"RIVI-ASINI" DAYLIGHT HARVESTING SYSTEM

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ABSTRACT

In the current context people expect green and energy efficient initiatives to be applied to daily activities. Among those, lighting houses and buildings has gain major attention. Due to large amount of energy being wasted to facilitate lighting building, there rises a need for natural lighting to be harvested in order to replace consumption of electrical energy. This research aims at designing and developing a system to achieve optimum daylight harvesting in an energy efficient manner by incorporating dimmable lighting controller and automatic louver controller for daylight harvesting. The outcome of this research "RIVI-ASINI" is a new daylight harvesting system with a dimming controller along with monitoring ability through a personal computer or a mobile device.

***Keywords*:** Daylight Harvest, Optimum Daylight, Dimmable Lighting Controller, Automatic Louver Controller

1. INTRODUCTION

Daylight harvesting systems aim to reduce wastage of energy by using natural sunlight when possible. Today the green movement has gone main stream and people expect green & energy efficiency initiatives to be applied to new constructions. With large amount of energy being expended to light buildings, it stands to reason that natural lighting could be harvested to replace consumption of electrical energy [1], [2]. Nowadays Day lighting systems [3], [4] reflect sunlight through an opening in the roof or sidewall of a building into the desired room or space, thereby replacing the light required from electric sources. This concept can be further improved by introducing fully defused glare free daylight through prismatic sheets. Advantage of defused natural daylight is; there are no shadows as in other form of lights [5], [6].

1.1. What is Daylight Harvesting?

When the sufficient daylight is available, the artificial light dims to appropriate level in order to get maximum usage from daylight [3], [7].

Daylight Harvesting saves energy without compromising comfort [8], [9] and it's becoming a standard requirement in many countries around the world [10].Daylight Harvesting reduces peak demand of electricity [11], [6], [12].

1.2. Research Problem

The currently available systems are not capable of harvesting day light to an optimum level [3]. These systems are not equipped with daylight controllers & letting too much of day light coming into the building which is more than the desired maximum light level varies according to the applications[3]. The day light transmittance with IR & UV rays. Without daylight controllable devices, too much of daylight increases the solar heat transmittance into the building. Hence increases the A/C load & consumes more electricity. The available systems control only the electrical lighting in the building according to the reducing of daylight transmittance due to the varying of sky conditions. These systems either switch on/off the entire electrical lights or partially switch on/off in steps according to the

reducing of daylight transmittance. It is important to research on a new concept which can harvest daylight efficiently base on an optimum level without releasing harmful IR & UV rays to the environment.

2. METHADOLOGY

The RIVI ASINI research was carried out focusing the go green concept. The system was implemented according to the prototype methodology. In the prototype methodology it performed the analysis, design and implementation phases concurrently and all three phases are performed repeatedly in a cycle until the system is completed.

Analysis

Background study has been carried out on existing daylight harvesting systems to identify the features, advantages and drawbacks of existing daylight harvesting systems. The target users were garment/textile manufactures where very high usage of electrical lights to achieve higher desired illumination levels (450-500LUX) as backup lighting. Office buildings, schools and warehouses, where there is a need of low illumination levels (e.g. 200-300LUX).

Design and Implementation

To design the system prototype object oriented approach was used. As shown in figure 2, system architectural diagram, the system was implemented based on three main modules.

a) Database
b) Web Application
c) Microcontroller

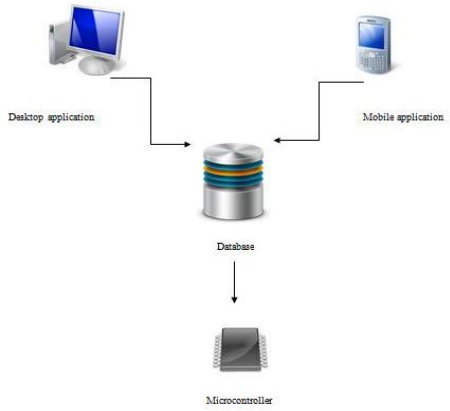

Figure 1: System Architecture Diagram

Database

Database was implemented using MySQL . This is used to store user details and required light levels.

Microcontroller

Microcontrollers are programmable and small devices. It requires almost zero power to operate and there are so many varieties to suit every need. A microcontroller is used within the motor circuit. Microcontroller read the user entered light level and the signal from photo sensor. After that Microcontroller will generate signal according to data received and the signal will be send to dimming device and the panel controller. Louver position is change according to that signal. Microcontroller is programmed by using Assembly language.

Web Application

RIVI-ASINI, a web based system, which can access through PC or mobile. Web application is developed using language PHP and Java Script. Web pages are designed using HTML and CSS. The web application provides following functionalities.

- Change the desired illumination level.
- Switch on/off electrical lights section by section as and when required.

- Read the current illumination levels.
- Read the current desired illumination level.
- Change the illumination of the electrical lights according the user input value.

Testing

Functionalities of the system prototype have been tested using black box testing approach. Nearly using "RIVI-ASINI" Daylight harvesting system for 40x40 work space you can reduce your monthly electricity bill up to 20% .Since the system is in the prototype level it has not been tested in a real world scenario.

3. RESULTS

According to the empirical study conducted on existing daylight harvesting systems it has been found that daylight brings lesser amount of heat compared to the heat generated by electrical lights for the same illumination level. Due to this fact not only the saving of electricity by switching off the electrical lights when daylight is available, but also the A/C load is being reduced. Electrical lamps are being used to illuminate the building spaces in many industries & commercial buildings. Consequently they spent large electricity bills for the illumination of the building. Therefore they have chosen to use natural light for the purpose of building illumination during the daytime.

"RIVI-ASINI" is implemented to provide an efficient way to harvest daylight to the optimum level. The basic mechanism comprises of automated electronic dimming controller for diming/brighten of electrical lights, an automated motor controlled louver for the purpose of controlling daylight transmittance through the skylights into the building and light sensor to determine the illumination level at any moment which is coupled to a programmable microprocessor. The system is having an Electronic embedded system to obtain illumination levels throughout the day which is interconnected to a PC. There is also a web service with a graphical interface to change desired light levels, switch on/off electrical lights, etc.

"RIVI-ASINI", the component controller provides desired amount of daylight transmittance into the building by using an automated louver controller. Further when daylight reduces beyond the desired illumination level due to variation of sky conditions, dimming mechanism activates in order to brighten the electrical lights for compensate the reduced amount of daylight for the purpose of maintaining the desired illumination level. As the daylight transmittance improves to the desired illumination, electrical lights gets switched off automatically. In the event, excess daylight transmittance through the skylights into the building, the louver position changes automatically until the desired illumination level is maintained.

"RIVI-ASINI" has few technical and non-technical limitations as follows.

- To get efficient use of this system, system should be installed around a place where daylight can be easily reached.
- User can expect an efficient usage of this system between 8.00a.m – 5.00p.m.
- Efficiency of the system will depend on weather and climate.
- Initial cost to install the system will be high.

Even though weather and climate limitation cannot be resolved further research can be carried out on finding to implement the same system by using less cost devices.

4. CONCLUTION

In many countries around the world, Daylight Harvesting has already become a standard requirement of the Building Codes, especially for

new buildings but also more & more for refurbishments. Especially in Sri Lanka Daylight Harvesting Systems have become an essential requirement because of the fluctuations of the electricity charges & interrupt power supply due to lack of electricity. Therefore, Daylight Harvesting is a highly effective strategy for any country that faces peak demand problems.
Utilities can use Daylight Harvesting on a large scale to push down peak demand. Daylight Harvesting not used in many more places because most available systems are too complicated, too unreliable & too expensive: Planning requires special skills, installation takes too long and is too expensive. So the ***"RIVI-ASINI"*** Daylight Harvesting System was built for overcome those problems.

The system *"**RIVI-ASINI"*** is designed & developed by careful studying of the existing systems in order to achieve optimum daylight harvesting in energy efficient & user friendly manner. System provide an energy efficient daylight harvesting system while addressing above related industrial research areas & system provides effective energy efficient solution within the eco-friendly concept.

5. REFERENCES

[1] The relationship between GDP and electricity consumption in 10 Asian countries, Available: http://www.sciencedirect.com/science/article/pii/S0301421506003685, [Accessed: 02-03-2012]

[2] How sky conditions affect, Available http://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc49498/nrcc49498.pdf [Accessed: 11-03-2012]

[3] Lighting energy savings in offices using different control systems and their real consumption,Available: http://www.mendeley.com/research/systemlevel-modeling-for-economic-evaluation-of-geological-co2-storage-in-gas-reservoirs/, [Accessed: 05-03-2012]

[4] The Daylight Site, Available: https://www.cis.rit.edu/~cnspci/references/sarkar2008.pdf, [Accessed: 25-03-2012]

[5]Infrared Definition, Available: http://dictionary.reference.com/browse/infrared, [Accessed: 09-03-2012]

[6] What's Daylight Harvesting? Available: http://www.daytronicballast.com/Daylight_Harvesting.php, [Accessed: 21-03-2012]

[7] Lighting Controls: Reducing Cost, Saving Energy, Available: http://www.facilitiesnet.com/energyefficiency/article/Sensing-Success-in-Lighting-Controls--8086, [Accessed: 16-03-2012]

[8] Why do DAY LIGHT harvesting Systems fail or succeed, Available: http://www.automatedbuildings.com/news/aug07/articles/zing/070723051101dilouie.htm,[Accessed: 26-03-2012]

[9] Ballast having a dimming device, Available: http://www.google.com/patents/US733000, [Accessed: 18-03-2012]

[10]Acrylic sheets prices, Available: http://www.alibaba.com/showroom/price-acrylic-sheet.html, [Accessed: 09-03-2012]

[11]Understanding Variable Speed Drives (Part 2), Available: http://ecmweb.com/mag/electric_understanding_variable_speed_3/,[Accessed: 20-03-2012]

[12] Measured energy savings due to photocell control of individual luminaires, Available: http://lrt.sagepub.com/content/31/1/19.abstract, [Accessed: 23-03-2012]