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# بسم الله الرحمن الرحيم

مركز الشبكات وتكنولوجيا المعلومات

قسم التوثيق الإلكتروني



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# جامعة عين شمس

التوثيق الإلكتروني والميكرو فيلم

## قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها  
على هذه الأقراص المدمجة قد أعدت دون أية تغيرات





Cairo University

# **DEVELOPMENT OF A UNIFIED CONTROL ALGORITHM FOR DEMAND RESPONSE BASED HOME ENERGY MANAGEMENT SYSTEM**

By

**Momen Samy El-Agamy**

A Thesis Submitted to the  
Faculty of Engineering at Cairo University  
in Partial Fulfillment of the  
Requirements for the Degree of  
**MASTER OF SCIENCE**

in

**Electrical Power and Machines Engineering**

FACULTY OF ENGINEERING, CAIRO UNIVERSITY  
GIZA, EGYPT

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**DEVELOPMENT OF A UNIFIED CONTROL ALGORITHM FOR DEMAND SIDE  
BASED HOME ENERGY MANAGEMENT SYSTEM**

**Key Words:**

Smart Grid, Home Energy Management Systems (HEMS), Demand Request Event, Appliances Load Profile, Appliances Scheduling, Load shift.

**Summary:**

This thesis presents the various control methodologies of home energy management systems (HEMS) in previous literature as part of demand response programs in smart grid systems, this is done by categorizing the HEMS various techniques and clarifying the differences between them. In addition, modeling and simulating each category have been implemented in MATLAB/Simulink environment to evaluate each algorithm based on a suggested residential load profile. A new unified control algorithm is proposed and adopted to show its advantages over the preceding types of HEMS algorithms. Appliances load models have been developed using the MATLAB/Simulink environment that will assist in evaluating each algorithm and comparing their results.

## Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

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## ACKNOWLEDGEMENTS

First of all, thanks for Allah for giving me the strength and persistence to finish my studies for the master of science degree.

I would like to express my gratitude and deep appreciation to my supervisor **Prof. Dr. Ahmed Bahgat** for his personal and technical support and helpful guidance through my years of study and through the process of researching and writing this thesis.

Special thanks to **Prof. Dr. Hassan Rashad** for her helpful advices and for providing me with useful tips throughout the research work.

Furthermore, I would like to thank **Prof. Ahmed Besheer** for introducing me to the topic as well for the support on the way, for useful comments, remarks and engagement through the learning process of this master thesis. The door to him was always open whenever I ran into a trouble spot or had a question about my research or writing. He consistently allowed this thesis and paper to be my first academic remarkable work, but steered me in the right the direction whenever he thought I needed it.

I must express my gratitude to my family for their encouragement to me through my studies and my life.

I must express my very profound gratitude to my brother and my superior in Schneider Electric Egypt **Eng. Sameeh Ahmad El-Naqr** for providing me with unfailing support, and for helping me get through the difficult times. He was more than a friend and a brother without whom this accomplishment would not have been possible.

Finally, it is difficult to overstate my gratitude to my friend and brother **Eng. Ahmed Naguib El-Sheikh**, he is and was always my role model who have taught me a lot in my professional and my personal life, and for being a valued person in my life.

Thank you.



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# Nomenclature

HEMS:	Home Energy Management System
DR:	Demand Response
WH:	Water Heater
AC:	Air Conditioning
CD:	Clothes Dryer
EV:	Electric Vehicle

# ABSTRACT

The recent energy efficiency and conservation programs has created an unprecedented demand for home energy management systems (HEMS) in residential sector to reduce electricity consumption and hence conserve electric bills.

In this thesis, a proposed unified control algorithm is presented that targets to manage the home appliances' hourly power operation in a daily basis. The proposed algorithm is generic in the sense of getting the ability to achieve three different objectives for the electricity generation and distribution utility/customer dual benefits. Range of constraints such as load priority, customer preferences, demand response limit signal (utility request) and utility tariffs' pricing are taken into consideration. The ultimate goal of this algorithm is not only to curtail or control the appliance load power but also to shift it to better pricing period based on different tariff rates. The results reflect the effectiveness of the proposed algorithm that extends the previous results in literature by considering wider range of limitations applied on HEMS simultaneously.

In this context, firstly the main objectives of the demand response principle and its role in the energy conservation procedures are discussed as a one of the major mechanisms in the demand side management approach. Then, the general definition, goals and methodologies of HEMS are given. Moreover, the technical strategies developed and different algorithms in the literature are also presented.

The development of the load profile used in this thesis is presented to test the effects of each algorithm, the results of each algorithm is discussed showing their drawbacks. The proposed unified control algorithm is then implemented on the same load profile to show the difference and its paybacks over the traditional algorithms. Test results are presented and discussed with the help of illustrative figures and curves.