UNIVERSITI PUTRA MALAYSIA

STANDBY MODE MINIMIZATION FOR EFFICIENT BUILDING MANAGEMENT SYSTEM USING FUZZY LOGIC

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By

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Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirement for the Degree of Master of Science

June 2015

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DEDICATION

After thanking to Allah Almighty and his last messenger Prophet Muhammad (PBUH). This thesis is especially dedicated to my parents and my younger sister.I would like to dedicate this project to my other beloved family members, all my supervisors and lecturers in the Department of Electrical and Electronic Engineering of University Putra Malaysia and friends. Their guidance, prayers and relentless support have been a great inspiration to the realization of this project.

Abstract of the thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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June 2015

Chairman : Mohammad Lutfi Othman, PhD, Ir
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In regards of smart and efficient energy management, many think that standby mode purely the solution in reducing the electrical usage. However, the standby mode of electrical appliances is also among one of the main factors that contributes to the electrical wastage as the appliances still consumes electrical energy during the standby operation. This research mainly focuses on creating a FES with a combination of image processing that minimize the standby mode and to evaluate the performance of the created dummy load system based by real-time lecture room case studies. The problem statement on energy wastage is strongly upheld by all previous studies done on this respective issue. The outcome of this research can be used to enhance the existing Building Management System (BMS) with the addition of standby mode minimization automation system. With this research, the standby mode of the electrical appliances can be automatically and manually controlled or minimized based on the desired fuzzy rules set by the feedback system of image processing intact by the system. The role of image processing in this system is as same as of occupancy sensor, but the role of camera image processing filters makes it feedback more precise. The controlling of the electronic devices like TV, LCD, Gaming consoles or mobile and laptop chargers are totally dependent on the presence of the user in the premises or for charging and discharging phenomenon load detection circuit is used in this proposed research. Overall the proposed research can be explained as the system is comprised of fuzzy logics and rules which are monitoring and controlling the power consumption of electronic and electrical devices. Whereas controlling and monitoring is done through GUI developed in Matlab and controlling and monitoring is done with sets of fuzzy rules with the feedback of image processing with the use of filters to make the feedback more accurate and precise for this purpose GAIT reorganization system. It addresses the main point of concern that is the minimization of the standby operation of electrical appliances.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

SIAP SEDIA PENGURANGAN MOD BAGI SISTEM PENGURUSAN BANGUNAN YANG CEKAP MENGGUNAKAN LOGIK KABUR

Oleh

WAQAR TARIQ

Jun 2015

Pengerusi : Mohammad Lutfi Othman, PhD, Ir
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Dalam hal pengurusan tenaga pintar dan cekap, ramai beranggapan bahawa mod siap sedia merupakan penyelesaian semata-mata dalam mengurangkan penggunaan elektrik. Walau bagaimanapun, mod siap sedia peralatan elektrik juga merupakan salah satu daripada faktor yang menyumbang kepada pembaziran elektrik kerana peralatan masih lagi menggunakan tenaga elektrik semasa operasi siap sedia. Kajian ini memberikan tumpuan utama dalam menwujudkan **FES** dengan gabungan pemprosesan imej yang meminimumkan mod siap sedia dan menilai prestasi model sistem beban semu berdasarkan kajian masa sebenar bilik kuliah. Kenyataan masalah pembaziran tenaga amat didukung oleh semua kajian yang dilakukan sebelum ini ke atas isu ini. Hasil daripada kajian ini boleh digunakan bagi meningkatkan *Building Management System (BMS)* yang sedia ada dengan penambahan mod siap sedia sistem peminimuman automasi. Dengan kajian ini, mod siap sedia peralatan elektrik boleh dikawal secara automatik dan secara manual atau boleh diminimumkan berdasarkan peraturan kabur yang telah ditetapkan oleh sistem maklumbalas daripada imej pemprosesan utuh oleh sistem. Peranan imej pemprosesan dalam sistem ini adalah sama seperti sensor penggunaan, tetapi peranan kamera penapisan pemprosesan imej ini menjadikan maklumbalas lebih tepat. Pengawalan alat-alat elektronik seperti TV, LCD, konsol permainan atau telefon mudah alih dan pengecas komputer riba adalah bergantung sepenuhnya kepada kehadiran pengguna di dalam premis atau fenomena untuk mengecaj dan menyahcaj litar pengesanan beban dalam kajian yang dicadangkan ini. Pada keseluruhannya, cadangan kajian boleh diterangkan sebagaimana sistem ini terdiri daripada logik kabur (*fuzzy logics*) dan peraturan yang memantau dan mengawal penggunaan kuasa alat-alat elektronik dan elektrikal. Manakala pengawalan dan pemantauan telah dilakukan melalui GUI yang telah dibangunkan di Matlab dan kawalan dan pemantauan dilakukan dengan mengeset peraturan kabur dengan maklum balas daripada pemprosesan imej dengan menggunakan penapis untuk menjadikan maklum balas yang lebih tepat bagi tujuan sistem penyusunan semula GAIT. Ia menunjukkan titik utama yang menitikberatkan peminimuman operasi siap sedia peralatan elektrik.

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Last but not lease, I am grateful to my family, who has been replenishing moral support every time I faced a problem. Besides that, I would like to thank my friends and course mates for spending their time and efforts when I am in need.

WAQAR TARIQ

I certify that a Thesis Examination Committee has met on 10 February 2015 to conduct the final examination of Waqar Tariq on his thesis entitled "Standby Mode Minimization for Efficient Building Management System Using Fuzzy Logic" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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INTRODUCTION

1.1 Background

Modern era is known as the age of energy efficient building either commercial or residential sector. Advanced engineering introduced many new technologies for this purpose as energy saving is a constant concern factor and a continuous work is done on this issue like Building management system (BMS), EBMS and many more technological setups which helps is saving energy to some extent. The purpose of a BMS is to automate and take control the energy related operations like electrical equipment's in the most efficient way. That makes it possible for the consumers to save energy and gets economical perks as well as can full fill their social responsibility.

1.2 Energy Saving Systems

As modernization goes on many newer systems of saving energy are introduced, which are quite successful till some extent, not only systems many campaigns are also supporting these systems by giving awareness and a sense of responsibility to both commercial and residential consumer to make sure minimum wastage of energy at their end.

Wastage of energy may occur of many factors, for example, distribution losses, human negligence, and one of the most important factor which is a hurdle in the way of zero energy buildings that is standby mode loss, also known as phantom load, vampire load or leakage current. So far many procedures and systems are present to overcome these factors, but a continuous development is always needed to attain maximum results.

One of the systems is BMS, which monitor and control services such as heating, ventilation, air-conditioning, lighting, security, and switching, ensuring that operation are at the maximum level of efficiency and economy. This is achieved by maintaining the optimum balance between environmental conditions, energy usage and operating requirements.

The BMS is a "standalone" computer system that can calculate the pre-set requirements of the building and controls the connected load to meet switching, monitoring and controlling needs. Its inputs, such as motion, temperature, light sensors and outputs, such as on/off signals are connected into the main system, server or controlling unit around the building. Programs in the respective system, server or controlling unit use the information to decide the necessary level of applied control.

The level of control via the BMS is dependent upon the information received from its sensors and the way in which its programmers tell it to respond to that information. As well as offering a precise degree of control to its environment, it can be made to alarm on conditions that can't meet specification or warn of individual items of load fail, the whole BMS process is divided floor to floor and load to load and then connected to main control and monitor panel.

Occupancy times for different areas are programmed into the BMS such that the plant is brought on and off to meet the occupational requirements. These times are often under optimum start control. This means that the heating plant is enabled, at a varying predetermined time, to ensure that the heated space is at the set desired temperature for the start of the day. The BMS therefore, based on the outside air temperature the space temperature and the building structure, determines the plant start time.

1.3 Problem Statement

To overcome the wastage factors such as phantom load or standby mode wastage automation is required. This is the era of computer networking, automation and optimization which make possible to solve any sort of troubleshooting remotely anywhere any time. There is a general thinking that standby mode in electronic devices is purely the solution for minimizing the electrical usage. However, in reality the standby mode of electrical appliances is also among one of the main factors that contributes to the electrical wastage as the appliances still consumes electrical energy during the standby operation. Roughly estimated 10 to 15% consumption of electricity is still there during the standby mode. This consumption is usually termed as phantom load, vampire load or leaking electricity (Tariq, Mustafa & Rasool, 2012).

As aforementioned, the power wastage factors, i.e. human negligence, and phantom load or standby wastage are the key concern toward the zero energy buildings. Zero energy cities are the real future and the final goal concerning energy in the building sector. To achieve such cities the highlighted wastage factors should be addressed.

1.4 Objective

This research will try to emphasize on limiting the use of electricity in a particular building by the mean of developing a prototype i.e. dummy load. An operational feature like Periodic controlling, automation of the devices/appliances will be the main target of the research will be the minimization of standby mode. The main target is to overcome the issue of human negligence in wasting electrical power. Elaborating it further objectives of the research can be laid as.

1. Developing a BMS prototype to test a monitoring and controlling system which may help to control switching of connected load in a periodic manner to avoid after use power wastage.
2. To develop a controlling program to minimize standby mode/ phantom load, by using the tool of image processing and fuzzy logic.
3. Synchronize the standby mode minimization program with the developed BMS prototype for monitoring and controlling.

1.5 Scope of Work

The research will be oriented on a dummy load which will be used to show the usage of particular equipments used in a building such as air conditioner, lighting system, and multimedia equipments which will be attached to a DAQ and then to a controlling and

monitoring unit on a computer, on which monitoring and controlling will be done by constructing a GUI on Matlab then by using fuzzy logic and image processing controlling will be done. The aim of this research is to develop a technique to ensure minimum use of standby mode and make sure that there is no power loss of devices after the particular time period of use.

1.6 Thesis Layout

This thesis is composed of five chapters.

The first chapter is the introductory chapter and it provides basic background of the study, problem statement, objectives, and scope of the work.

Chapter 2 provides the review and analysis of different type of power wastage, its factors and effect. This chapter also provides an explanation of several previous research works on BMS. It also discusses all the previous techniques used in BMS technology, i.e. controlling and monitoring methods. Discussion about different type of devices, equipment's used in setting up BMS. Standby minimization, phantom load factor and its prevention techniques and comparison with proposed technique also discussed in this chapter.

Chapter 3 presents the methodology and research design to achieve the objectives of the proposed research.

Chapter 4 presents the results and findings on voltage; current and power monitoring base .This chapter also presents comparative survey results in order to prove they obtained results satisfy the benchmark. Survey results consist of power consumption, power wastage and tariff.

Finally, Chapter 5 concludes this research. BMS Design using fuzzy logic is the most suitable technique, when to avoid energy losses occur in building power consumption also this technique is effective to reduce losses because of standby mode, fuzzy logic and image processing offer low power consumption and Design simplicity. The Contributions of this work are also stated and ideas for future development of the BMS Technology design are suggested for respective target oriented usage.

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