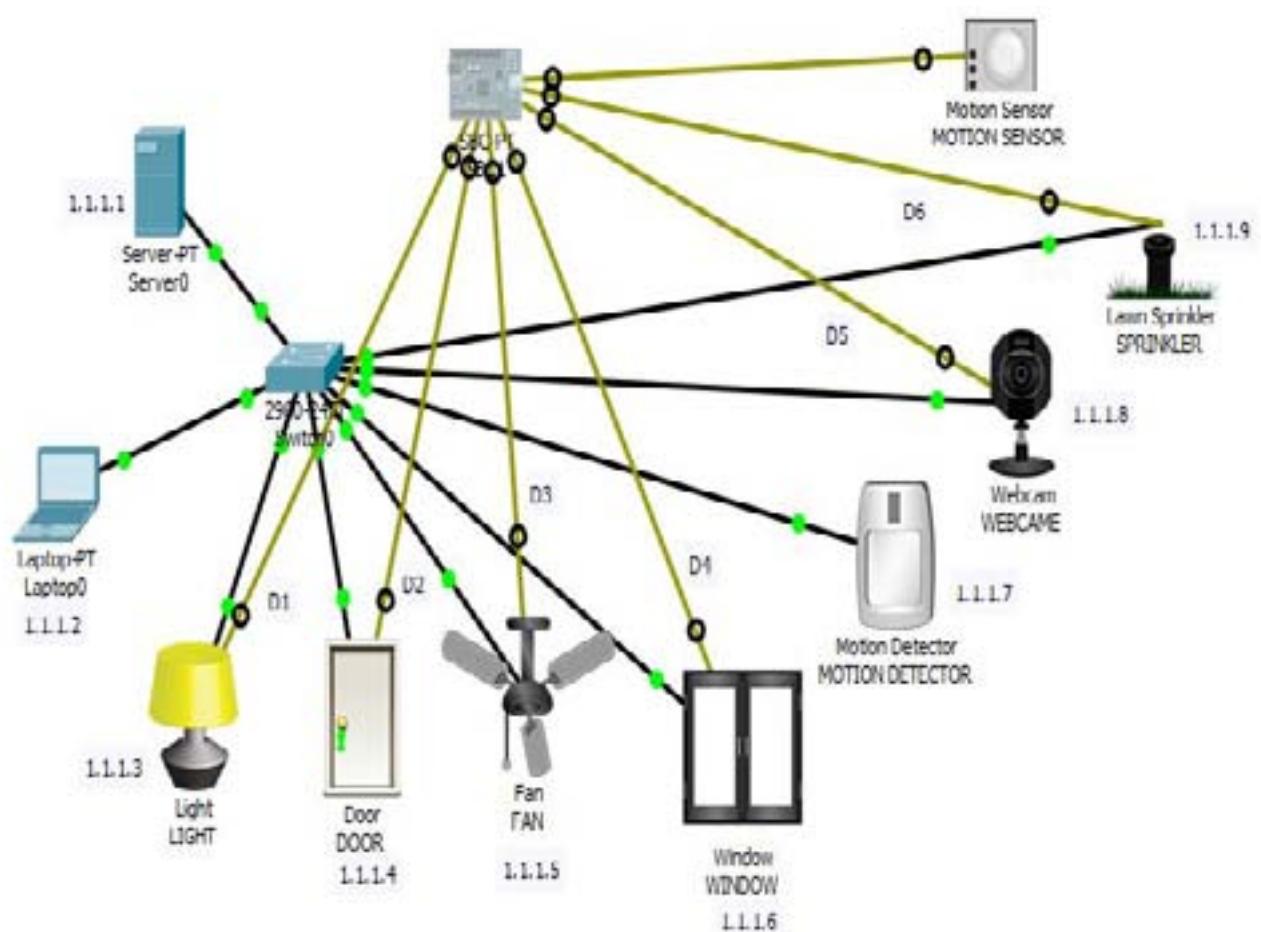
162 15 Result

163 In this system, we calculate the time for seven equipment, and here we give four equipment's (light, fan, door,
164 window) real-time in-home automation system. In our next paper, we will discuss and calculate the time for
165 other three equipment. We passed data packet through every device for ten different ways. Collecting values
166 and plotting those for creating a graph that helps us to view real-time response. We excrement for measuring
167 a mediocre period and comparing with other existing systems. From the diagram, we see that our systems
168 Sensitivity, Specificity, Precision, Accuracy, F1-score, and G-mean provide a better graph line than others. And
169 we see that our systems response is better than another system.

170 16 VI.

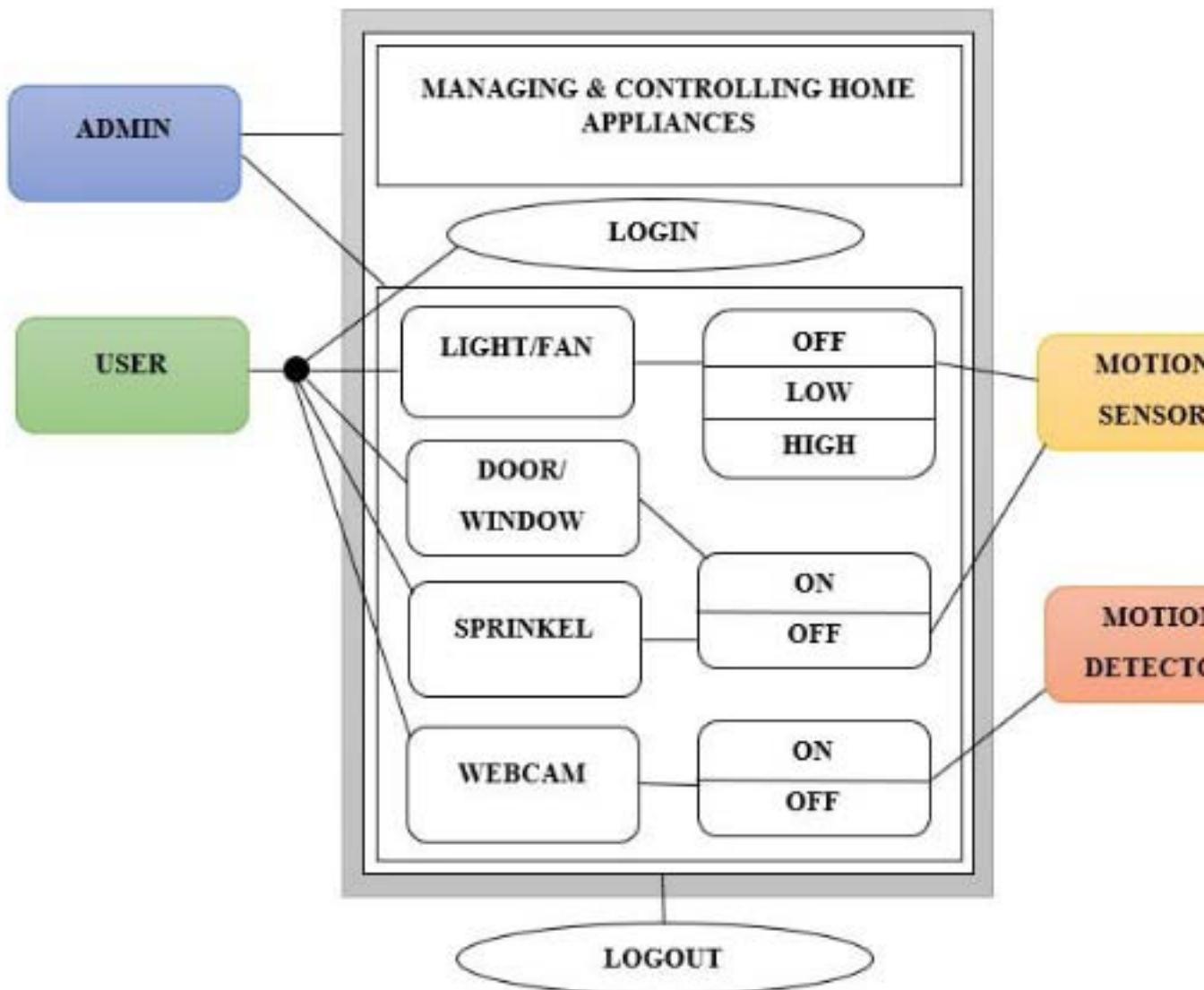
171 17 Conclusion

172 IoT promotes the proficiency of existence by joining the digital world to the real world via setting different sensors
173 in daily life objects [27]. If we utilize our system correctly, we save our valuable time, energy; electric power
174 moreover comforts of life. This work may be expanded to additional provision from other networks as those rules
175 may provide better insight into the conduct [28].¹



1

Figure 1: Fig. 1 :



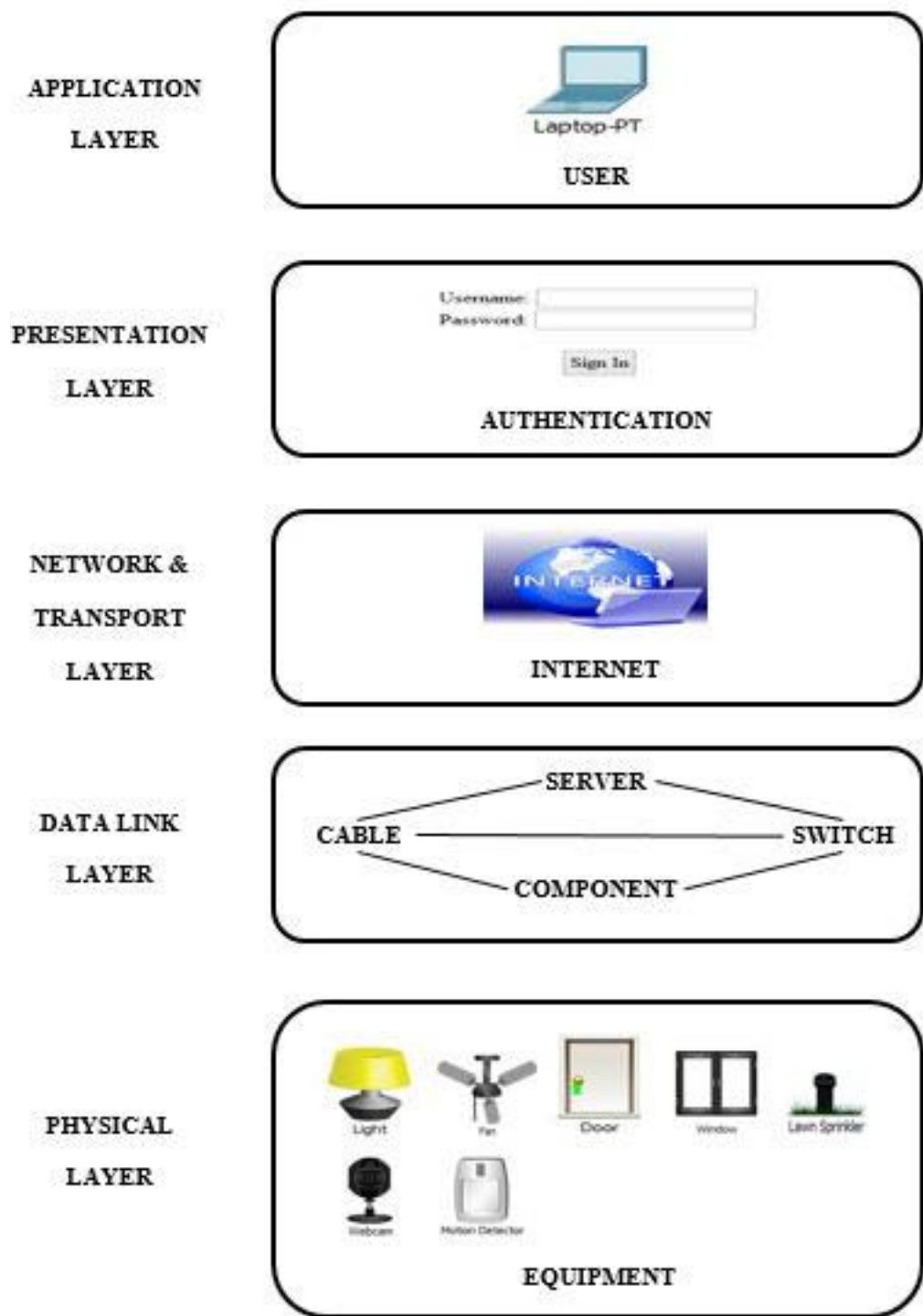


Figure 3: ??F1

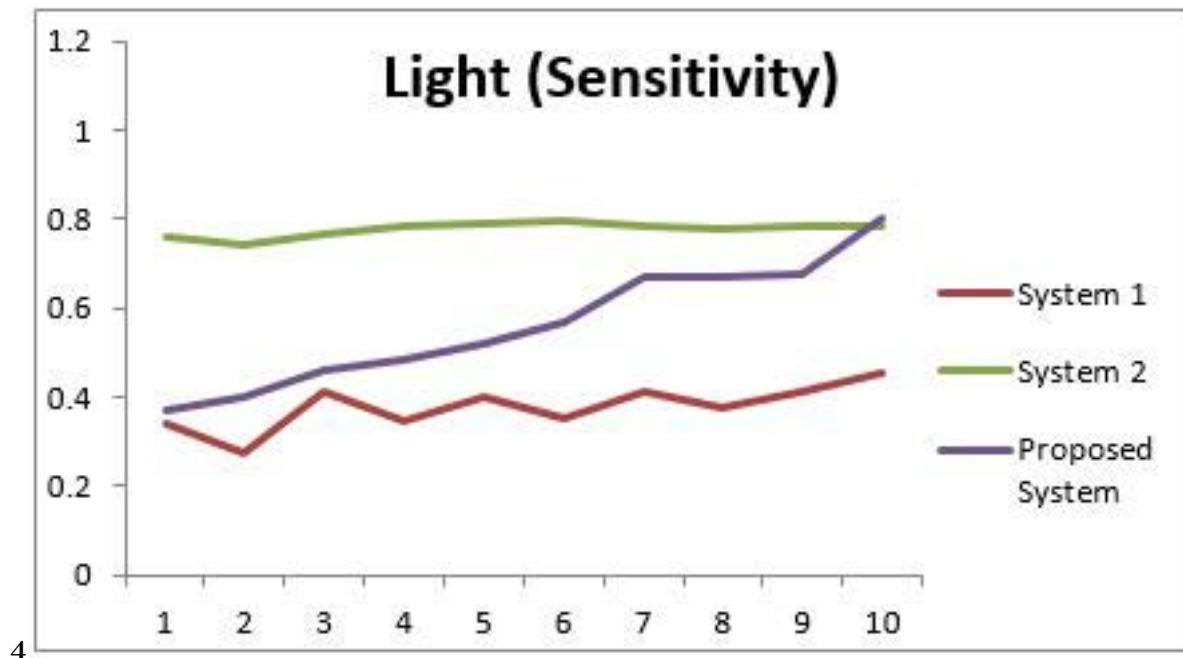


Figure 4: Fig. 4 :

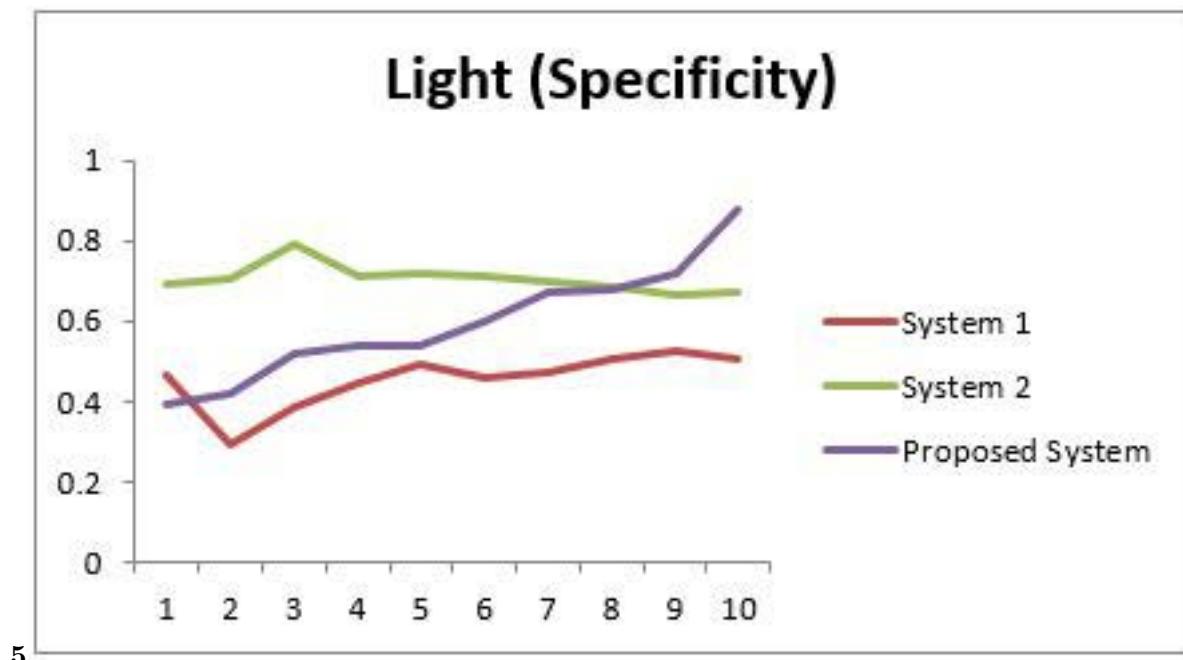


Figure 5: Fig. 5 :

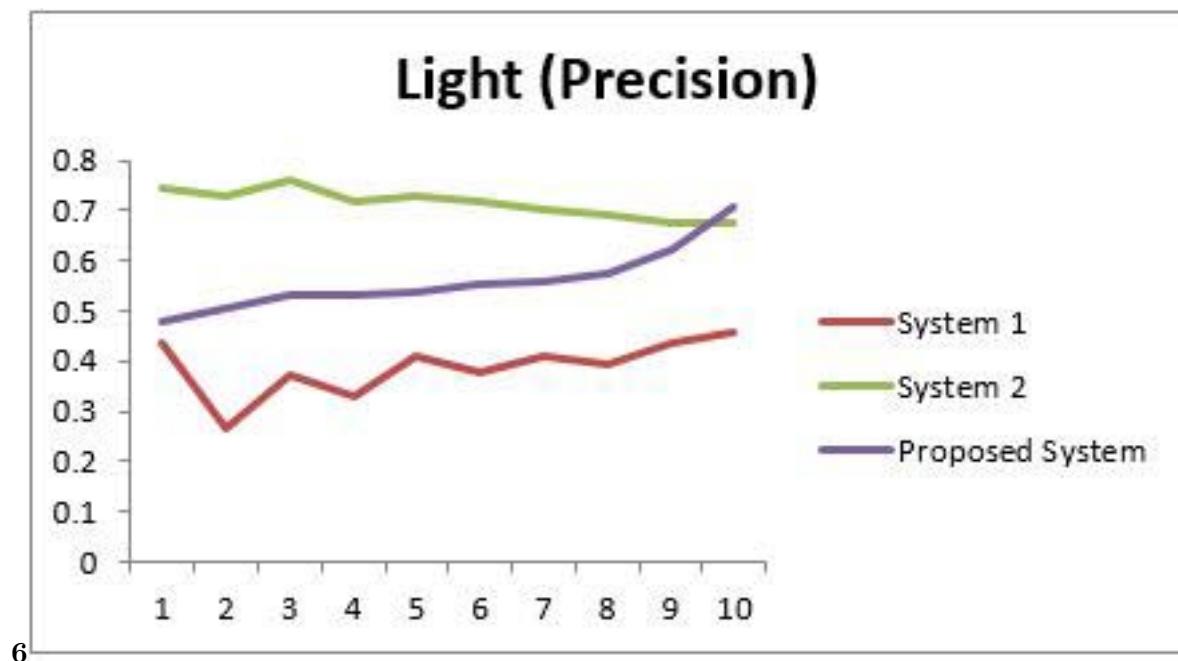


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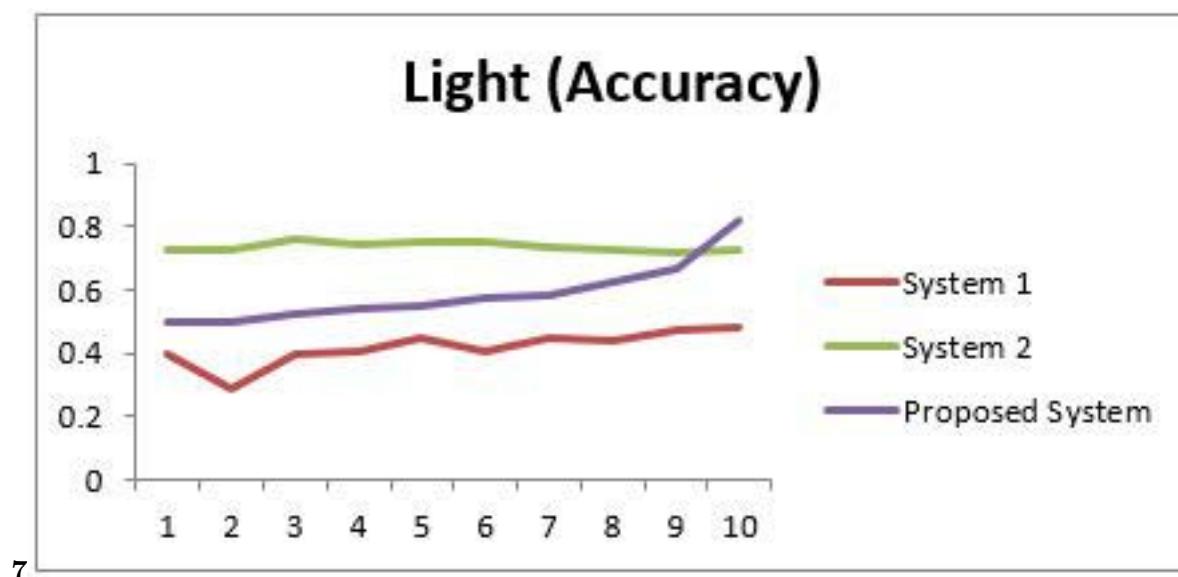


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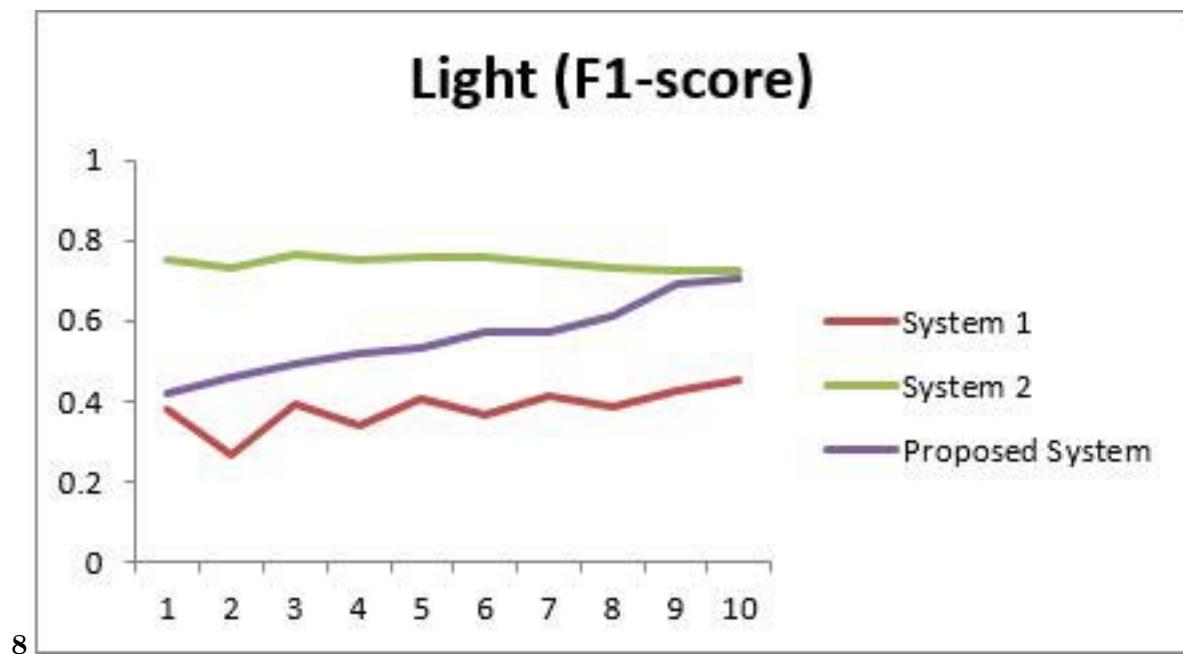


Figure 8: Fig. 8 :

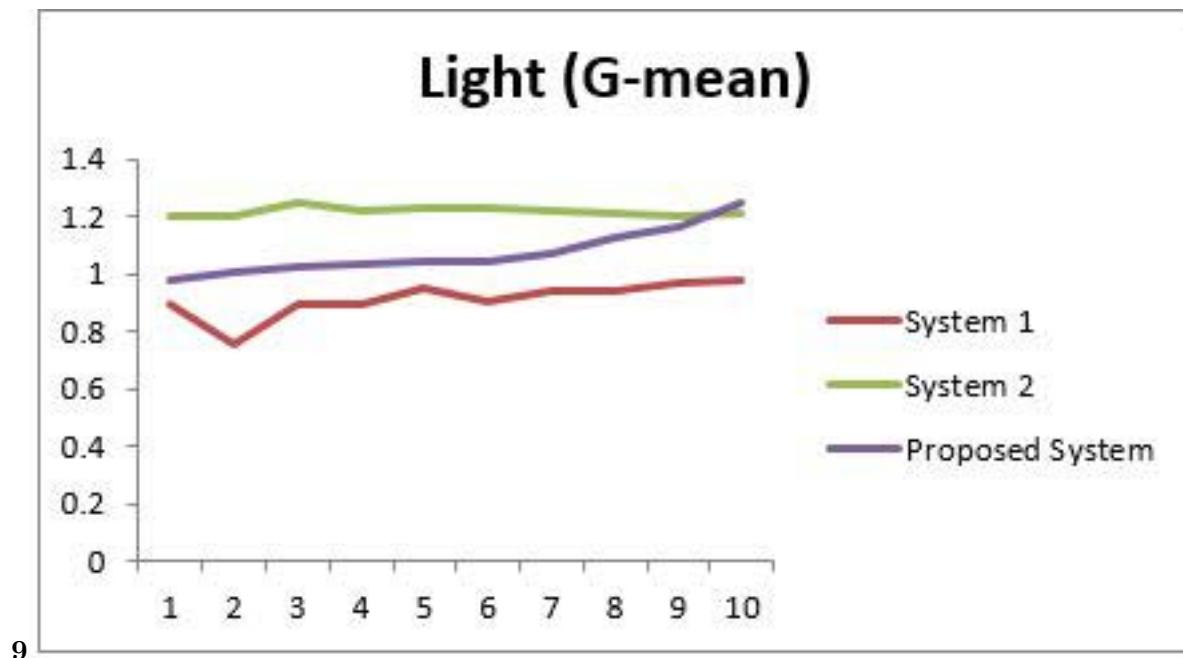


Figure 9: Fig. 9 :

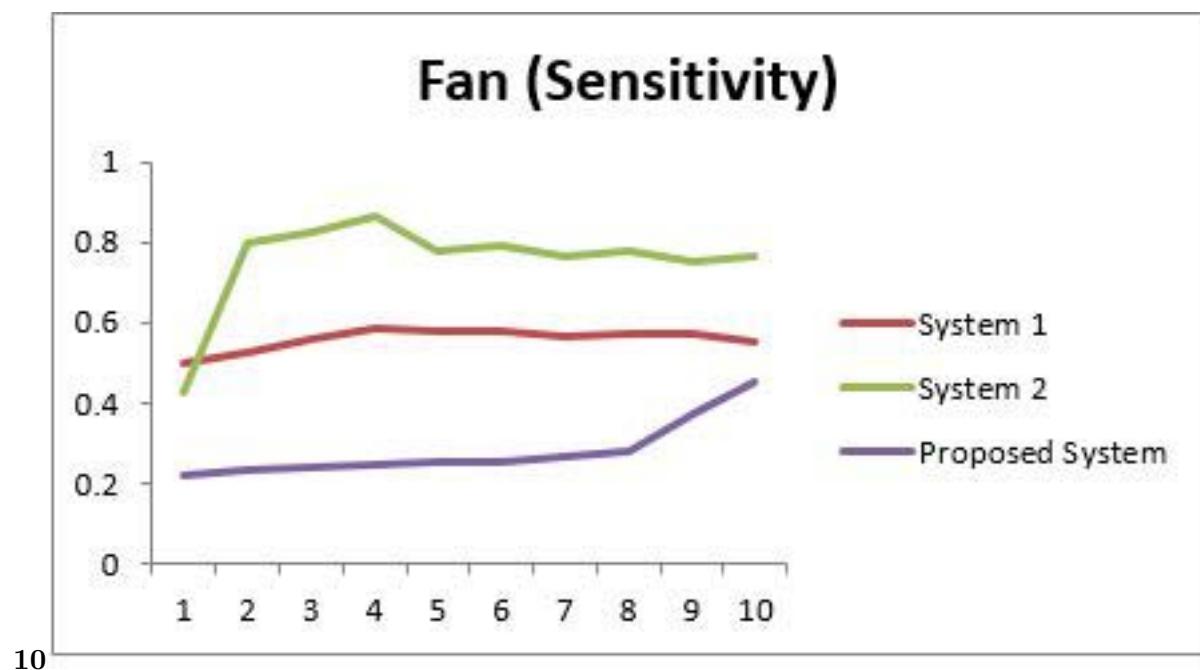


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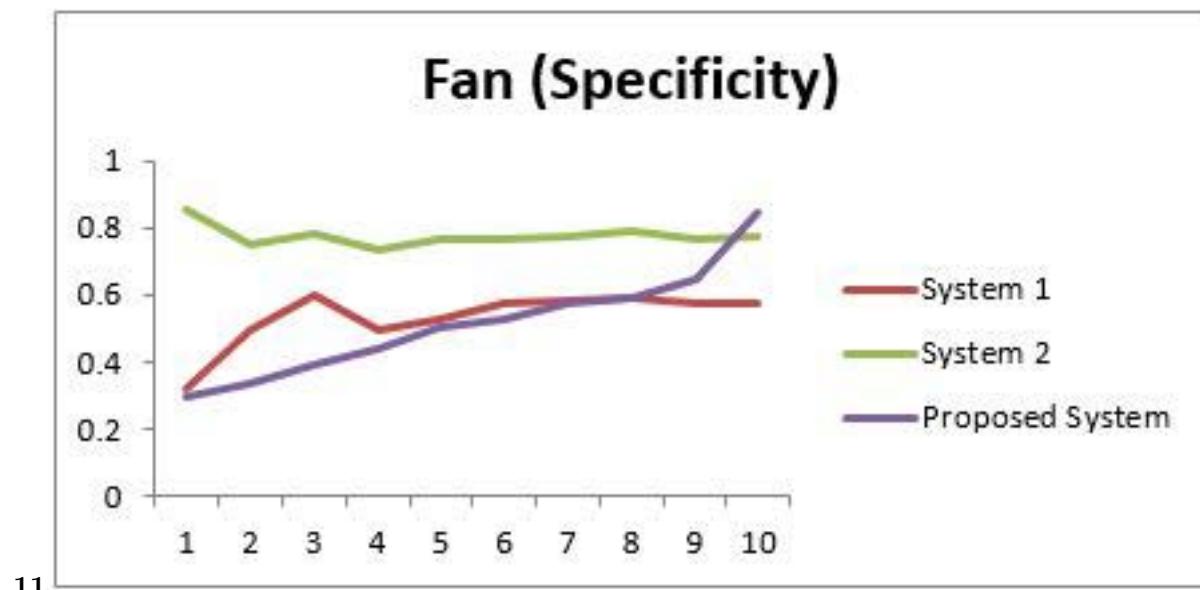


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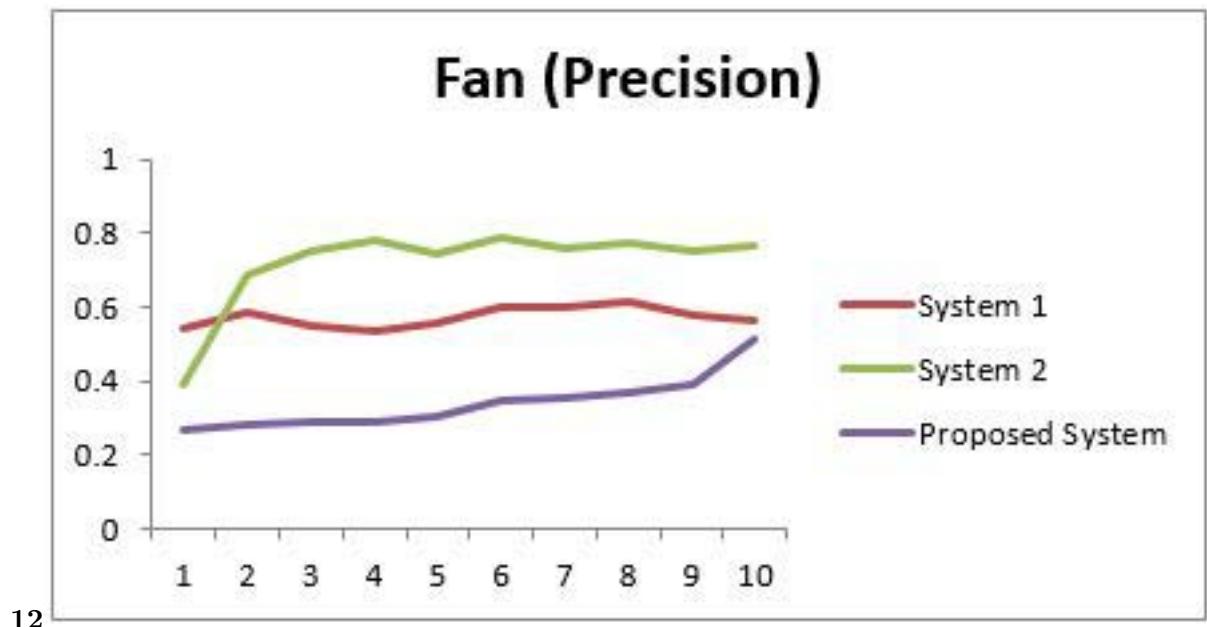


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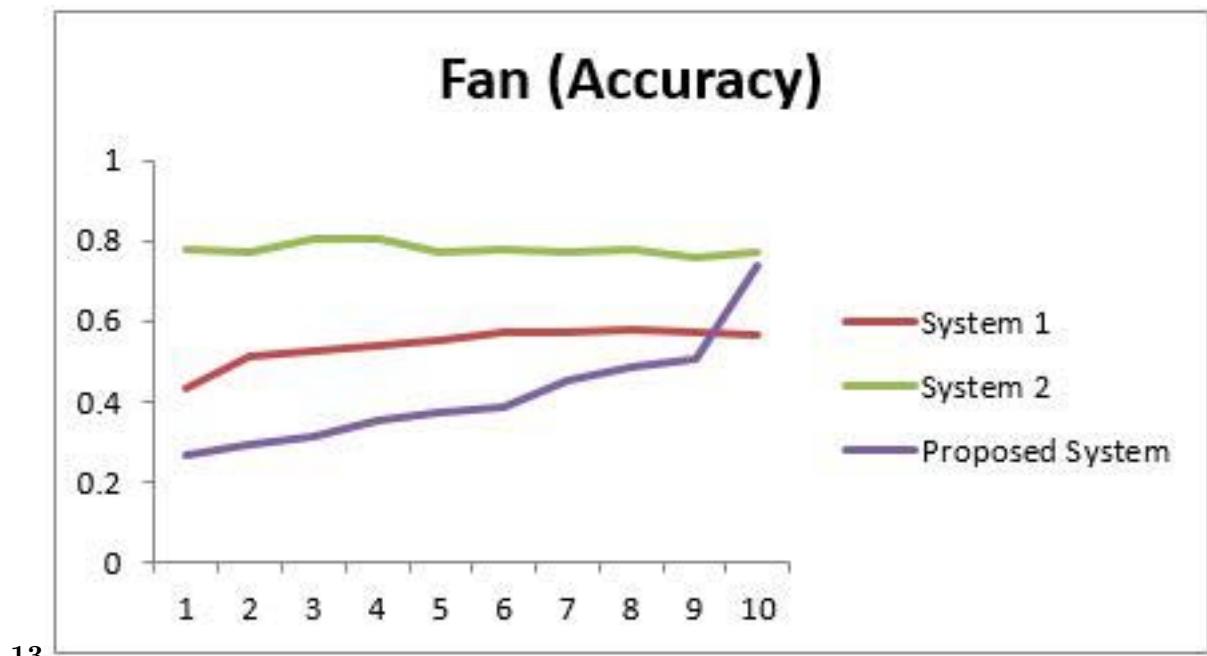
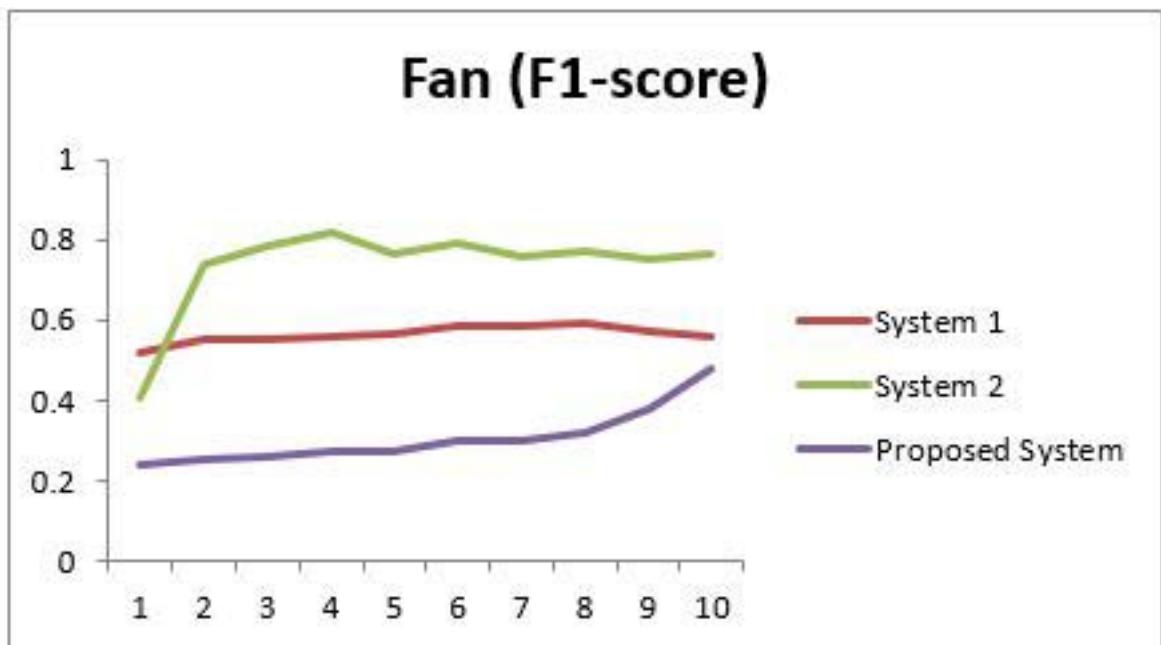
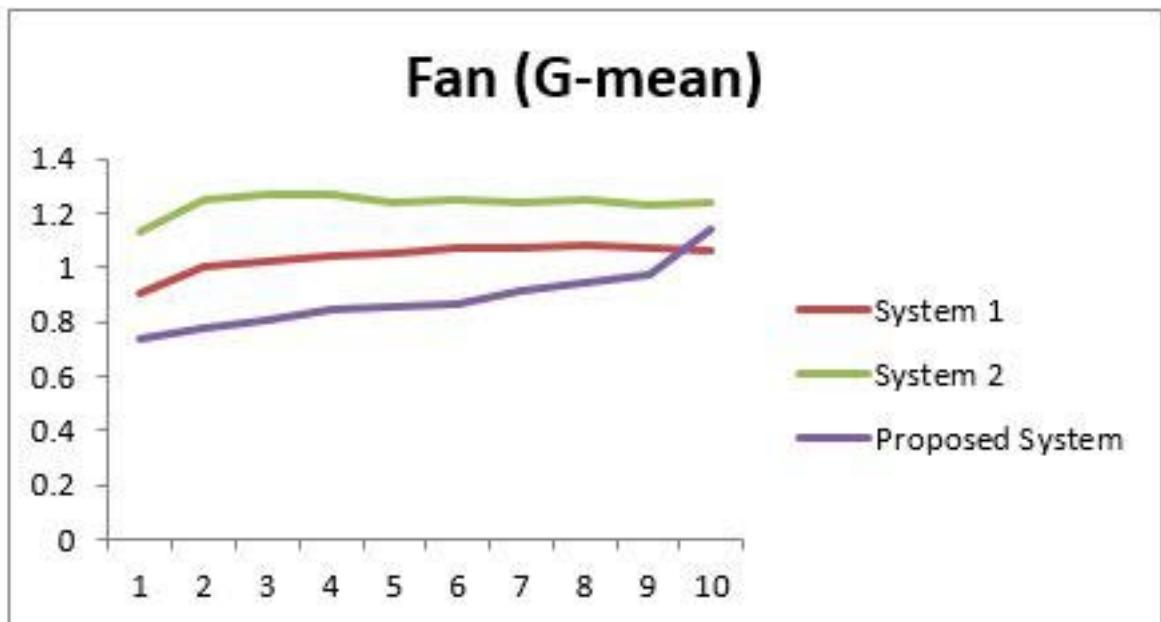


Figure 13: Fig. 13 :



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Figure 14: Fig. 14 :



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Figure 15: Fig. 15 :

16

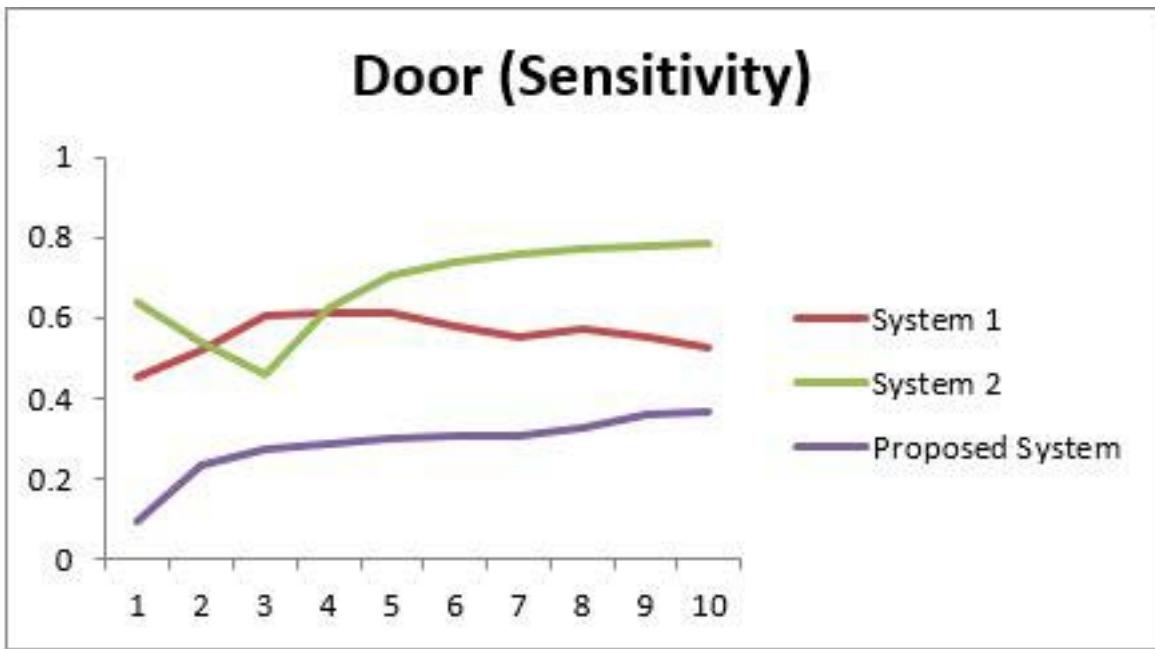


Figure 16: Fig. 16 :

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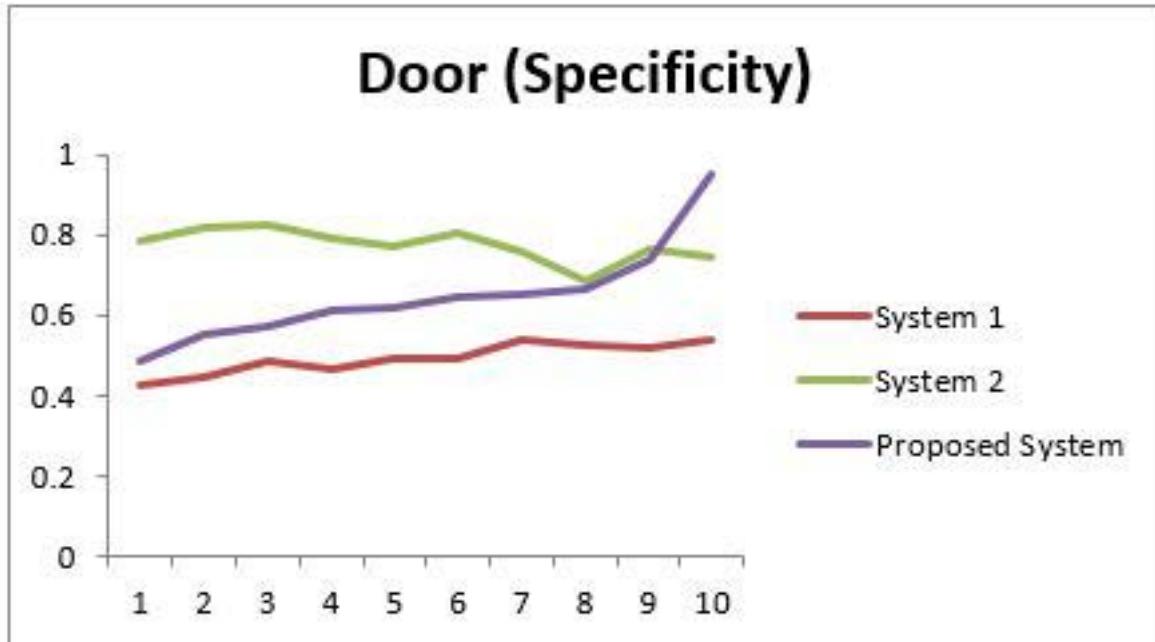


Figure 17: Fig. 17 :

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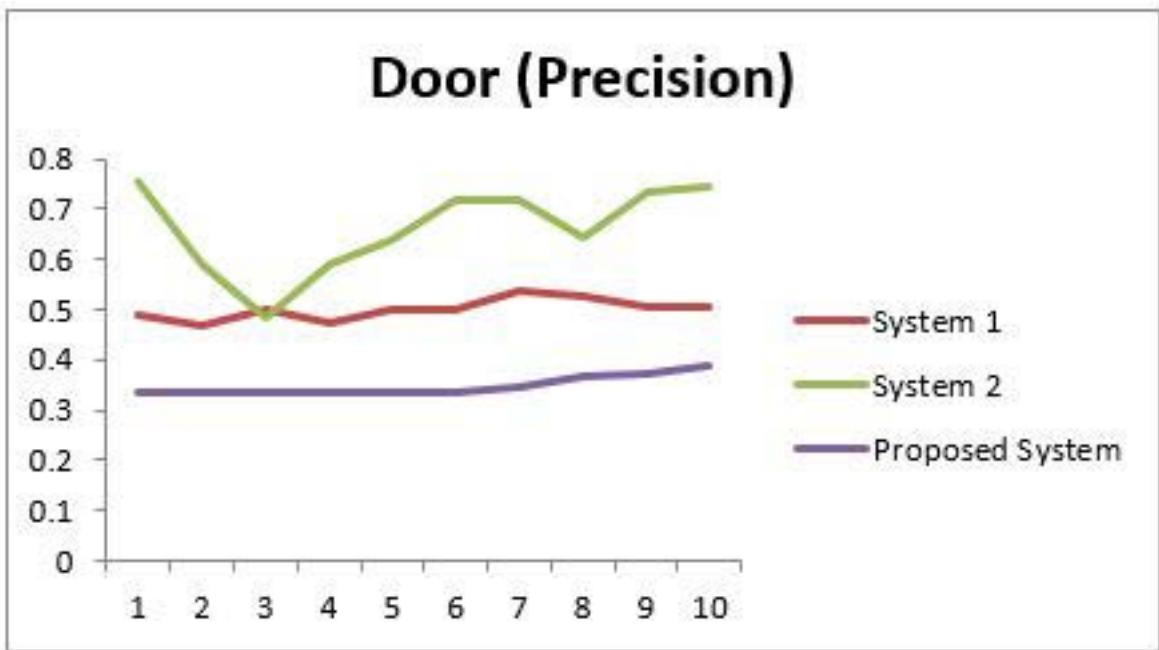


Figure 18: Fig. 18 :

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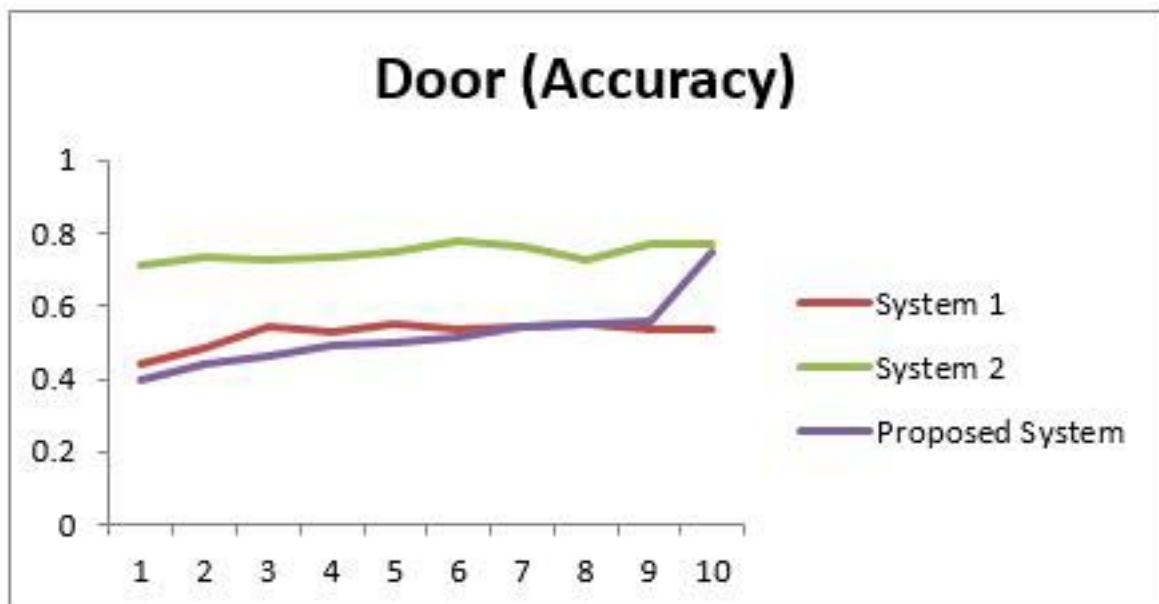


Figure 19: Fig. 19 :

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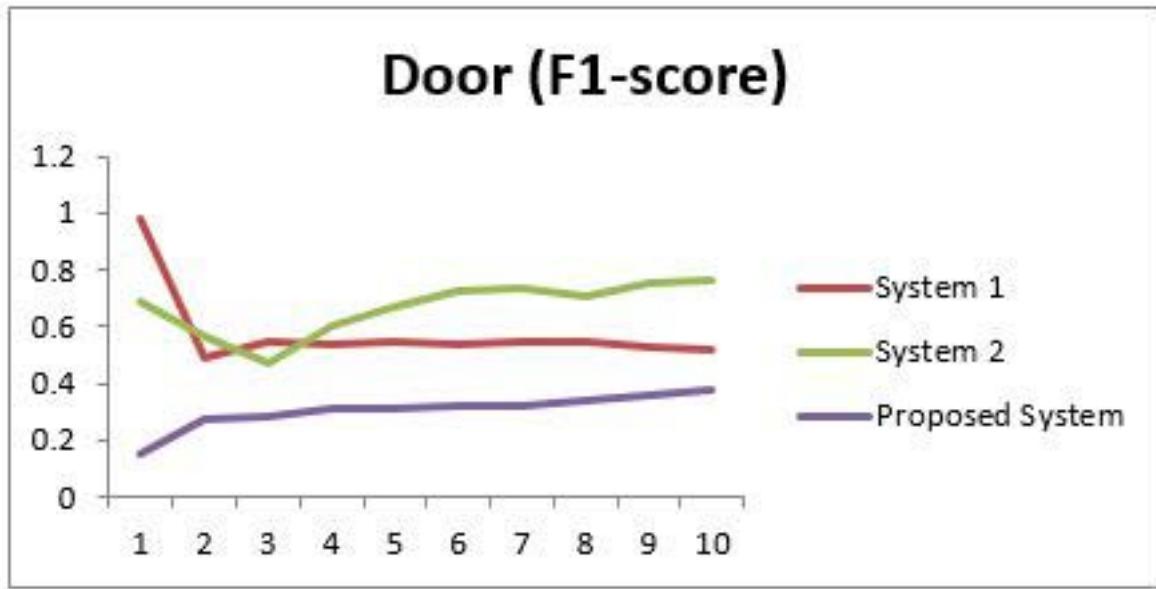


Figure 20: Fig. 20 :

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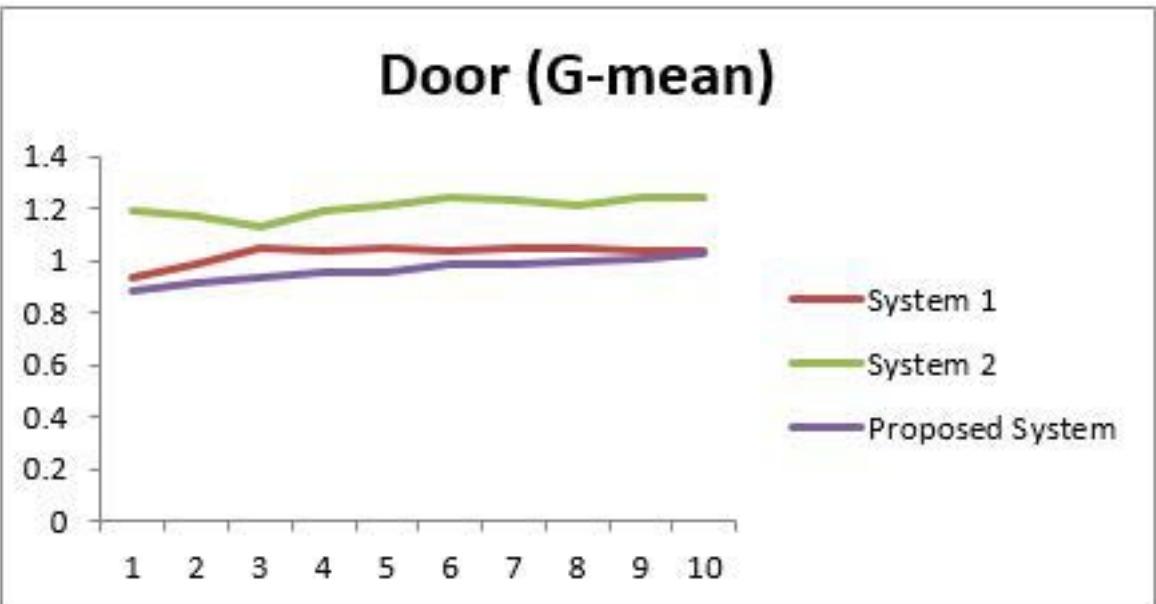


Figure 21: Fig. 21 :

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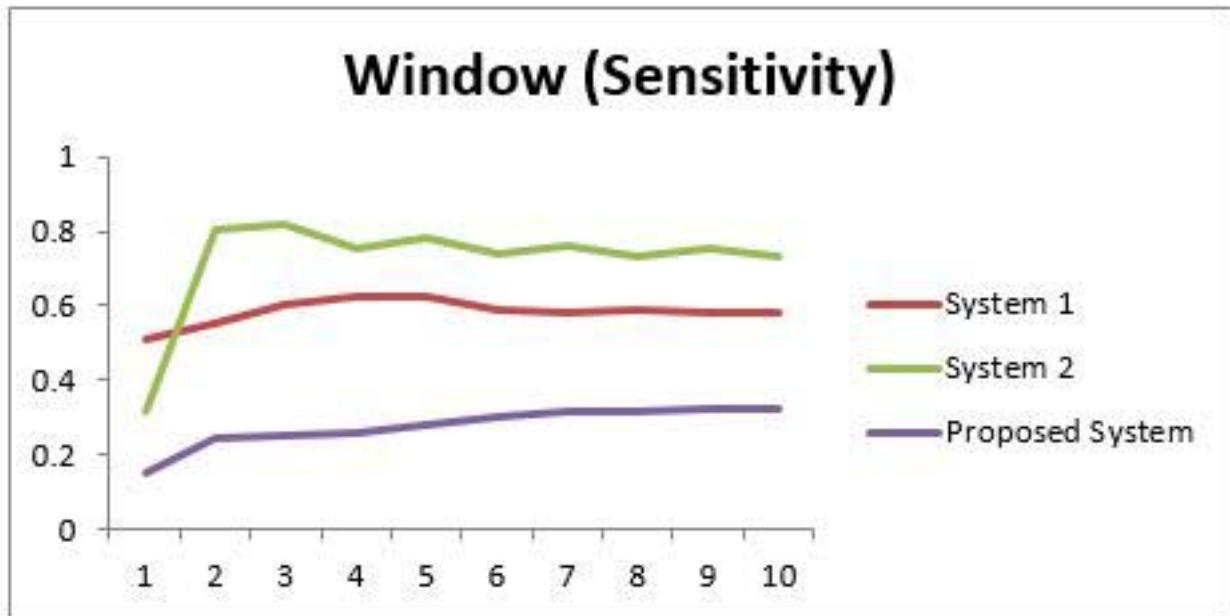


Figure 22: Fig. 22 :

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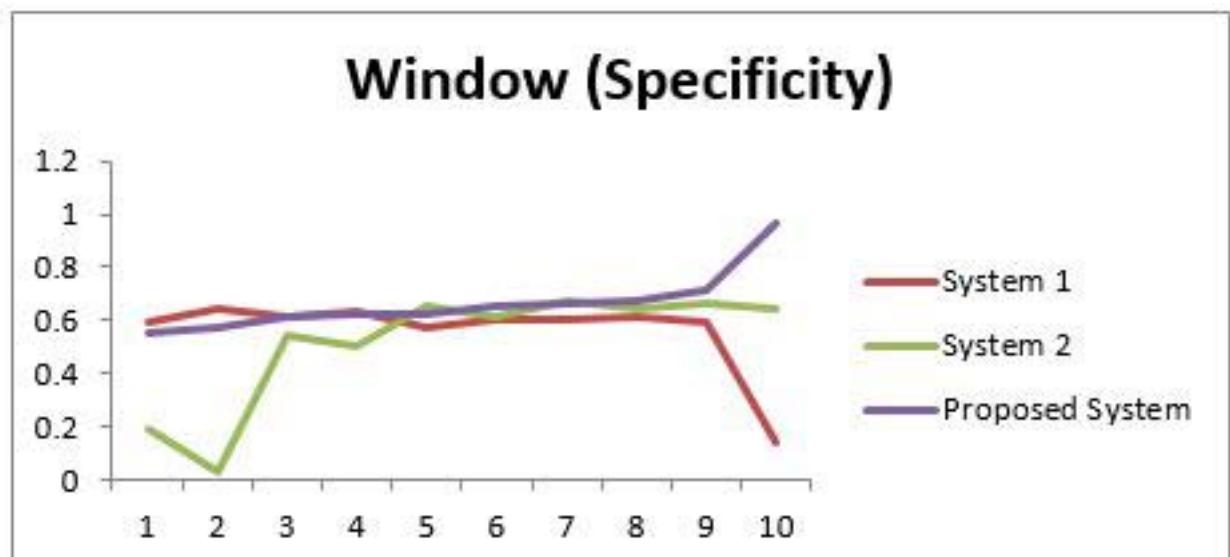


Figure 23: Fig. 23 :

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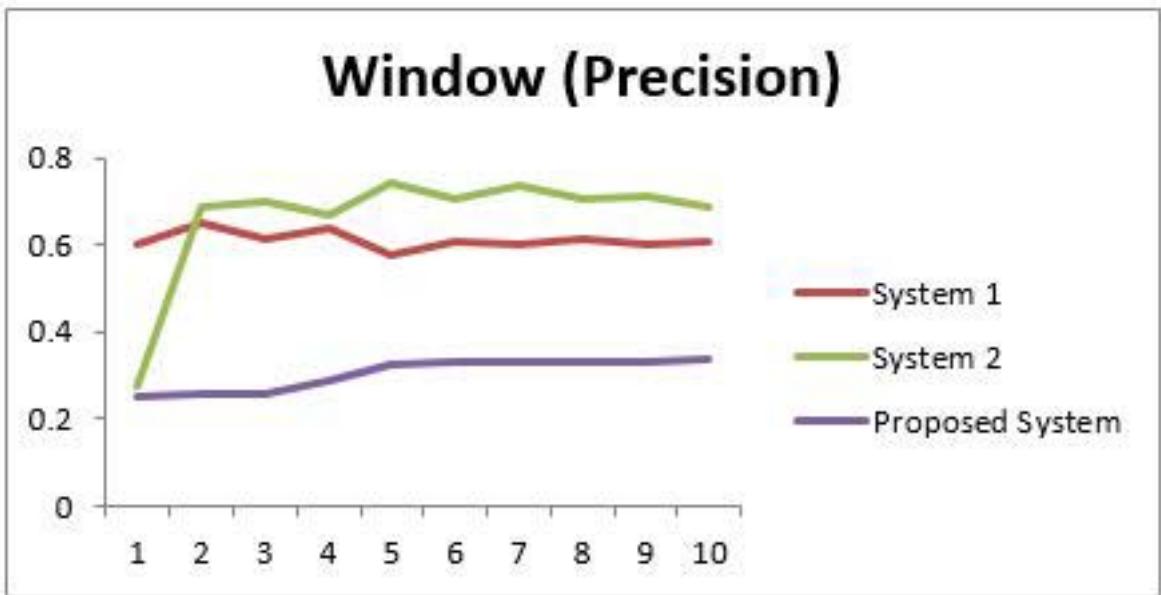


Figure 24: Fig. 24 :

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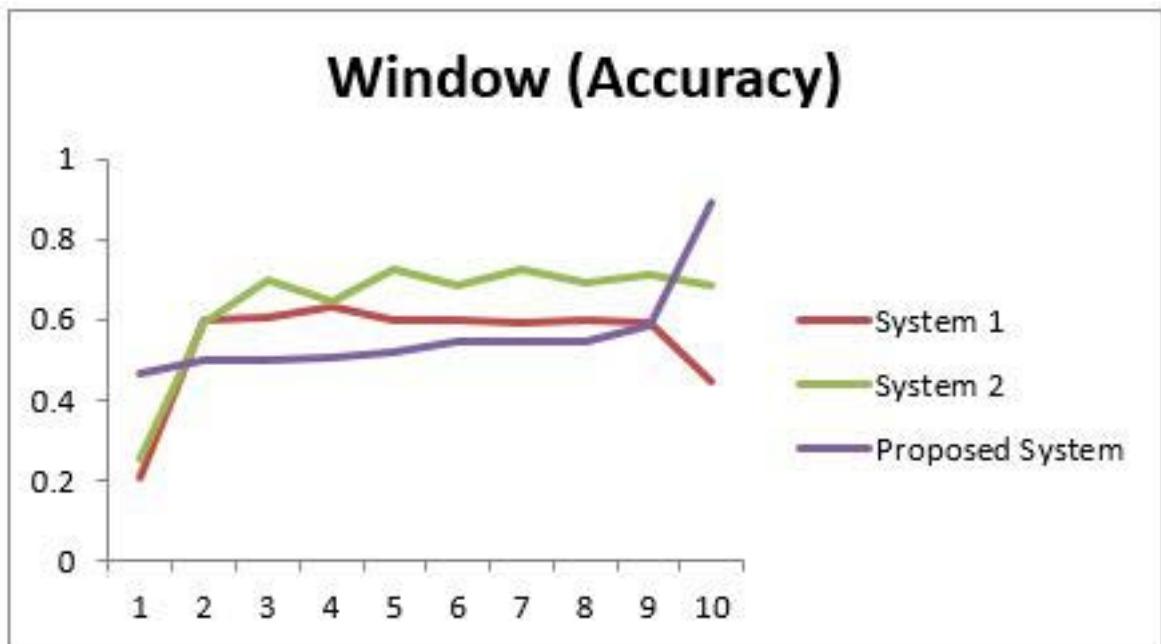
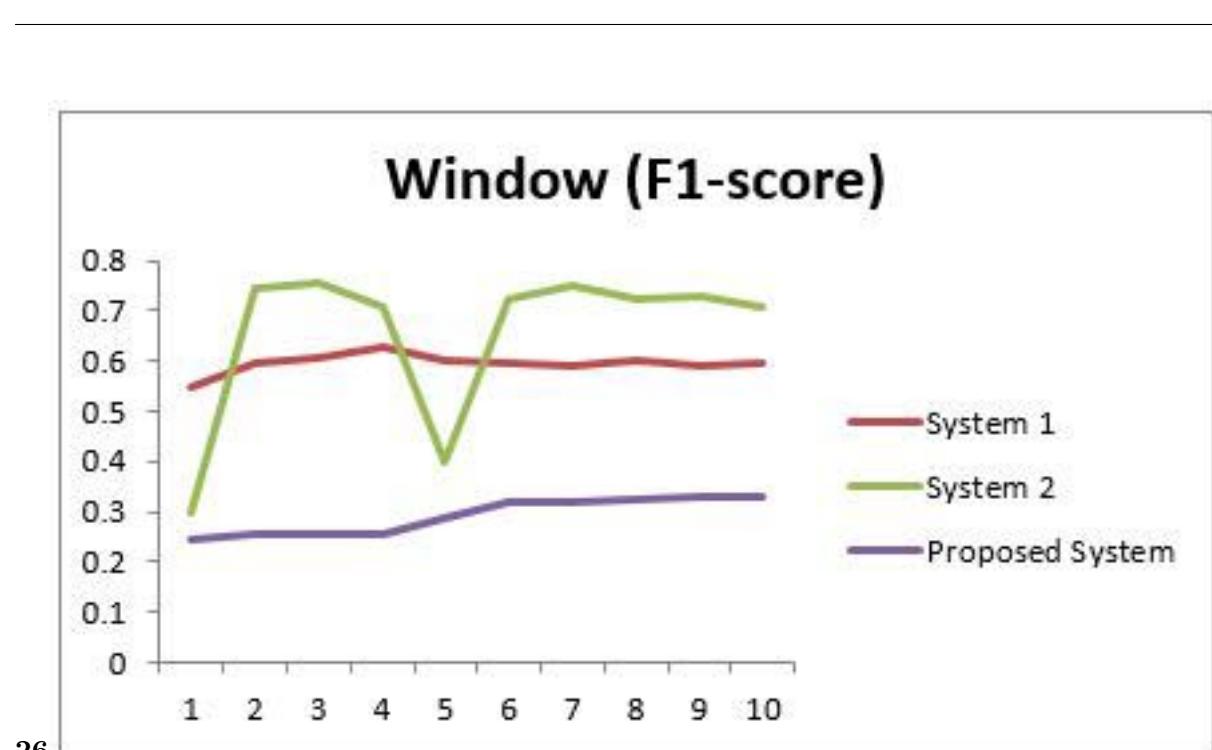
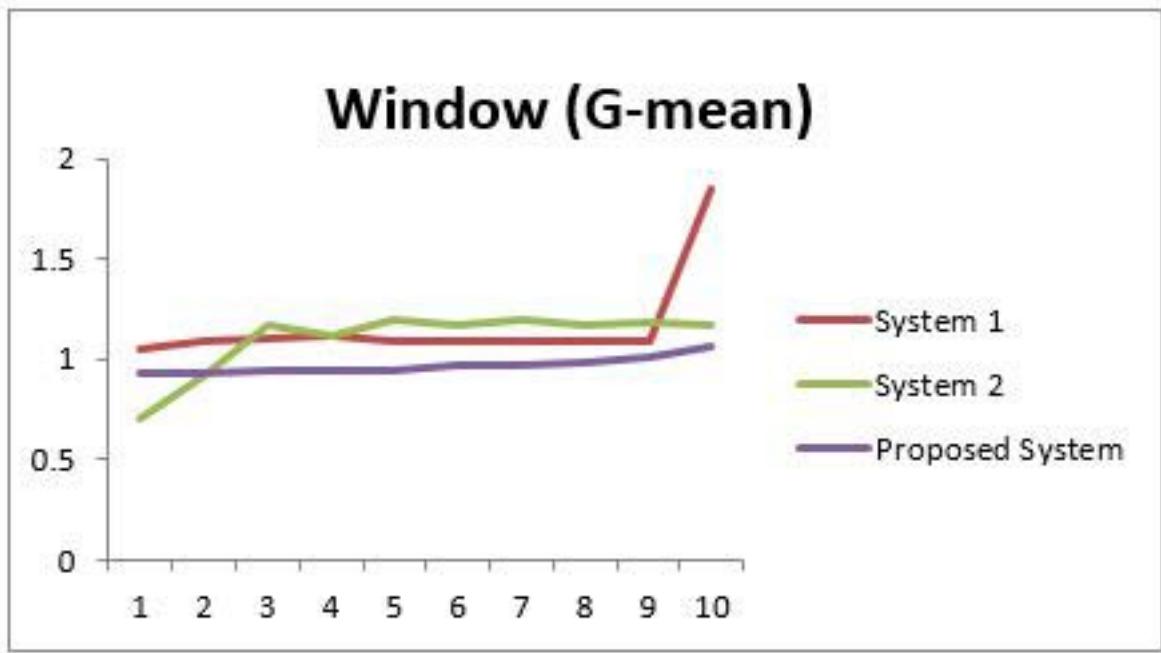


Figure 25: Fig. 25 :



26

Figure 26: Fig. 26 :



27

Figure 27: Fig. 27 :

1

Equipment to Server	Equipment to Server	Server to Equipment
Server to Equipment	Passing Time(x) Obstacle Time(y)	Obstacle Time(x') Passing Time(y)

Figure 28: Table 1 :

2

Light		
System 1	System 2	Proposed System
0.339	0.759	0.368
0.273	0.740	0.398
0.412	0.766	0.461
0.349	0.783	0.484
Sensitivity	0.793 0.799	0.518 0.571
0.414	0.786	0.671
0.374	0.776	0.669
0.414	0.782	0.679
0.452	0.787	0.805

Figure 29: Table 2 :

3

Light		
System 1	System 2	Proposed System
0.467	0.692	0.394
0.293	0.705	0.421
0.388	0.789	0.519
0.446	0.710	0.538
Specificity	0.719 0.712	0.541 0.597
0.475	0.697	0.669
0.503	0.687	0.681
0.525	0.668	0.721
0.503	0.673	0.881

Figure 30: Table 3 :

4

Light		
System 1	System 2	Proposed System
0.437	0.743	0.479
0.266	0.727	0.503
0.373	0.761	0.530
0.332	0.720	0.532
Precision	0.727 0.718	0.539 0.554
0.409	0.703	0.558
0.395	0.692	0.575
0.435	0.673	0.622
0.459	0.677	0.708

Figure 31: Table 4 :

5

Light		
System 1	System 2	Proposed System
0.397	0.729	0.499
0.284	0.723	0.500
0.399	0.758	0.528
0.403	0.746	0.537
Accuracy	0.450 0.407	0.551 0.576
	0.447	0.585
	0.443	0.625
	0.473	0.669
	0.478	0.821

Figure 32: Table 5 :

6

Light		
System 1	System 2	Proposed System
0.382	0.751	0.417
0.269	0.734	0.456
0.391	0.764	0.493
0.340	0.750	0.517
F1-score	0.406 0.365	0.529 0.573
	0.413	0.575
	0.384	0.609
	0.424	0.693
	0.455	0.702

Figure 33: Table 6 :

7

Light		
System 1	System 2	Proposed System
0.898	1.205	0.982
0.752	1.202	1.001
0.894	1.247	1.028
0.892	1.222	1.033
G-mean	0.946 0.900	1.044 1.044
	1.229 1.229	
	1.218	1.069
	1.209	1.126
	1.204	1.160
	1.208	1.249

Figure 34: Table 7 :

8

Fan		
System 1	System 2	Proposed System
0.497	0.425	0.218
0.524	0.798	0.232
0.558	0.825	0.243
0.586	0.867	0.248
Sensitivity	0.79 0.576	0.252 0.255
0.566	0.762	0.264
0.570	0.775	0.283
0.569	0.752	0.375
0.555	0.764	0.454

Figure 35: Table 8 :

9

Fan		
System 1	System 2	Proposed System
0.323	0.854	0.292
0.491	0.752	0.334
0.595	0.783	0.394
0.496	0.736	0.437
Specificity	0.79 0.571	0.499 0.527
0.579	0.777	0.572
0.594	0.787	0.593
0.573	0.765	0.648
0.572	0.774	0.843

Figure 36: Table 9 :

10

Fan		
System 1	System 2	Proposed System
0.545	0.392	0.271
0.582	0.688	0.280
0.552	0.752	0.287
0.538	0.777	0.292
Precision	0.79 0.597	0.305 0.348
0.601	0.760	0.357
0.613	0.774	0.367
0.577	0.751	0.389
0.563	0.763	0.513

Figure 37: Table 10 :

11

Fan		
System 1	System 2	Proposed System
0.431	0.777	0.268
0.509	0.771	0.294
0.528	0.802	0.315
0.541	0.804	0.355
Accuracy	0.552 0.573	0.374 0.389
0.572	0.769	0.453
0.581	0.781	0.489
0.571	0.758	0.503
0.564	0.769	0.739

Figure 38: Table 11 :

12

Fan		
System 1	System 2	Proposed System
0.520	0.408	0.242
0.551	0.739	0.254
0.555	0.787	0.263
0.561	0.819	0.271
F1-score	0.567 0.586	0.274 0.297
0.583	0.761	0.300
0.591	0.774	0.319
0.574	0.751	0.382
0.559	0.764	0.481

Figure 39: Table 12 :

13

Fan		
System 1	System 2	Proposed System
0.906	1.131	0.735
1.007	1.245	0.773
1.026	1.268	0.806
1.040	1.266	0.849
G-mean	1.049 1.071	0.852 0.863
1.070	1.241	0.914
1.079	1.249	0.949
1.069	1.232	0.973
1.062	1.240	1.139

Figure 40: Table 13 :

14

Door		
System 1	System 2	Proposed System
0.455	0.638	0.096
0.522	0.542	0.236
0.607	0.456	0.272
0.612	0.628	0.289
Sensitivity	0.615 0.578	0.298 0.304
0.555	0.761	0.309
0.572	0.772	0.329
0.552	0.781	0.357
0.526	0.788	0.367

Figure 41: Table 14 :

15

Door		
System 1	System 2	Proposed System
0.427	0.787	0.486
0.446	0.820	0.554
0.486	0.826	0.573
0.463	0.789	0.615
Specificity	0.492 0.495	0.619 0.644
0.536	0.759	0.649
0.523	0.687	0.666
0.520	0.762	0.737
0.542	0.747	0.949

Figure 42: Table 15 :

16

Door		
System 1	System 2	Proposed System
0.492	0.756	0.334
0.467	0.589	0.334
0.498	0.486	0.335
0.473	0.588	0.335
Precision	0.499 0.500	0.336 0.338
0.540	0.716	0.347
0.527	0.646	0.365
0.506	0.732	0.373
0.508	0.745	0.391

Figure 43: Table 16 :

17

Door		
System 1	System 2	Proposed System
0.443	0.713	0.399
0.482	0.731	0.438
0.541	0.728	0.465
0.529	0.737	0.494
Accur 0.547 0.534	0.748 0.779	0.496 0.515
0.545	0.760	0.542
0.547	0.723	0.548
0.535	0.771	0.555
0.534	0.767	0.751

Figure 44: Table 17 :

18

Door		
System 1	System 2	Proposed System
0.983	0.688	0.152
0.493	0.565	0.278
0.547	0.470	0.281
0.533	0.607	0.310
F1- score 0.551 0.536	0.671 0.728	0.315 0.319
0.548	0.738	0.321
0.549	0.703	0.338
0.528	0.756	0.363
0.516	0.766	0.378

Figure 45: Table 18 :

19

Door		
System 1	System 2	Proposed System
0.939	1.194	0.885
0.984	1.167	0.918
1.045	1.132	0.939
1.036	1.190	0.957
G- mean 1.052 1.035	1.215 1.243	0.959 0.986
1.045	1.233	0.989
1.046	1.208	0.997
1.035	1.242	1.008
1.033	1.239	1.022

Figure 46: Table 19 :

17 CONCLUSION

20

Window	System 1	System 2	Proposed System
Sensitivity	0.507	0.318	0.150
	0.554	0.805	0.244
	0.601	0.818	0.254
	0.622	0.757	0.256
	0.622 0.587	0.781 0.742	0.283 0.303
	0.584	0.763	0.317
	0.587	0.735	0.318
	0.584	0.753	0.322
	0.581	0.731	0.325

The Graph for Window (Sensitivity):

Figure 47: Table 20 :

21

Window	System 1	System 2	Proposed System
Specificity	0.594	0.187	0.549
	0.647	0.035	0.570
	0.614	0.541	0.617
	0.636	0.499	0.621
	0.576 0.607	0.655 0.615	0.622 0.649
	0.599	0.673	0.662
	0.611	0.645	0.677
	0.598	0.661	0.716
	0.141	0.639	0.969

Figure 48: Table 21 :

22

Window	System 1	System 2	Proposed System
Precision	0.601	0.276	0.249
	0.650	0.690	0.258
	0.616	0.702	0.259
	0.638	0.666	0.288
	0.577 0.608	0.740 0.706	0.325 0.334
	0.600	0.734	0.334
	0.612	0.708	0.334
	0.599	0.709	0.334
	0.607	0.689	0.339

[Note: The Graph for Window (Precision):System 1 and 2 create sprawl line. Our system makes a straight line. It is favorable.]

Figure 49: Table 22 :

23

Window	System 1	System 2	Proposed System
0.209		0.252	0.468
0.597		0.595	0.498
0.607		0.699	0.502
0.629		0.646	0.507
Accur	0.598 0.597	0.725 0.686	0.519 0.546
	0.591	0.722	0.547
	0.599	0.694	0.548
	0.591	0.709	0.585
	0.447	0.687	0.894

Figure 50: Table 23 :

24

Window	System 1	System 2	Proposed System
0.549		0.296	0.247
0.598		0.743	0.254
0.608		0.755	0.256
0.629		0.709	0.257
F1-	0.599 0.596	0.399 0.723	0.286 0.318
score			
	0.592	0.748	0.321
	0.599	0.721	0.325
	0.591	0.730	0.328
	0.594	0.709	0.329

[Note: The Graph for Window (F1-score):]

Figure 51: Table 24 :

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