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Design of DIALux Based Lighting Controller for Energy Savings

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Abstract— The paper aims in integration of daylight and artificial lighting simulation for efficient lighting scheme in order to save energy as almost 30% to 40% of our energy consumption depends upon lighting scheme. A room with known dimension is designed in DIALux and is mounted with fluorescent tubular lamp to light up the room and to maintain considered average illuminance and uniformity of the classroom remaining uniform throughout the room and the artificial lights are accordingly grouped in different control groups with different dimming values in order to maintain uniformity and save energy from the throughout system. The simulation is done using DIALux and lighting parameters (Eavg, Emin, Emax and uniformity) are obtained from the isoline diagram and electrical parameters (Wattage) are obtained. The daylight is allowed to enter the room and accordingly artificial light is controlled leading to energy efficient Lighting Controller where the dimming values of the lamps changes with the change in intensity of the daylight as it is dynamic in nature. Data is obtained for three different time of the year with different sky conditions viz. Overcast Sky, Clear Sky and Mixed sky.

Keywords— Iso - Lux Counture, Light Scene, Control Group, DIALux, Day Light, Artificial Light.

I. INTRODUCTION

Energy crisis plays an important role in our daily life somewhere someone or the other people are deprived of electricity. Keeping this in mind a study is carried out to minimize energy demand utilizing the daylight. Daylight is dynamic in nature and thus it creates a better lighting condition which is healthy and adaptive for working environment [1]. The paper presents a simulation environment and daylight utilization strategy to reach energy efficient lighting [2]. Office and classroom possess unique property of successfully permitting daylight and electric light can be controlled accordingly [3] .Both daylight and artificial light is taken into account for the stimulation purpose with the basic concept behind the integration of light output obtained in the working plane controlling the artificial light with respect to daylight [4]. Almost 20% to 50 % of the electricity consumption is acquired by lighting load and this can be minimized making efficient and effective use of daylight which is cost free [5]. Daylight if taken into consideration can provide up to 70% of the required illuminance throughout the year [3]. Simulation is done to utilize the daylight design and to improve measuring lighting control system where thee measured daylight is taken into consideration without sacrificing visual comfort and quality of lighting and a proposed dimmable artificial lighting scheme is introduced [1,5].

To reduce the energy consumption and cost efficient lighting control is utilized and a room with known dimension and location is considered where the luminiers are mounted in different control group working at different control group working at different point of time depending on the incoming daylight and its isoline diagram is obtained and its visual parameters is maintained in the room.

II. PROPOSED CONTROLLER SCHEME

In the proposed scheme we have divided year into 3 seasons zone (SZ) viz SZ – I (November – February), SZ – II (March – June) & SZ - III (July – October) and its average data is calculated. Each Season Zone possess time zone (TZ) viz TZ – I (10 AM – 12 PM), TZ – II (12 PM – 2 PM), TZ - III (2 PM – 4 PM) and TZ - IV (4 PM – 6 PM) and the average value is calculated from the above time zones. Each day possess 8 working hours distributed in 4 time zones working with different light scenes and different control group and the data is obtained from daylight and daylight integrated with artificial light where the artificial lights are accordingly dimmed.

A. Room parameter:

The existing room parameter age given bellow,

Table 1. Room Parameter

SL No.	Item	Parameters
1	Room Length (Mtr.)	9
2	Room width (Mtr.)	7
3	Room Height (Mtr.)	3
4	North Position	30^0
5	No. of windows	3
6	Wall Colour	White
7	Window 1 & 2 dimensions (Mtr^2)	2 x 1.25
8	Window 3 dimensions (Mtr^2)	3 x 1.25
9	Address	KOLKATA - 104
10	Occupunant working hour	8

B. Lamp specification:

The Luminaries used in a PHILLIPS TCS605_136 M1 of count 20 numbers and specifications are: Luminous Flux: 2450 lumen, Wattage: 49 W,

Lamp / Luminiere: 1, Fixtures: 1 * TCS_36W

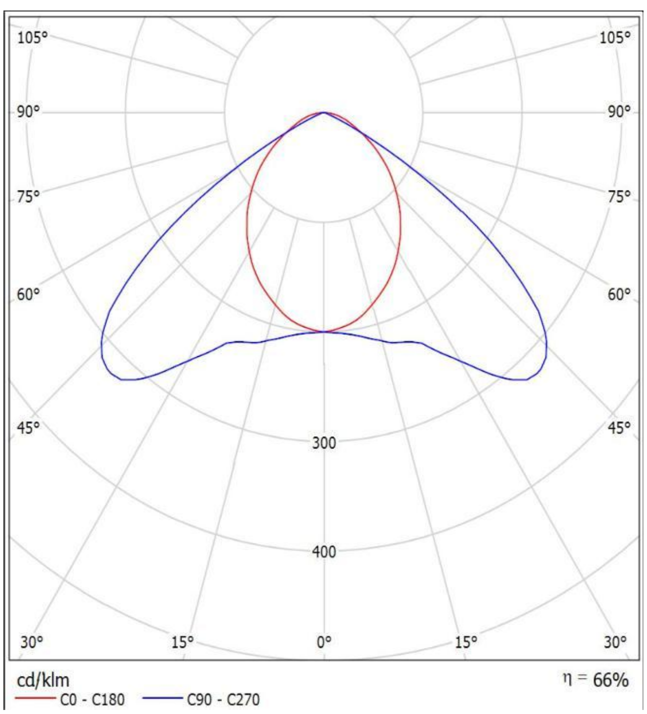

Figure 1. Polar Curve the Luminaire

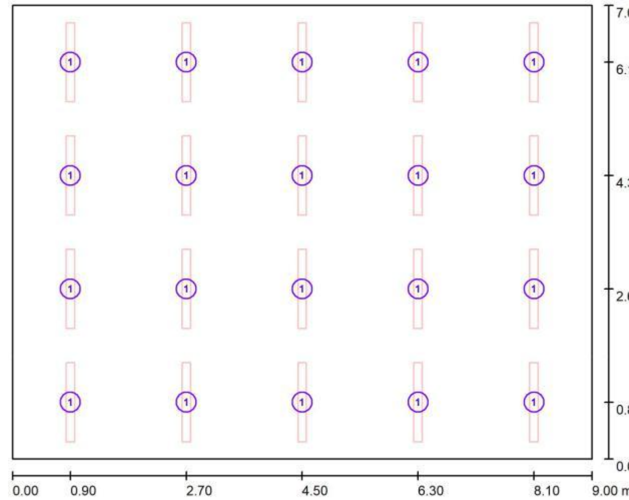

Figure 2. Lamp Position & room lay out diagram

III. DESIGN OF DIALUX BASED LIGHTING CONTROLLER

Relevant to the design of DIALux based lighting controller, we have considered an E_{avg} = 300 lux and an uniformity = 0.40 and obtained the daylight parameters at different time zone (E_{avg} and uniformity) and according to the nature of the daylight we have introduced artificial light integrated with daylight. We have grouped the artificial light under different control group and accordingly grouping them to different dimming values maintaining the desired parameters (E_{avg} and uniformity). The simulation results of the controller with different season zone & time zone is given bellow.

A. Simulation result of (SZ – I & TZ – I):

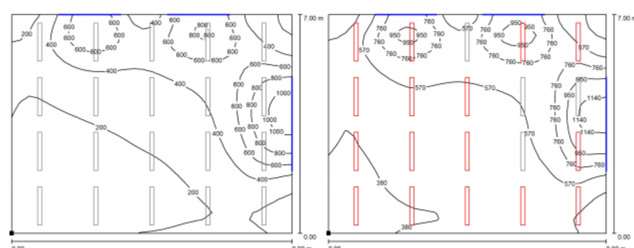

Figure 3.Iso Lux Diagram Before controller & After Controller

Table 2. Comparison of Lighting Parameter

Parameters	Outcome from Daylight	Outcome from Proposed Controller
E_{max} (Lux)	1100	1218
E_{min} (Lux)	108	282
E_{avg} (Lux)	351	561
Uniformity	0.308	0.502

B. Simulation result of (SZ – I & TZ – II):

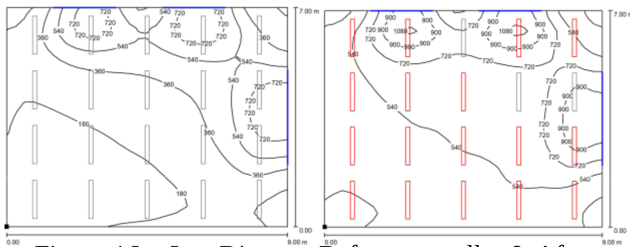

Figure 4.Iso Lux Diagram Before controller & After Controller

Table 3. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	1000	1191
E_{min} (Lux)	105	302
E_{avg} (Lux)	340	598
Uniformity	0.308	0.504

C. Simulation result of (SZ – I & TZ – III):

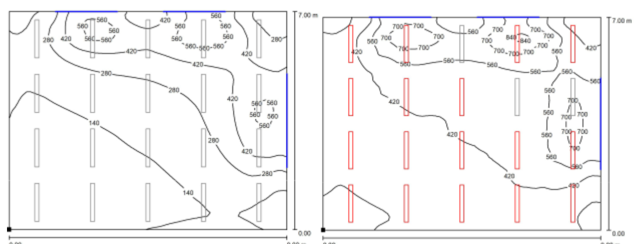

Figure 5. Iso Lux Diagram Before controller & After Controller

Table 4. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	766	905
E_{min} (Lux)	73	225
E_{avg} (Lux)	255	449
Uniformity	0.287	0.501

D. Simulation result of (SZ – I & TZ – IV):

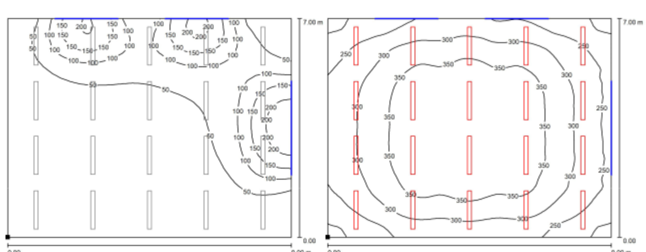

Figure 6. Iso Lux Diagram Before controller & After Controller

Table 5. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	228	400
E_{min} (Lux)	7.92	187
E_{avg} (Lux)	55	313
Uniformity	0.146	0.598

E. Simulation result of (SZ – II & TZ – I):

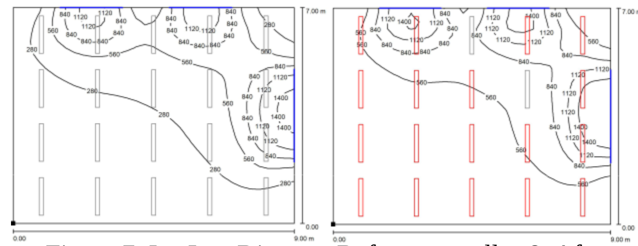

Figure 7. Iso Lux Diagram Before controller & After Controller

Table 6. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	1479	1676
E_{min} (Lux)	104	300
E_{avg} (Lux)	412	650
Uniformity	0.247	0.460

F. Simulation result of (SZ – II & TZ – II):

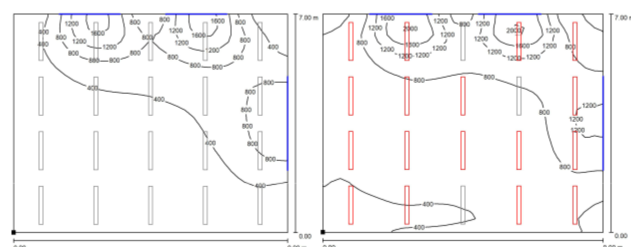

Figure 8. Iso Lux Diagram Before controller & After Controller

Table 7. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	1958	2172
E_{min} (Lux)	110	321
E_{avg} (Lux)	468	719
Uniformity	0.235	0.447

G. *Simulation result of (SZ – II & TZ – III):*

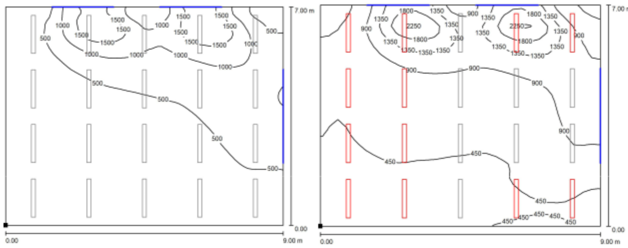

Figure 9. Iso Lux Diagram Before controller & After Controller

Table 8. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	2373	2553
E_{min} (Lux)	114	316
E_{avg} (Lux)	543	738
Uniformity	0.209	0.428

H. *Simulation result of (SZ – II & TZ – IV):*

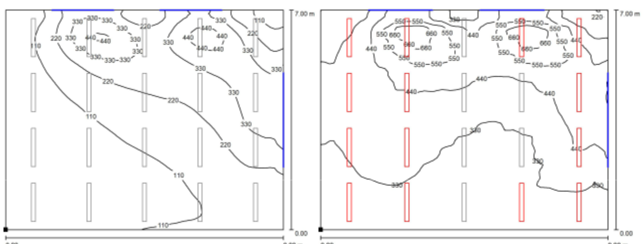

Figure 10. Iso Lux Diagram Before controller & After Controller

Table 9. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	555	748
E_{min} (Lux)	42	210
E_{avg} (Lux)	181	388
Uniformity	0.229	0.54

I. *Simulation result of (SZ – III & TZ – I):*

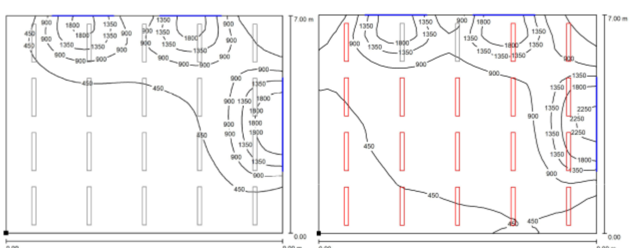

Figure 11. Iso Lux Diagram Before controller & After Controller

Table 10. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	2376	2423
E_{min} (Lux)	275	294
E_{avg} (Lux)	721	786
Uniformity	0.382	0.374

J. *Simulation result of (SZ – III & TZ – II):*

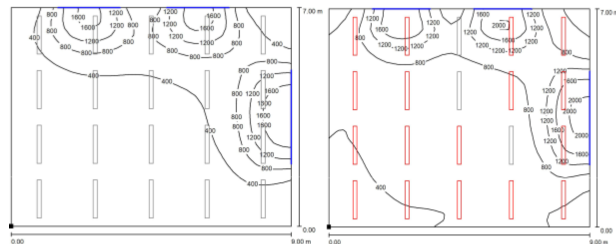

Figure 12. Iso Lux Diagram Before controller & After Controller

Table 11. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	1979	2148
E_{min} (Lux)	72	285
E_{avg} (Lux)	484	734
Uniformity	0.382	0.374

K. *Simulation result of (SZ – III & TZ – III):*

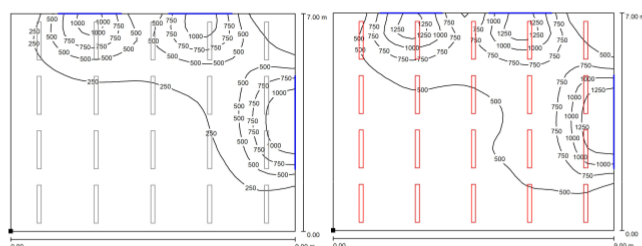

Figure 13. Iso Lux Diagram Before controller & After Controller

Table 12. Comparison of Lighting Parameter

Parameters	*Outcome from Daylight*	*Outcome from Proposed Controller*
E_{max} (Lux)	1252	1496
E_{min} (Lux)	46	256
E_{avg} (Lux)	307	594
Uniformity	0.149	0.431

L. Simulation result of (SZ – III & TZ – IV):

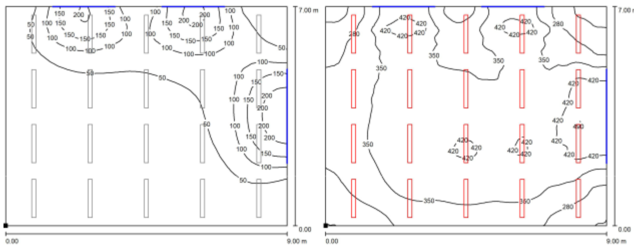

Figure 14. Iso Lux Diagram Before controller & After Controller

Table 13. Comparison of Lighting Parameter

Parameters	Outcome from Daylight	Outcome from Proposed Controller
E_{max} (Lux)	236	504
E_{min} (Lux)	8.62	177
E_{avg} (Lux)	58	354
Uniformity	0.149	0.5

IV. EVALUATION OF THE PROPOSED CONTROLLER

Table 14. Evaluation Table

Wattage Consume Before Controller	Wattage Consume After Controller	Watt-Hrs Before Controller	Watt-Hrs After Controller
Season Zone I and Time Zone I			
980	622.3	1960	1244.6
Season Zone I and Time Zone II			
980	749.7	1960	1499.4
Season Zone I and Time Zone III			
980	563.3	1960	1126.6
Season Zone I and Time Zone IV			
980	901.6	1960	1803.2
Season Zone II and Time Zone I			
980	686	1960	1372
Season Zone II and Time Zone II			
980	735	1960	1470
Season Zone II and Time Zone III			
980	588	1960	1176
Season Zone II and Time Zone IV			
980	627.2	1960	1254.4
Season Zone III and Time Zone I			
980	710.5	1960	1421
Season Zone III and Time Zone II			
980	735	1960	1470
Season Zone III and Time Zone III			
980	842.8	1960	1685.6
Season Zone III and Time Zone IV			
980	857.5	1960	1715

It From the above evaluation table we can draw an idea about that the energy is being saved by implementing a controller to the lighting system integrating with daylight and keeping the considered parameters uniform, utilizing the daylight the dimming value of the artificial light results in energy saving.

From the evaluated data we can calculate the energy consumption before the implementation of controller and after the implementation of controller are obtained below :

The annual energy consumption before the implementation of the controller is 1881.60 units annually.

After the implementation of the proposed scheme , the reduced energy consumption obtained is :

- For Season Zone I consumption is 453.9 units
- For Season Zone II consumption is 421.79 units
- For Season Zone III consumption is 503.32 units

The total energy consumption after the implementation of the controller is 1379.02 units.

Thus, from the above data the total energy that is saved implementing the controller can be calculated.

V. CONCLUSION AND FUTURE SCOPE

From the paper it can be concluded that if daylight is integrated with artificial light, can be utilised to save energy efficiently. The considered parameters of Eavg and uniformity is maintained utilising the nature of the daylight simultaneously saving a huge amount of energy per day basis by dimming the artificial light according to the incoming daylight.

From the collected data, we have calculated the annual consumption of electrical energy before controller is 1881.6 units.

On the implementation of Controller the annual consumption of electrical energy is 1379.02 units.

Thus the total electrical energy saved from the proposed scheme annually is 502 units maintaining the Average Illuminance (Lux and Uniformity) as per the consideration.

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