Technology Based E-Management System

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Abstract: A design, implementation, and testing of a proposed Technology Based E-Management system at the Department of Electrical Engineering-Ajman University of Science and Technology (AUST), UAE, is presented. It is a PLC-Based E-Management System (EMS) which gives better management of space usage, financial resources and lower power consumption if deployed. Implementation involved both hardware and software elements; Delta PLC and Ladder Logic. In this paper, a comparison between the proposed system with an existing system running at 40% off-time rate is presented. It was found that, relying on this technology does not only save energy, but also reduce manpower provided that a skilled operators are assumed to be available to run such a system.

Keywords: *AUST, E-management System, PLC-Ladder Logic, Ecological footprint.*

1. Introduction

Humanity's ecological footprint has exceeded earths ecological capacity through the degradation of the earth minerals and resources. Better management of space usage, financial resources, lower power consumption will reduce our impact on the environment.
In this paper, a comparison between a proposed EMS system with an existing system running at 40% off-time rate was investigated. Energy saving was of the main concern. The developed software can provide a skilled user with a leverage to access the database and modify the settings online while the system is running. A master shutdown switch for safety as well as manual operation mode are provided by the software. Higher management can also benefit from the data provided by the proposed system. Full integration of the proposed system with the air conditioning system is to be studied in the next phase. Deployment of such system in a large public areas, schools, universities, ministries, etc., will result in cut of operational expenditure (manpower and energy consumption), therefore, it is highly recommended.

2. Methodology

Energy saving is the main concern of Ajman University of Science and Technology. At one stage, replacing the light tubes Fig.1,a, with power saver shown Fig. 1, b and c was considered as an option. The initial cost had heavy impact on the budget and as a result this option was phased out.

Fig. 1. Fluorescent Tubes, a. TL-D 18W/54-765 ISL,
b. Master TL-D Power Saver Set 12=18W/830 ISL, c. Master TL-D Eco 16W/830 ISL.

Searching for other alternatives such as a tight monitoring of workers proved to be inefficient due to human errors that are unavoidable, this option was also discarded. Finally, The feasibility of integrating technology was investigated, that led to the proposed E-management system. In the following section, a brief description of the technology used as a back bone of the proposed system, that is the PLC.

The development of low cost computer has brought the most recent revolution, the Programmable Logic Controller (PLC). The advent of the PLC began in 1968 [2,3]. PLCs are solid-state members of the computer family, using integrated circuits instead of electromechanical devices (relays) to implement control functions. They are capable of storing instructions, such as sequencing, timing, counting, arithmetic, data manipulation, and communication, to control industrial machines and processes. PLCs can be used in every aspect of industry from power generation to automobile painting to food packaging. The widely used language in designing a PLC program is the Ladder Logic (open source). Different type of PLCs is depicted in Fig. 2,a.

Fig. 2. a. Different type of PLC, b. Human Machine Interface (HMI) unit.

The proposed E-management system comprises three units: DVP- SX PLC [5], input units (DOP-B HMI and sensors) Fig. 2,b, and output units (DOP-B HMI, indicators) as shown Fig. 3.

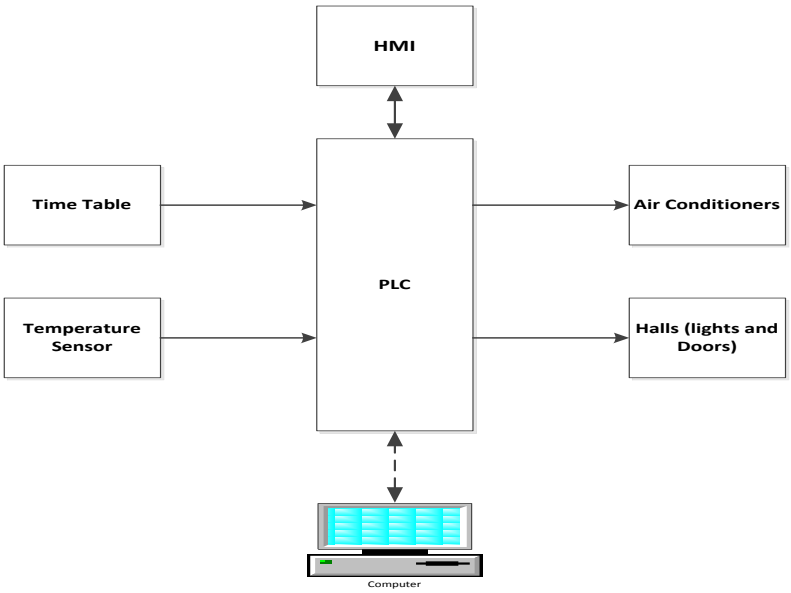

Fig.3. Proposed E-management system EMS.

As the PLC is the heart of the system. The functionality of this controller is achieved through loading, via PC, with appropriate code [4]. Once the PLC is loaded and the program within is

running, the I/O units are used to communicate with the PLC and HMI. Analog temperature sensors are used to give indications to the PLC about the status of the Halls. The output units are interfaced with the PLC. Once the main switch is activated the program will start running and controlling the lights, doors, and the air conditions of the halls according to the time table of the chosen semester.
Testing of the system involves different test scenarios. The sensors circuits were tested and modified to suit the PLC in terms of voltage and current levels. The program was written and traced to satisfy all semester time tables in college of engineering at AUST. All tests gave positive results indicating a fully functional and efficient system.

First, the user has to enter a 4 digit password of different accessibility levels shown in Fig. 4. Security is provided so that after three trials of faulty password the system will issue an alarm.

Fig.4. Password screen

If the user enters a lower security level password then he/she can monitor the status of the halls only (temperature, light, doors lock) without the ability of controlling any of the settings as shown in Fig.5, a,b.

Fig.5. a. Home screen, b. Hall 201

Second, if the user enters a higher security level password then he/she can monitor the halls, controlling the settings and activating or deactivating the controlled parameters at the same

time. Master shutdown switch for safety in case of emergency is provided for the operator with this authority.
Manual setting for all features of the system is granted for the user inside the hall.
Finally, by choosing desired semester Fig. 6,a, the ladder program will run with the time-table of the selected semester. A sample of lectures runs in Hall 201 on Monday is shown Fig. 6,b. The output can be easily monitored by HMI. Switching between pages can easily be done by pressing the desired icon on the screen.

Fig.6. a. Semester, b. Time table in hall 201

3. Results

The testing of the system involves different scenarios. Regular energy consumption of the light in 5 halls of the college of engineering at AUST is shown in the table 1. The data provided in this table represents the existing light tubes and their power consumption based on the Fall semester schedule at AUST.

Table 1. Power consumed by regular light tubes

Hall/Day	*201*		*202*		*203*		*204*		*205*	
	No. of lights 48		*No. of lights 56*		*No. of lights 56*		*No. of lights 56*		*No. of lights 56*	
	L.T 18W/h*	*Cons. kW/8.5h*	*L.T* 18W/h*	*Cons. kW/8.5h*	*L.T* 18W/h*	*Cons. kW/8.5h*	*L.T* 18W/h*	*Cons. kW/8.5h*	*L.T* 18W/h*	*Cons. kW/8.5h*
	864	*7.34*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*
Mon	*864*	*7.34*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*
Tue	*864*	*7.34*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*
Wed	*864*	*7.34*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*
Thu	*864*	*7.34*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*	*1008*	*8.56*
Weekly cons. kW	*36.72*		*42.84*		*42.84*		*42.84*		*42.84*	
Monthly cons. kW	*Total weekly*4 + 2*Total/5* *915.552kW*									

Fig. 7. represents a comparison of power consumption of regular lights, EMS system, two types of power saver fluorescent lamp and the combination of EMS and power saver

fluorescent lamp according to the total power consumption per month. The chart clearly indicates that by using the proposed system, a considerable saving has been achieved. As a result of using the EMS, the university can save up to 380.8 kW which is 41.6% of the regular power consumption per month.

An optimal solution for power saving could be achieved by combining both the proposed EMS and the power saving fluorescent light tubes (MASTER TL-D Power Saver Set 12=18W/830 ISL). The University can save up to 542.99 kW/month which is 59.3% of the power consumed in the existing lights tubes.

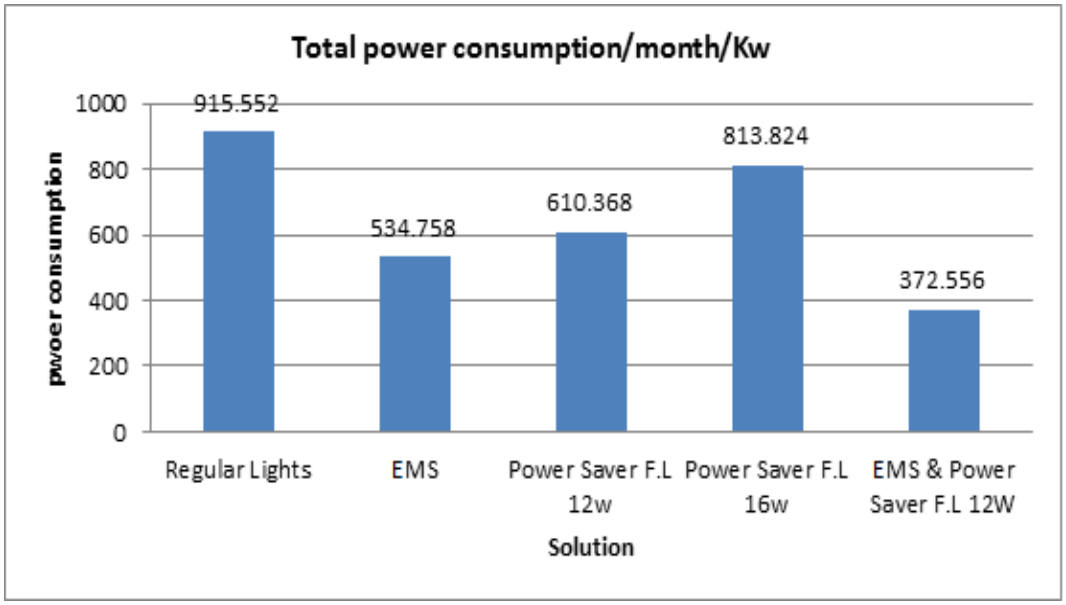

Fig.7. Total power consumption per month

On the other hand, Fig. 8. shows a comparison between the 40% of the OFF time rate (no lectures) is actually OFF and proposed system indicates the extra saving in power consumption that can be achieved.

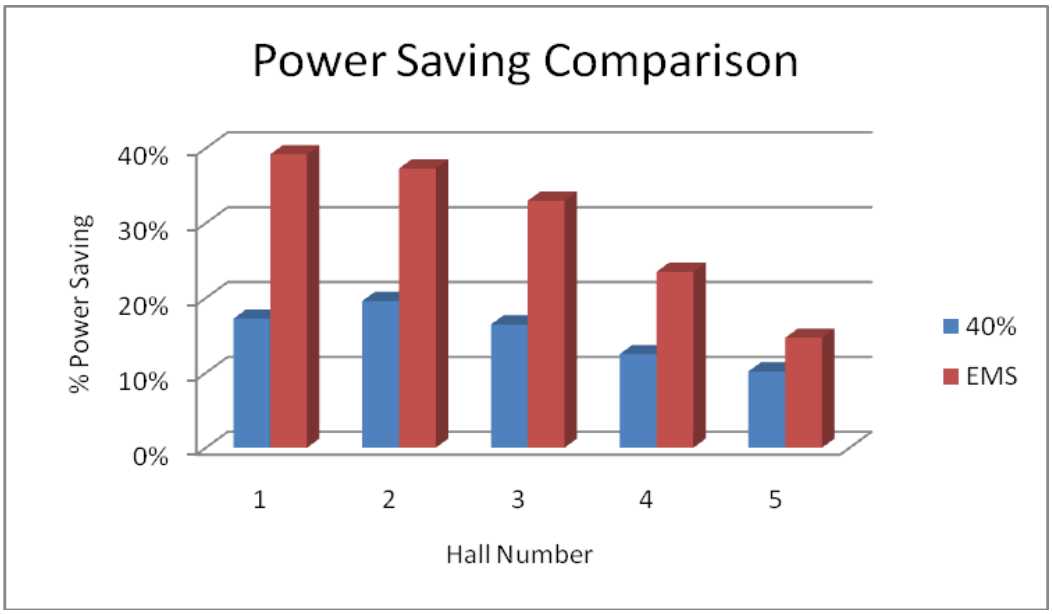

Fig.8. Power saving comparison

4. Discussion and/or Conclusions

This paper has presented the design, implementation, and testing of a PLC-based E-Management system at College of Engineering-Ajman University of Science and Technology, UAE. The system operated properly when tested under various conditions. The hardware and software components used in this project provided an economic solution to the implementation of the E-Management system. Further reduction in cost could be achieved if the infrastructure was considered during the construction phase of the building.

The system was cost effective. The system however, requires that a skilled operators are available for operation. Implementing this system will reduce cost in the long term.

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